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ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH BHUBANESWAR

Techno Campus, Ghatikia, PO: Mahalaxmi Vihar, Bhubaneswar-751029
Odisha, India

OUTR RESEARCH CONCLAVE 2025

February 28, 2025

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH BHUBANESWAR

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Odisha, India

OUTR RESEARCH CONCLAVE 2025

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सत्यमेव जयते

RAJ BHAVAN
BHUBANESWAR-751008

February 17, 2025

Dr. Hari Babu Kambhampati
Governor, Odisha

Message

I am glad to know that Odisha University of Technology and Research (OUTR), Bhubaneswar is organising the OUTR Research Conclave-2025 on February 28, 2025, providing a dynamic platform for academicians, technocrats, and young researchers to exchange ideas -edge and interdisciplinary and showcase advancements in cutting research. A souvenir-cum-proceedings is also being brought out on the occasion.

Innovation and research are the cornerstones of progress, driving technological advancements and addressing contemporary challenges. This conclave will not only facilitate meaningful discussions but also inspire young minds to explore new frontiers of knowledge and contribute to scientific and technological development. The participation of research scholars from various universities and institutes will foster collaboration, encouraging a culture of inquiry, creativity, and excellence.

I commend OUTR for this initiative, which will undoubtedly play a significant role in shaping the future of research and innovation. May this event inspire groundbreaking research for the greater good of society.

I wish the Research Conclave 2025 and publication all success.

(Hari Babu Kambhampati)

Phone: 91-674-2536111/2536222, Fax: 91-674-2536582, E-mail: govodisha@nic.in, Website: www.rajbhavanodisha.gov.in

SHRI SAMPAD CHANDRA SWAIN
MINISTER OF STATE (Ind. Charge)
Industries, Skill Development &
Technical Education, Odisha

Phone: Office : (0674) 2530650
EPABX : 2322197
Res. : (0674)-
Assembly : (0674)-
Email: minind2024@gmail.com

D.O. No...../MoS(I)ISD&TE.
BHUBANESWAR

Date: 13.02.2025

Message

It gives me immense pleasure to know that Odisha University of Technology and Research, Ghatikia, Bhubaneswar is going to organize the OUTR Research Conclave on 28th February 2025 and a Souvenir-cum-Conclave Proceeding is being published on this occasion.

This conclave aims to provide a forum for distinguished academicians, technocrats and young innovative researchers to share their expertise in research on the latest developments in cutting edge technology and inter-disciplinary fields. It is matter of great satisfaction that the University since its establishment has rendered commendable contribution and has produced so many eminent scholars. I hope the University will keep its high academic standard in future.

I wish the Conclave-2025 and publication of the Souvenir all success.

(SAMPAD CHANDRA SWAIN)

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH
Techno Campus, Ghatikia, PO: Mahalaxmi Vihar, Bhubaneswar-751029
Odisha, India

Date: 18.02.2025

Prof. B. B. Biswal
Vice Chancellor &
Patron,
OUTR research Conclave - 2025

Message

It gives me immense pleasure to know that Odisha University of Technology and Research (OUTR) is going to hold its first Research Conclave meet on 28th February, 2025. This is going to be a historic day as the research scholars, faculty, and students shall be a part of the first of its kind event organized by OUTR.

Research has played a pivotal role in shaping today's society. Research today is not confined to disjoint boxes but demands collaborative contributions from researchers in diverse fields to deliver truly effective solutions to the real-world problems. The explosion of information and dissemination of knowledge to every nook and corner of the world have opened the doors to a multitude of research opportunities in all fields. Breakthroughs and innovations in the field of technology have played a crucial role in transforming altogether today's world as a whole. It is, therefore, essential to keep abreast of a rapidly changing scenario in the developments taking place in various facets of technology and come up with new ideas to envision a better tomorrow for all.

Since its inception as a University in 2021, OUTR is committed to imparting quality education, extensive research, and innovation in technology. The sole objective of this Conclave is to bring all researchers, faculty, and students under one umbrella where they showcase the progress of their novel work, share and discuss ideas, propose innovative solutions to existing problems, and deliberate upon a multitude of topics to provide a common platform for sustainable development.

I earnestly hope that this conclave will prove to be extremely fruitful and useful for all participants, furthering new paradigms of research and ushering in an ambience of growth driven by technological innovations and research.

I wish the conclave a grand success.

(Prof. Bibhuti Bhusan Biswal)

Prof. A. N. Acharya
Dean, Academic Affairs &
Convenor,
OUTR Research Conclave - 2025

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH
Techno Campus, Ghatikia, PO: Mahalaxmi Vihar, Bhubaneswar-751029
Odisha, India

Message

Date: 15.02.2025

The Odisha University of Technology and Research (OUTR) was established as a Unitary Public University on 8th October 2021 through the Odisha University of Technology and Research Act, 2021 (Odisha Act 17 of 2021), Skill Development and Technical Education Department, Government of Odisha. It may also be mentioned that this University was established by upgrading the College of Engineering and Technology (CET), Bhubaneswar, which was established in 1981. The University, OUTR, started functioning since 8th October, 2022.

The University offers 15 Undergraduate programs and 28 Postgraduate programs in various disciplines of study such as Engineering, Architecture, Planning, Science, and Management for the students of Odisha. At present, 5070 students are pursuing their studies in these programs.

Dr. APJ Abdul Kalam, the 11th President of India, an eminent scientist and visionary leader, once said *"The ignited mind of the youth is the most powerful resource on the earth, above the earth, and under the earth*."

For better exploitation of these powerful resources, the University takes the solemn opportunity to organize a **Research Conclave 2025** for the first time on February 28, the day **National Science Day** is celebrated in India every year to mark the discovery of the Raman effect by Indian Physicist Sir C. V. Raman on February 28, 1928.

The objectives of the research conclave are to bring together young, budding researchers, scholars, and students from various academic disciplines to exchange ideas, present their research findings, and explore interdisciplinary research. It will serve as a dynamic platform for the young minds to converge, collaborate, and overcome the challenges using the best opportunities. It has rightly been said that discovery is a journey, not a destination, and that every question answered opens the door to new mysteries. As we embark on this journey of discovery and intellectual exchange, let us keep in mind the impact of our collective efforts. The insights and innovations shared here have the potential to shape not just the future of science and technology, but the future of society as a whole.

On behalf of the University, I congratulate all the participants, particularly students and young researchers, for their enthusiasm to make it a success. In addition, my heartfelt thanks to all the committee members, authorities and staff members of the University for their valuable support to let the dream become a real vibrant event.

AAcharya

(Prof. A. N. Acharya)

Prof. (Dr.) P. K. SATPATHY
Professor,
School of Electrical Sciences and
Dean,
PGS&R- Organising Secretary

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH
Techno Campus, Ghatikia, PO: Mahalaxmi Vihar, Bhubaneswar-751029
Odisha, India

Date: 18.02.2025

Message

The **Research Conclave-2025** is being conducted in **Odisha University of Technology and Research, Bhubaneswar** with an objective to create an open platform for the Research Scholars, Academicians, Researchers, Scientists, persons from industries, R&D organizations and various other stake holders within and outside of the State of Odisha, for promotion of quality research through exchange of technology and ideas.

I am hopeful that the Research Conclave-2025 will be instrumental in opening various avenues for extending the research outcomes for the benefit of the society as well, through deliberations, poster presentations, invited talks, mutual discussions and interaction.

(Prof. (Dr.) P. K. SATPATHY)

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CONTENTS

An alternative synthetic approach for the construction of Ensifentrine analogues and its highly potent derivatives

Abasaheb Gaikwad, Pramod V. Chavan, B.R. Das*

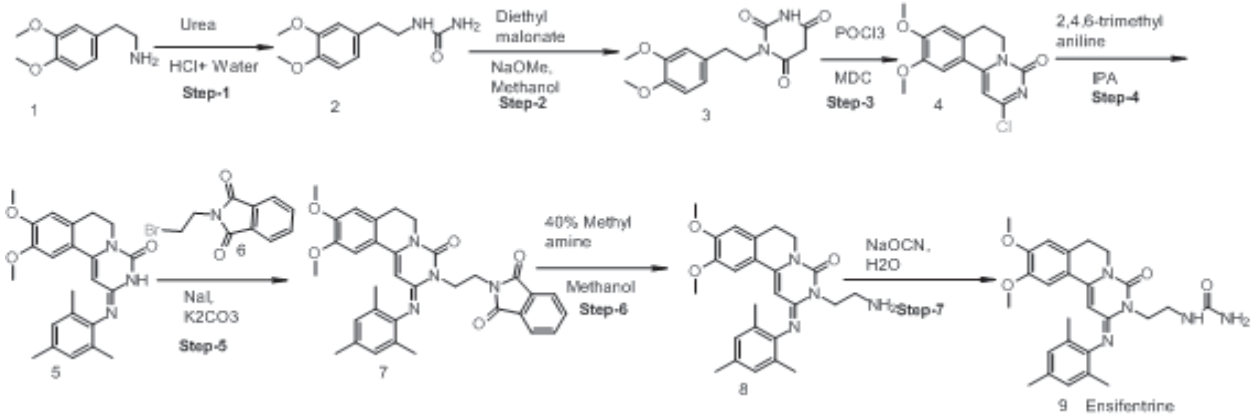
School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: brdas@outr.ac.in

Introduction: An alternative synthetic approach has been developed to access novel Ensifentrine analogues,providing a practical and cost-effective route to construct this privileged scaffold along withits amide derivatives, which may possess promising COPD properties. This strategyemploys less expensive reagents, readily available precursors, and a streamlined pathwaywith fewer intermediary steps, ensuring high yield and efficiency. Unlike traditional syntheticroutes, this method avoids unnecessary regeneration of intermediates and limits the use ofcostly, metal-catalyzed coupling reactions. The designed multi-step procedure forsynthesizing these Ensifentrine derivatives is both affordable and efficient, incorporatingaccessible reagents and catalysts. Furthermore, the approach was extended to create variousamide derivatives with diverse functional groups, each potentially offering distinct biologicalactivities. This expanded functionality may increase the therapeutic versatility of theEnsifentrine analogues, contributing to broader COPD potential.

Materials and Methods: Compared to previousmethods, this synthesis is notable for its simplicity, reduced reagent costs, and fewer reactionsteps. In summary, this innovative synthetic route provides an accessible and efficientpathway to produce high-quality Ensifentrine analogues with promising biological applications.

Results and Discussion:



Conclusion/Recommendation:

In summary, we have designed an alternative synthetic route to access a series of novel Ensifentrine derivatives. The method demonstrates easily affordable multi-step procedures that involve less expensive and readily available reagents and catalyst, leading to the targeted Ensifentrine analogues in good yields. In comparison to the other synthetic procedure, the present method avails a promising choice by avoiding the regeneration of the intermediates and excessive use of metal-catalyzed coupling reaction.

Keywords:

Ensifentrine analogues, Phosphodiesterase 3 and 4 inhibitor, Cost-effective method, Amide derivatives, Metal-free synthesis

LaFeO*ƒ* Perovskite Nanomaterials: Synthesis, Characterization and Photocatalytic Applications

Aditya Rana, Sonali Mohapatra, Jyoti Prakash Dhal* and B.R.Das

SchoolofBasicSciencesandHumanities,
OdishaUniversityofTechnologyandResearch,Bhubaneswar-751029,Odisha,India

*CorrespondingauthorE-mail:jyoti84.chem@gmail.com

Introduction: Withgrowingenvironmentalconcernsinrecentyears,photocatalysishas gained significant attention as a promising strategy for addressing environmental pollution. Perovskite oxide materials have emerged as potential photocatalysts due to their unique structural and electronic properties. Perovskites are a major class of catalysts with the general formula ABO_3, whereA represents arare-earth element andB isa 3d transition metal. Previous studies have demonstrated that nanosized perovskite powders can be synthesizedusing the combustion method, which offers a simple and efficient route for producing nano-sized $LaFeO_3$ particles. In this study, we investigate the synthesis of $LaFeO_3$nanocrystals and evaluate their photocatalytic performance in dye degradation applications.

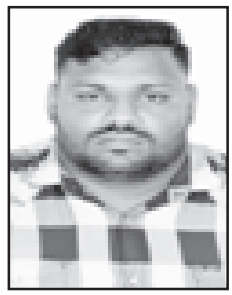
Materials and Methods: All reagents used in this study were of analytical grade and were employed without further purification. Initially, stoichiometric amounts of lanthanum nitrate [$La(NO_3)_3{\cdot}6H_2O$] and iron nitrate [$Fe(NO_3)_3{\cdot}9H_2O$] were dissolved in distilled water under continuous magnetic stirring. Subsequently, 1NHNO_3 was prepared and added to the mixture. Glycine, serving as a fuel, was then introduced in an appropriate ratio, and thesolution was stirred magnetically for 5 to 6 hours while maintaining a constant temperature.The resulting $LaFeO_3$nanoparticles were obtained in powder form and subsequently calcinedat 500 °C for 2 hours to enhance crystallinity and phase purity.

ResultsandDiscussion: Afterthecalcinationprocess,thesynthesized$LaFeO_3$was employed as a photocatalyst for the degradation of various dyes in a photocatalytic reactor. Indigo carmine and malachite green dye was selected for degradation. A 100 PPM solution of both dyes were prepared by dissolving 0.1 g of the dye in distilled water. Then, 0.05 g of $LaFeO_3$nanomaterialwasaddedto100mlofthedyesolutionandsubjectedtovisiblelight irradiation in a 150W UV-visible photoreactor for 180 minutes. The degradation process was monitored at regular intervals of 30 minutes by recording UV-Vis spectra (i.e., at 30, 60, 90, 120, 150, and 180 minutes). The results indicated that malachite green was almost completely degraded after 180 minutes of exposure.

Conclusion/Recommendation: The$LaFeO_3$nanomaterialsynthesizedviatheauto-combustionmethodproved to be cost-efficient and highly effective for dye degradation applications. The study demonstratedthat $LaFeO_3$exhibits excellentphotocatalytic performance,makingita promising candidate forenvironmental remediation. The floral-like nanostructures composedof nanosheets further enhance its potential as an economically viable perovskite oxide for sustainable and efficient photocatalytic applications.

Keywords: $LaFeO_3$;Perovskite;Photocatalyticdegradation;Malachitegreen;Indigo carmine.

Luminescent Lanthanum Quantum Dots as High-Performance Sensors for Anions and H, O, Detection



Amit Sahoo, Achyuta N. Acharya*

School of Basic Sciences & Humanities (Chemistry), Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India.

*Corresponding author E-mail: Achyuta N. Acharya, aacharya@outr.ac.in

Introduction: Quantum dots (QDs) have attracted the attention of researchers in recent years because of their size-dependent optical and electronic characteristics, which have been used in lasers, solar cells, light-emitting diodes, nanoelectronics, optoelectronics, and quantum computation. Additionally, QDs exhibit chemoluminescence properties, which are used for sensing devices for a variety of analytes. Reactive oxygen species (ROS/RNS) are important in biological systems. Understanding how cells produce and channel H_2O_2 into particular signaling pathways is critical for understanding various diseases like cancer, heart disease, Alzheimer's, and aging. QD-based fluorescent chemosensors detect chemical species, including ROS and anions. This work is focused on developing QDs-based chemosensors for some anions and H_2O_2.

Materials and Methods: Lanthanum nitrate ($La(NO_3)_3.6H_2O$, AR grade, FINAR, India) and Sodium borohydride($NaBH_4$, Loba) were used for synthesis, with Millipore distilled water as a solvent.

A new method for synthesizing La QDs involves one-pot reduction of La^{3+} to La^0, resulting in QDs ranging from 2-6 nm in size. Various analytical techniques such as XRD, XPS, HRTEM, FESEM-EDS, PCCS, and UV-visible spectroscopy (DRS) were then used to characterize the QDs. The photoluminescence properties of La QDs and their potential as innovative optical anion chemosensors are investigated in this work. Anions with varying structures and affinities were used in this study: F^-, Cl^-, $C_2O_4^{2-}$, CO_3^{2-}, HPO_4^{2-}, Br^-, BrO_3^-, and $OH^-$and H_2O_2 (a major ROS).

Results and Discussion: The d-spacing of La QDs is calculated from the XRD peaks at ë=0.15406 nm using Brag's equation. The synthesized La QDs are compared with the PDF data from the International Centre for Diffraction Data. The PDF data file No: 96-900-8526 (La_4, Hexagonal), 96-900-8504(La_2, Hexagonal), and 01-089-2913(La, Cubic) are used to determine the Miller indices. Seven peaks between 29° and 45° in the PXRD data show the amorphous nature of the La QDs, which agrees with the PDF data confirming their composition. The EDS data established 100% purity of the synthesized La QDs. The HRTEM and FESEM data supported the La QDs' small, spherical, homogeneous shape with the size between 2 to 6 nm diameter. The La QDs exhibit two band gap energies of about S 3.26 eV and ~ 4.66 eV, indicating that it is a mixture of two (binary) semiconductors. The luminescence intensities of the La QDs are sensitive to the interaction with various anions and H_2O_2, indicating that it can be considered a suitable sensor for the latters. At 315 nm and 440.5 nm, the Stern-Volmer equation fitted to the variation in emission intensity of La QDs on interaction with varying concentrations of anions and H_2O_2. The LOD and LOQ of H_2O_2 and anions sensing with La QDs have also been determined. The Langmuir binding plots and FTIR spectra supported the fact that surface functionalization of La QDs occurred during interactions with these anions.

Conclusion/Recommendation: La QDs could be considered as a better anion sensor for several anions, such as F^-, Cl^-, $C_2O_4^{2-}$, CO_3^{2-}, HPO_4^{2}, Br^-, BrO_3^-, and OH^-, with CO_3^{2-}being the most effective. They may also be able to detect ROS in biological systems by acting as H_2O_2 sensors.

Keywords: Quantum dots, chemosensors, lanthanum, H_2O_2, anions.

Generalization Of Optimization Technique With Analytical And Computational Methods For Solving Linear Programming Problem

Miss. Ankitapuja Pradhan* and P. K. MISHRA

School of Basic Sciences and Humanities (Mathematics),

Odisha University of Technology and Research,

Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: pankitapuja@gmail.com

Introduction: This work studies traditional simplex methods for solving Linear Programming Problems (LPP) and extends them by replacing multiple basic variables with non-basic variables per iteration, comparing the modified methods. A MATHEMATICA-based program was developed to apply these methods to large-scale real-life problems in the garment and textile industries. Additionally, a computational technique was designed to visualize the feasible region of two-dimensional LPPs for optimal solutions. The research also explores inventory management, analyzing deterioration, amelioration, and demand variations using exponential and Weibull distributions, while considering inflation's impact on stock replenishment.

Materials and Methods: To analyze and extend the traditional simplex methods, we developed new computational techniques that allow replacing multiple basic variables with non-basic variables at each iteration. The implementation was carried out using the MATHEMATICA programming language, enabling efficient handling of large-scale LPPs. The developed program was applied to real-life cases in the garment and textile industries, where large-scale optimization is crucial.

We also developed a visualization technique using MATHEMATICA to display the feasible region of two-dimensional LPPs. This technique not only provides an accurate depiction of the feasible region but also ensures the identification of the optimal solution. Furthermore, we analysed inventory models considering deterioration and amelioration. The study incorporates exponential and Weibull deterioration models under varying demand conditions and examines the effects of inflation.

Results and Discussion: Our computational experiments demonstrate that the generalized simplex method, which replaces multiple basic variables with non-basic variables per iteration, improves convergence speed compared to traditional methods. The application of this method to large-scale industrial problems shows promising results, optimizing resource allocation efficiently. The visualization technique developed using MATHEMATICA accurately illustrates the feasible region and assists in identifying optimal solutions for two-dimensional LPPs. This method provides an intuitive understanding of solution spaces, making it a valuable tool for decision-makers. Regarding inventory management, our study confirms that deterioration significantly affects stock levels over time. The analysis incorporating exponential and Weibull deterioration models under varying demand conditions highlights the importance of considering deterioration rates in LPP solutions. Furthermore, the influence of inflation on inventory replenishment strategies was studied, revealing key insights into cost-effective stock management.

Conclusion/Recommendation: The Simplex Method provides a systematic and reliable approach to solve linear programming problem with high accuracy. Unlike graphical methods, which are limited to two variable cases. The Simplex Method efficiently handles complex problems with multiple variables and constraints with high accuracy.

Key words: Linear Programming Problem, Simplex Method, MATHEMATICA, Inventory Management, Deterioration, Amelioration, Feasible Region, Optimization, Inflation, Large-Scale Systems.

Liquid-Liquid Extraction of Zirconium (Iv) from Nitric Acid Medium Using A Binary Mixture of Salicylic Acid and Cyanex 921 in Kerosene

Bhikari Charana Bhatta*

Department of Chemistry

Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India.

*Corresponding author E-mail: bcbhatta14@gmail.com

Introduction: Zirconium (with symbol Zr) is a soft, malleable, lustrous, greyish-white, and ductile transition metal that becomes brittle, hard at lower purities, and solid at room temperature. It is a strong transition metal that resembles Hafnium (Hf) to a greater extent and, to a lesser extent, Titanium (Ti). The silicate mineral zircon ($ZrSiO_4$) is the chief source of Zirconium. Zircon has been produced as the by-product of mining and processing, where rutile and ilmenite are mined. 1% - 3% of Hf contaminant is present in commercial Zr because of the similar chemical properties of both elements. Zirconium and Hafnium differ strongly in neutron-absorbing properties, and Hafnium has been separated from Zirconium for nuclear reactor applications.

Materials and Methods: Zr(IV) was extracted from a stock solution of $ZrOCl_2.8H_2O$ for the study using two commercial extractants, Cyanex 921 with Salicylic acid and a kerosene diluent. After 30 minutes of shaking the solution in a separating funnel, total equilibrium was reached. Before disengaging, the phases were given five minutes to settle. Arsenazo III was employed as a colorimetric reagent. Using a Perkin Elmer UV-visible spectrophotometer and the Arsenazo(III) technique, the concentration of Zr(IV) in the aqueous phase was ascertained. By contrasting the equilibrium concentration of Zr (IV) in the organic phase with the aqueous phase, the distribution coefficient (D) was computed. The mass balance was used to determine the amount of Zirconium in the organic phase.

Results and Discussion: Zirconium (IV) extraction behavior from nitric acid medium has been investigated using a unique liquid-liquid extraction approach utilizing a binary mixture of Cyanex921 and Salicylic acid in kerosene. The effects of varying various parameters, including those related to acidity, extractant variation, temperature, metal concentration variation, and diluent effect, were investigated in the quantitative extraction of Zirconium (IV) using a binary mixture of Cyanex921 and Salicylic acid in kerosene. As Cyanex921 and Salicylic acid concentrations increased, the extracted Zirconium (IV) percentage increased. With a binary mixture of Cyanex921 and Salicylic acid, kerosene was an efficient diluent for zirconium (IV) extraction.

Conclusion/Recommendation: The study uses a liquid-liquid extraction method employing Cyanex921 and salicylic acid in kerosene to investigate the behavior of zirconium (IV) extraction from nitric acid. Changes in temperature, metal concentration, diluent effect, extractant, acidity, and other parameters were investigated.

Keywords: Salicylic acid, Cyanex921, Nitric acid, Zirconium, Solvent extraction.

Synthesis, Characterization and Application of Cu-Zn bimetallic Nanoparticles

Chetana Suman, Achyuta Nanda Acharya, Priyabrata Mukhi*

School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: priya.babul1991@gmail.com

Introduction: Bimetallic nanoparticles are significant because, depending on the metal combination and structure, they often exhibit better properties than single-metal nanoparticles due to the synergistic effects between the two metals. Cu-Zn nanoparticles exhibit excellent catalytic performance, particularly in hydrogenation and oxidation reactions.These synergistic properties accelerate reaction rates, enhance catalyst efficiency, and contribute to improved reactivity.

Materials and Methods:Cu-Zn nano catalysts were synthesized using a reduction method, where polyvinyl alcohol (PVA) served as the capping agent and NaBH,, acted as the reducing agent. After synthesis, the nanoparticles were separated by centrifugation and subsequently dried in an oven.Their structural and optical characteristics were analyzed using various physio-chemical techniques, including UV-Vis spectroscopy, powder X-ray diffraction (XRD), and field emission scanning electron microscopy (FESEM).

Results and Discussion: Copper-zinc (Cu-Zn) nanoparticles were successfully synthesized. The production of Cu-Zn nanoparticles was verified by X-ray diffraction (XRD) patterns, which showed distinct peaks corresponding to the crystalline Cu-Zn phases.The particle size varied from 10 to 40 nm, depending on the synthesis technique. Variations in intensity reflected differences in zinc incorporation. The average crystalline size was also observed using UV-Vis spectroscopy, confirming the production of Cu-Zn nanoparticles. Bandgap tunability, which is crucial for catalytic applications, was indicated by broadening effects, suggesting nanoscale dimensions. An absorption peak in the 250–350 nm range was observed, which was attributed to the modest shift in the absorption edge based on the synthesis process.

Conclusion/Recommendation: This study successfully synthesized and characterized Cu-Zn nanoparticles, highlighting the influence of synthesis parameters on their properties. The results indicate that Cu-Zn nanoparticles can be optimized for specific applications.

Keywords:Nanoparticles, Cu-Zn, polyvinyl alcohol, Bimetallic, $NaBH_4$

Molecular interaction between Allantonin and Human Serum Albumin

Chinmayee Mahapatra, Bijnyan Ranjan Das, Achyuta Nanda Acharya, and Rojalin Pradhan*

School of Basic Science and Humanities (Chemistry), Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: *rojirojalin23@gmail.com*

Introduction: Human serum albumin (HSA), the most prevalent serum protein, plays a very important role in balancing the volume of extracellular fluid and osmotic pressure. It is produced by the liver and called as carrier protein. HSA is a globular protein composed of a single polypeptide chain folded into a well-defined tertiary structure. It consists of three homologous domains, each containing two subdomains. Allantoin, chemically known as 5-ureidohydantoin, is a heterocyclic compound with the molecular formula $C_4H_6N_4O_3$ and has become a staple ingredient in many skincare formulations and pharmaceutical preparations.

Materials and Methods: To get information on the site and types of interaction of Allantoin with Human serum albumin (HSA) protein, molecular docking studies have been performed by using AutoDock tools. HSA's flexible regions allow it to undergo conformational changes in response to ligand binding or environmental factors, influencing its interactions and biological activities.

Results and Discussion: The molecular docking results best solution based on highest binding energy and lowest RMSD values of receptor-ligand complexes. The clustering histogram for all the 10 different conformations of allantoin with the HSA protein have been analysed. Among them the best conformation has highest binding energy -5.54 kcal/mol with 5 hydrogen bonds: ARG445, GLU442, ALA 443, GLN 385 and ASP 340.

Conclusion/Recommendation: Molecular docking analysis has been done to throw light on the binding mode of Allantoin with Human Serum Albumin. The interaction studies of drugs with proteins have received great significance owing to their diverse applications in pharmaceutical industries and several biotechnological processes.

Keywords: Allantoin, Molecular Docking, Energy optimization, ligand-protein interaction.

Dragon Fruit Peel Pectin Films Enriched with Cucumber Peel Extract for Meat Packaging Applications

Chiranjib Pattanaik, Bijnyan Ranjan Das and GaneswarDalei*

Department of Chemistry, School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: gdalei1988.gd@gmail.com

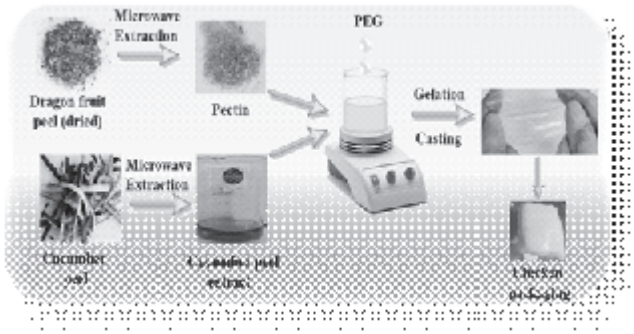
Introduction: With plastic packaging posing severe risk on ecosystem; there is a crucial need for the development of sustainable and eco-friendly packaging materials for food preservation. This demand will eventually be followed by the uphill task of managing food packaging materials. Thus, there is a crucial need for the development of sustainable packaging materials for food preservation. This work aims to develop cucumber peel extract imbued into dragon fruit peel pectin films for meat packaging.

Materials and Methods: Cucumbers and red fleshed dragon fruits were bought from local markets in Bhubaneswar. Analytical grade reagents were acquired from Sigma-Aldrich and/ or HiMedia Laboratories, India and used as such.

Results and Discussion: The study demonstrated that cucumber peel extract imbued dragon fruit peel pectin films could be potentially employed for packaging of chicken meat. Addition of cucumber peel extract led to an enhancement in the density and thickness of the pectin thin films. In addition to improving the tensile strength, antioxidant potential and opacity of the films; the water-barrier properties were also augmented. Furthermore, the fabricated hydrogel film offered versatility in terms of stretched flexibility, anti-puncture resistance, and biodegradability. Trials on chicken meat indicate that PecCPE3 might be a potential candidate for meat preservation. Our results noted that the meat samples packaged with the hydrogel films were fit for consumption even after 10^{th} day. The presence of pectin and the cucumber peel extract might have an inhibiting effect on the microbial decomposition of the meat protein and delayed the process in the packaged samples.Thus, taken altogether from the above experimental data, it could be inferred that the developed hydrogel films, and PecCPE3 film in particular, are potential packaging materials towards preservation of chilled chicken meat. In summary, this work complies two meritorious prospects: (i) the synthetic route is environmentally benign since microwave-assisted extraction is used and (ii) valorization of dragon fruit peel and cucumber peel waste towards the design of a value-added product in the form of a packaging for chicken meat.

Conclusion/Recommendation: Incorporation of cucumber peel extract led to an enhancement in the density and thickness of the pectin thin films. In addition to improving the tensile strength, antioxidant potential and opacity of the films; the water-barrier properties were also augmented. Trials on chicken meat indicated lower pH changes, weight loss and TVB-N values during the refrigerated storage tenure. Thus, our work paves the path for the design of a sustainable packaging for meat and simultaneously addresses the valorization of fruit peel wastes.

Keywords: Dragon fruit peel pectin; cucumber peel extract; packaging film; meat packaging



Structural and Photoluminescence Modificationsin Low Concentration Sm^{3+}-Doped CaBi,, Ti,, O … : Innovations for Anti-Counterfeiting and Fingerprint Applications

Chittaranjan Satapathy, SJNalini, Sushri Sangita Nanda*

SchoolofBasicScienceandHumanities,OdishaUniversityofTechnologyandResearch, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail:sangitapayal94@gmail.com

Introduction: The Aurivillius family of layered perovskite materials has gained attention due to its ferroelectric, dielectric, and photocatalytic properties, making it suitable for optoelectronics, sensors, and energy storage. CaBi,, Ti,, O … is a notable member of this family, and its properties can beenhanced through rare-earth doping. Sm³z doping is an effective method to modify the electronic structure and defect states, influencing overall performance. This study investigates the impact ofSm³z doping on the structural, morphological, and optical properties of CaBi,, Ti,, O … to explore its potential for technological applications.

Materials and Methods: Sm³z -doped CaBi,, Ti,, O … was synthesized via the solid-state reactionmethod using high-purity precursors. The powders were mixed, ground, and subjected to thermal treatment to achieve phase formation and densification. Characterization techniques included X-ray diffraction (XRD) for phase purity and crystallinity, scanning electron microscopy (SEM) for morphology, diffuse reflectance spectroscopy (DRS) for optical properties, and Raman spectroscopy for vibrational analysis.

Results and Discussion: XRD analysis confirmed phase purity and crystallinity, with lattice distortions indicating successful Sm³z incorporation. SEM images revealed changes in grain size and uniformity, suggesting an influence on microstructural evolution. DRS analysis showed a shift in the absorbance spectrum, leading to bandgap variation with increasing Sm³z content. This suggests that Sm³z doping can effectively tune the electronic structure of CaBi,, Ti,, O … , making it suitable for optoelectronic applications. Raman spectroscopy further revealed changes in vibrational modes, indicating modifications in bond strength and local structural symmetry. Photoluminescence studies demonstrated enhanced optical emission properties with Sm³z doping, suggesting potential applications in luminescent and optoelectronic devices. The improvements in structural and optical characteristics indicate that doping can be optimized for specific technological needs.

Conclusion/Recommendation: Sm³z doping significantly influences the structural and optical properties of CaBi,, Ti,, O … . Phase purity, morphological changes, and bandgap variations were confirmed, indicating its potential for optoelectronic applications.

Keywords:Aurivilliusperovskite,CaBi,, Ti,, O … ,Sm³z doping,structuralproperties,opticalproperties, photoluminescence, dielectric materials, energy storage, optoelectronics.

Extraction, Characterization and Bioactivities of Essential Oil of Tagetes patula

Darshni Mohanty and GaneswarDalei*

Department of Chemistry, School of Basic Sciences and Humanities

Odisha University of Technology and Research, Bhubaneswar, 751029Odisha, India

*Corresponding author E-mail: gdalei1988.gd@gmail.com

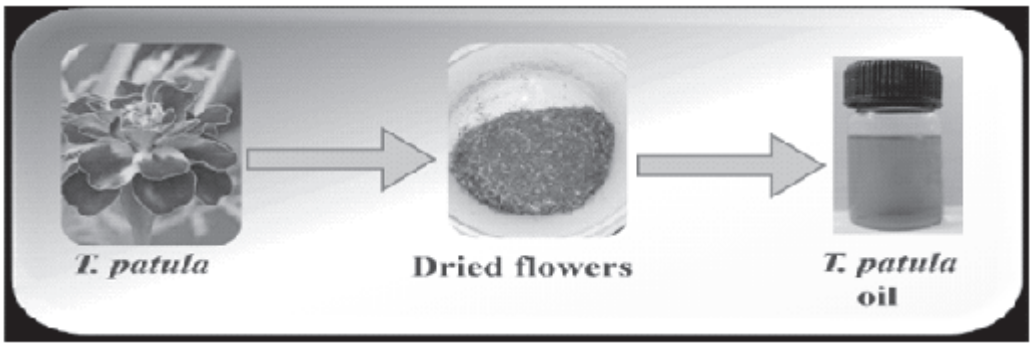
Introduction: Plants have been used for medicine and industry for centuries. Nowadays, much attention has been directed towards the utilization of plants either in the form of extracts or a source for isolation of natural compounds in order to restrict the use of synthetic drugs that have been reported for carcinogenic issues. Plant extracts and essential oils have been reported as safe alternative remedy acaricides, antiprotozoal agents etc. *Tagetes patula* oil, rich in bioactives, has antibacterial, antifungal, and antioxidant properties. This study explores ultrasound-assisted hydrodistillation (UAHD) of *Tagetes patula* essential oil for improved extraction, analyzing its composition and bioactivities for potential pharmaceutical applications.

Materials and Methods: *Tagetes patula* flowers were collected from a local farm in Cuttack, Odisha, dried, powdered, and stored at 4°C. UAHD (25 kHz, 40 W, 30 min) followed by 3-hour hydrodistillation was used for oil extraction. GC–MS, FTIR, and ^{1}H NMR analyzed the composition, while FESEM assessed morphological changes. Antioxidant activity (DPPH, ABTS, FRAP), antibacterial efficacy(*S. aureus, L. monocytogenes, E. coli, P. aeruginosa*), and antibiofilm activity were evaluated.

Results and Discussion: UAHD extraction significantly improved oil yield (0.88%) compared to conventional hydrodistillation (0.56%). GC–MS analysis identified major compounds like terpinolene, piperitenone, and (E)-tagetone, with UAHD oil containing additional bioactives such as menthol, eucalyptol, and eugenol. FTIR and ^{1}H NMR confirmed a diverse range of functional groups, and FESEM imaging showed that ultrasound pretreatment caused cellular damage, facilitating better oil release. UAHD-extracted oil had higher total phenolic (48.14 mg GAE/g) and flavonoid (59.07 mg CAT/g) content, contributing to stronger antioxidant activity (lower IC50 in ABTS and FRAP assays). It exhibited enhanced antibacterial effects, especially against *S. aureus* and *L. monocytogenes*, with lower MIC/MBC values. UAHD-extracted oil also demonstrated significant antibiofilm activity against *S. aureus* and *E. coli*, suggesting its potential for biomedical applications. Overall, UAHD proved to be an efficient method for improving oil yield, bioactive composition, and therapeutic potential.

Conclusion/Recommendation: UAHD efficiently enhanced *Tagetes patula* oil yield and bioactive composition. The oil showed strong antioxidant, antibacterial, and antibiofilm activities, especially against *S. aureus* and *E. coli*. Overall, the results of this study put forth ultrasound-assisted extraction of oil is a promising technique and that the UAHD-extracted oil will reap better benefits in pharmaceutical industry beneficial to mankind.

Keywords: Plants, Ultrasound-assisted hydrodistillation (UAHD), Physico-chemical properties, Antibacterial efficacy, Antibiofilm activity.



An alternative synthetic strategy to construct Apixaban analogues and its highly potent derivatives as FXa inhibitors of blood coagulation

Dattatray Gaikwad, Rana Chatterjee, Sujeet Gaware, Achyuta Nanda Acharya,* Rambabu Dandela*

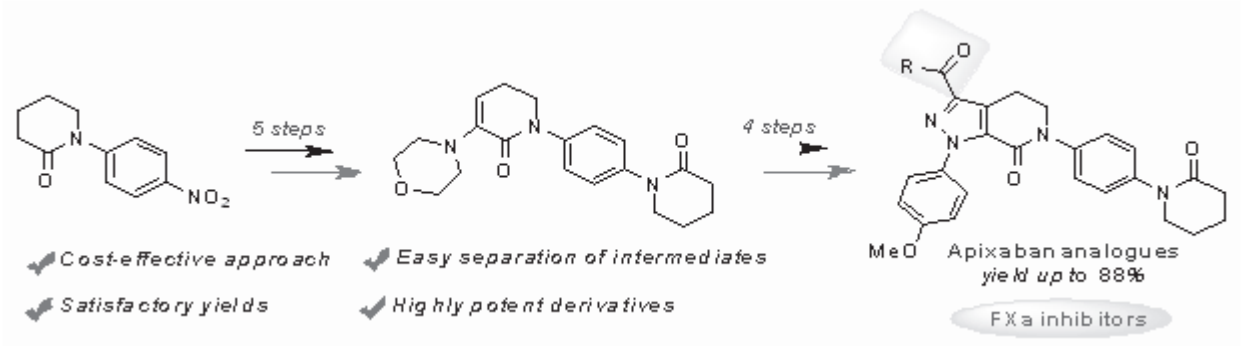
School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: aacharya@outr.ac.in

Introduction: An alternative synthetic approach has been developed to access novel apixaban analogues, providing a practical and cost-effective route to construct this privileged scaffold along with its amide derivatives, which may possess promising anticoagulant properties. This strategy employs less expensive reagents, readily available precursors, and a streamlined pathway with fewer intermediary steps, ensuring high yield and efficiency. The designed multi-step procedure for synthesizing these apixaban derivatives is both affordable and efficient, incorporating accessible reagents and catalysts. Furthermore, the approach was extended to create various amide derivatives with diverse functional groups, each potentially offering distinct biological activities. This expanded functionality may increase the therapeutic versatility of the apixaban analogues, contributing to broader anticoagulant potential. In summary, this innovative synthetic route provides an accessible and efficient pathway to produce high-quality apixaban analogues with promising biological applications.

Materials and Methods: Complete research work done at Pune, India. All raw materials/ chemicals used from standard company and solvents used from commercial vendors. Synthesis of intermediates and final compounds done under inert atmosphere at cooled/ RT/ heating temperature. Intermediates and final compounds are isolated by column chromatography and solvent titration. Compounds confirmed by NMR, Mass and IR analysis.

Results and Discussion:



Conclusion/Recommendation: In summary, we have designed an alternative synthetic route to access a series of novel apixaban derivatives. The method demonstrates easily affordable multi-step procedures that involve less expensive and readily available reagents and catalyst, leading to the targeted apixaban analogues in good yields. In comparison to the other synthetic procedure, the present method avails a promising choice by avoiding the regeneration of the intermediates and excessive use of metal-catalyzed coupling reaction.

Keywords: Apixaban analogues, Anticoagulant synthesis, Cost-effective method, Amide derivatives, Metal-free synthesis.

Influence of Lanthanum on Structural, Optical and Dielectric Properties of $Mg_{0.5}Mn_{0.5}Fe_2O_4$

Gorachand Biswal, Babita Ojha*, Rakesh Ranjan Sahoo, Varsa Purohitand Dhrubananda Behera

School of Basic Sciences & Humanities, Odisha University of Technology and Research, Bhubaneswar, Odisha-751029, India.

*Corresponding author E-mail: babitaojhacet@gmail.com

Introduction: Ferrites are utilized in a variety of products, such as sensors, data storage , catalyst and microwave absorber. The general chemical formula for Spinel Ferrite is MFe_2O_4, where M indicates valency +2 metal ions. The cubic spinel symmetry of the crystal structure is a member of the Fd-3m space group.Interesting characteristics like higher dielectric constant and lower dielectric loss are reported for ferrite samples, which are suitable for application in high frequency devices. In this article, the structural, morphological, optical and electrical properties of La-doped manganese magnesium spinel ferrites have been investigated. The rare earth ion like lanthanum have been presented to be perfect element for substituting in the mixed spinel system.The electrical properties are infuenced by the 4f orbital of RE ions. RE ions tend to form a secondary orthorhombic phase of rare earth iron oxide which greatly modify their relaxation and transport behaviour. For the reduction of EM pollution, materials which can absorb microwave are in main focus. Due to low dielectric loss, ferrites are used in microwave communication.

Materials and Methods: The sample $Mg_{0.5}Mn_{0.5}Fe_{2-x}La_xO_4$ (x=0, 0.1, 0.2, 0.3, 0.4, 0.5) is synthesized using solid state reaction route.The calcination and sintering temperatures are 1000^oC and 1050^oC respectively.

Results and Discussion: The crystallographic phase and lattice strains of the samples $Mg_{0.5}Mn_{0.5}La_{2-x}Fe_xO_4$(x=0.1,0.2,0.3,0.4,0.5) are analysed from the XRD graph. The cubic spinel phase isconfrmed from the JCPDS card no 17-0465 ($MgFe_2O_4$phase) .The peaks at 20^o,35^o,39^o, 47^o indicates the secondary phase due to the in-corporation of Perovskite $LaFeO_3$ system(JCPDS card no 74-0541) .The size of the irregularly shaped grains on the micrographs of the ferrites varies from 200 to 1000 nm. It is found that the doping concentrain of La^{3+} ions reduces the grain size. The bands noticed at 3450 cm^{-1}, 1634 cm^{-1}, 1388 cm^{-1} and 860 cm^{-1} are attributed to tetrahedral and octahedral metal- oxygen stretching mode.The absorption bands at lower and higher frequencies are due to the difference in distribution of metal ions in the structure of spinel cubic system and the chemical bond vibrations among the cations occupying A and B sites near to oxygen ions. The dielectric constant plots as a function of frequency (1Hz-20GHz) of applied field were investigated.It is observed that for all the specimens the permittivity reduces with respect to frequency.The resonance absorption of tetrahedron and octahedron sites ions are the main reason for the dielectric loss in ferrite. The increase of dielectric loss is associated with the increase of ionic conductivity.

Conclusion/Recommendation: The spinel ferrite $Mg_{0.5}Mn_{0.5}Fe_{2-x}La_xO_4$ (x= 0, 0.1, 0.2, 0.3, 0.4, 0.5) have been successfully fabricated using solid state reaction method. The XRD result confirms the mixed spinel phase formation.The dielectric constant and loss of spinel ferrite decreases as frequency increases. Therefore, it is suitable for microwave absorption performance.The doped spinel ferrites illustrate a low value of tanä at higher frequencies, which confirmed the applicability in microwave devices.

Keywords: Spinel Ferrite, Fd-3m spacegroup, Low dielectric loss, Microwave absorber

Synthesis of ZnO nanorods by microwave method for Piezoelectric device application

Jyoti Prakash Sahoo*, Sanat Kumar Mallick, K. P. S. S. Hembram

School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

* Corresponding author E-mail: jjnvjyotiprakash@gmail.com

Introduction: Zinc oxide (ZnO) nanorods (NRs) are promising for piezoelectric applications due to their high aspect ratio and superior charge transport properties. While conventional synthesis methods can be slow and complex, the microwave-assisted technique offers a rapid, energy-efficient alternative for producing high-quality ZnO NRs with controlled morphology. This study explores the synthesis of ZnO NRs using the microwave method and investigates their structural and piezoelectric properties. The use of NRs for piezoelectric devices demonstrates their potential for sensing applications. This work advances the development of efficient ZnO-based piezoelectric devices.

Materials and Methods: ZnO nanorods were synthesized using zinc acetylacetonate as a precursor and polyvinylpyrrolidone (PVP) as a capping agent. Zinc acetylacetonate (1 g) was dissolved in ethanol (40 mL) and stirred for 15 minutes. Separately, PVP (0.5 g) was dissolved in DI water (40 mL) and stirred. The solutions were mixed and subjected to microwave irradiation with 800 W for 5 minutes. A white colour solution was obtained. It was centrifuged to get precipitation. The precipitated samples were washed with DI water and ethanol five times, and dried at 70°C overnight.

Results and Discussion: The SEM analysis revealed well-defined hexagonal ZnO nanorods with an average diameter of 36 nm and a length of 180 nm (figure A). EDAX confirmed the stoichiometric presence of Zn and O, ensuring high purity. XRD analysis showed characteristic peaks matching the wurtzite ZnO structure, indicating high crystallinity. UV-Vis spectroscopy displayed a strong absorption peak at 396 nm, corresponding to a bandgap of 3.15 eV.

Prototype of piezoelectric devices were made on a flexible substrate with copper electrodes (figure B). Upon axially bending, voltage is generated as shown in figure C. The reliability of the device was tested for 50 times over a period of two weeks (figure D).

Fig. (A) ZnO nano rods. (B) Piezoelectric device. (C) Device testing. (D) Reliability test.

Conclusion/Recommendation: ZnO nanorods were successfully synthesized via the microwave method. The well-defined morphology (180 nm × 36 nm) was revealed by SEM. The prototype piezoelectric device demonstrates reliable performance, suggesting commercial viability.

Keywords: ZnO nanorods, Microwave synthesis, piezoelectric device

Co_3O_4 Nanostructures as Efficient Photocatalyst for Organic Dye Remediation

Latasha Khatai, Alfa Sharma, Bijnyan Ranjan Das*

Department of Chemistry, School of Basic Sciences and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha

*Corresponding author E-mail: brdas@cet.edu.in

Introduction: The waste water containing residues of dyes and chemicals require efficient remediation before releasing it into the waterbodies. Most of these dyes are resistant to biological, chemical and physical treatment methods. So that for the treatment of these dyes and chemicals, photocatalyzed degradation is considered as efficient treatment technology. The promising photocatalytic properties of Co_3O_4 owing to its narrow band gap 1.66 - 2.12 eV. Cobalt tetraoxide (Co_3O_4) is a versatile transition metal oxide, owing to its superior opto-electronic properties. From literature it is well known that nanostructure due to their surface modification properties enhances the dye degradation process often utilized as a photocatalyst.

Materials and Methods: The analytical grade chemicals such as Cobalt nitrate ($Co(No_3)$-$_2$.$6H_2O$) ,Ammonium Oxalate, Cobalt Chloride-Hexahydrate (Co_2Cl_2.$6H_2O$), Sodium Hydroxide (NaOH),Ethanol (C_2H_5OH), Standard solution of Methylene Blue ($C_{16}H_{18}ClN_3S$)were used in this study. These materials were purchased Loba chemie, India as without any further purification.

Results and Discussion: Co_3O_4 nanomaterials were synthesized using sol-gel method and co-precipitation method. The XRD result confirmed formation of cubic Co_3O_4 nanostructures bearing space group $Fd\bar{3}m$. FTIR result confirmed the presence of Co-O bond and O-Co-O bond at 569 cm^{-1} and 665 cm^{-1} due to distribution of Co^{3+} and Co^{2+} in octahedral and tetrahedral sites of Co_3O_4. The FESEM images identifies presence of Co_3O_4 nanoflakes and nanospheres depending upon the synthesis method *i.e.,* for sol-gel and co-precipitation respectively. Photocatalytic dye degradation study has been carried out using Co_3O_4 nanoparticles prepared from different methods. The study showed photocatalytic degradation efficiencies Co_3O_4 of 57.34% and 87.81% respectively upon subjection of 0.01g of Co_3O_4 under UV light irradiation. The degradation efficiency has been calculated depending upon the decrement in $ë_{max}$ value of methylene blue observed at 263 nm.

Conclusion/ Recommendation: In the present study, the Co_3O_4 nanostructure based photocatalyst prepared using Sol-gel method and Co-precipitation method and its photocatalytic dye degradation property has been investigated. Co_3O_4 nanoparticles are found to be very promising photocatalyst materials in UV range for degradation of organic dyes in an industrial waste water treatment process.

Keywords: Co_3O_4 Nanoparticle, Sol-gel Method, Co-Precipitation Method, Photocatalytic activity, Methylene Blue.

Polymer Nano-composite of Polyvinyl-pyrrolidone with Zinc oxide: An anti-corrosive Coating

Manoj Kumar Praharaj[1] Biswajit Samantaray*[2,] and Abhiram Satapathy[1]

[1]Department of Physics, ABIT, Cuttack, Odisha-753014

[2] Department of Chemistry, OUTR, BBSR, Odisha

*Corresponding author E-mail: cet.biswajit@gmail.com

Introduction: Corrosion is one of the most prevalent hazardous problems faced by all types of industries, with economic losses due to corrosion amounting $2.5 trillion annually. Corrosion can be controlled by applying anticorrosion coatings on metal surface. The most widely used anti-corrosion coatings are organic coatings, but corrosive substances often reach the substrate through the pores present in the organic polymers, causing localised corrosion. Nano-materials can be used as filler into the organic polymer to improve their corrosion resistance.

Materials and Methods: Nano-composite of ZnO and Polyvinyl pyrrolidone (PVP) were synthesized by Sol-Gel with different concentration of Nano-particle ZnO. All the polymer Nano-composites were characterized using Fourier transform Infrared (FTIR) spectroscopy, Ultraviolet visible (UV-vis) spectroscopy, thermo-Gravimetric Analysis (TGA), and field emission scanning electron microscopy (FESEM) technique. The prepared Nano-Composite coating is applied to mild steel by dip-coating method.

Result and Discussion: The surface morphologies of the ZnO nanoparticles and polymer nanocomposites observed using FESEM are shown in Figure-1. The FESEM image of the ZnO nanoparticles as presented in Figure 4a reveals that the ZnO nanoparticles are crystalline and rod like. The sizes of the synthesized ZnO nanoparticles are in the range of 50"90 nm. The presence of aggregated ZnO nanoparticles is evident from the image.

Fig-1

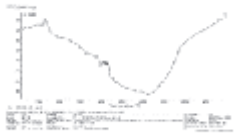


Fig-3

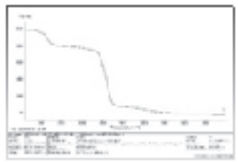


Fig-2

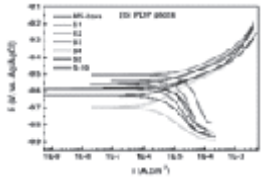


Fig-4

The TGA profile of ZnO/PVP as shown in figure-2 & 3 demonstrates three stages of weight loss, At the first stage, there is an 8.13% weight loss from 25 to 108 °C, which is attributed to the removal of residual solvent present in the nanocomposite. The second stage has a weight loss of 76.80%, which started at 365 °C and ended at about 450 °C due to the decomposition of PVP chains. Finally, an insignificant loss of about 2.00% occurred at 641 °C, and it is expected that the only change at this stage is in the crystal structure. It is observed that PVP is completely decomposed at 641 °C leaving only the carbon residue. From the thermal behavior of PVP observed in the curve, it is seen that an initial weight loss of 4.71% occurred at 270 °C, followed by a significant weight loss of 90.38% between 270 and 464 °C, which represents the decomposition of the polymer. The ZnO/PVP nanocomposite is more thermally stable compared with PVP, and this can be attributed to the higher chain compactness due to the interaction between the PVP and ZnO nanoparticles.

Conclusion/Recommendation: Corrosion inhibition potentials of the synthesized ZnO/PVP Nano-composites were investigated for mild steel in 5% HCl solution using potentiodynamic polarization (PDP). The result shoed that, each ZnO/PVP Nano-composites obstruct mild steel corrosion in 5% HCl solution better than the respective polymer alone. Out of five different compositions of ZnO/PVP, the Nano-composite with 2% of ZnO showed more anti-corrosive efficient. The FESEM images also revealed the protective attributes of ZnO/PVP polymer Nano-composites for mild steel in 5% HCl solution.

Keywords: Polymer Nano-composite, Nano-coating, anti-corrosive, Zinc oxide, Polyvinyl-pyrrolidone.

Structural, Morphological and Optical Study on $CaBi_4Ti_4O_{15}$ Doped with Higher Concentration of Sm^{3+} and it's applications

SJ Nalini, Chittaranjan Satapathy, Sushri Sangita Nanda*

SchoolofBasicScienceandHumanities,OdishaUniversityofTechnologyandResearch, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail:sangitapayal94@gmail.com

Introduction: Rare-earth ion activated luminescent oxides have gained significant international attention due to its application in display, optoelectronics, bio imaging etc. To accomplish desirable photoluminescent characteristics CaBi,, Ti,, O … is a suitable host due to it's high thermal, chemical and mechanical stability. It belongs to aurivillius phase which is a layer form of perovskite structure. Apart from choosing good host, selecting an appropriate dopant is also critical. Sm³z ion has been a popular dopant due to its intense red emission resulting from the $^4G_{5/2}$ '! $^6H_{9/2}$ transition. A comparative study of structural, morphological and optical properties of $CaBi_4Ti_4O_{15}$phosphors is carried out to examine the performance of lanthanide Sm^{3+} in this host and it's applicability in optoelectronics and solid state lighting.

Materials and Methods: The precursors $CaCO_3$ (98.0%, Himedia, Molar mass: 100.09 g/mol), Bi_2O_3 (99.0%, Himedia), TiO_2 (>= 99%, Merck, Molar mass: 79.90 g/mol) and Sm_2O_3 (99.9 %, Himedia , Molar mass: 348.72 g/mol) were selected. Solid state reaction technique under high temperature was used to generate parent compound $CaBi_4Ti_4O_{15}$ and$CaBi_{(4-x)}Ti_4O_{15}$:xSm^{3+} (x = 0.5, 1, 2 ,3 ,4 %) doped phosphors. Different characterization techniques are done to analyze phase purity, crystallinity, vibrational modes, band gap variation after doping and calculating the particle size.

Results and Discussion: X-ray diffraction analysis confirmed the Sm^{3+} doping and purity of phase in parent compound. Average crystallite size were calculated by using Debye-Scherrer equation. SEM incorporated the decrease in their size due to the doping of samarium. Raman spectroscopy reported the raman active sites and vibrational modes of molecules and also gave informations on symmetry and the chemical bonds between them. Diffuse reflectance spectra involved the electronic transition and decrease in band gap due to the higher concentration of doping of Sm^{3+}. This suggests that Sm³z can be a good dopant for the electronic structure of CaBi,, Ti,, O … to study photoluminescence properties. These observations of optical and structural changes collectively suggest that $CaBi_4Ti_4O_{15}$ doped with Sm^{3+} are expected to have potential applications in solid state lighting and optoelectronics with colour tunability by changing the concentrations of dopant ion.

Conclusion/Recommendation: TrivalentdopantSm³z resulted the absorption due to electronic transition from ground state to $^4H_{7/2}$ electronic state. So it may characterize the red emission which is widely used in lasers and display devices. This suggests the great potential of Sm^{3+} doped $CaBi_4Ti_4O_{15}$ in the field of photoluminescence applications.

Keywords:Aurivilliusphase, perovskite, red emission, photoluminescent characteristics, solid state lighting, optoelectronics

Hexagonal-to-Cubic Phase Transition in A-site Lanthanum substituted Strontium Manganite ($Sr_{1-x}La_xMnO_3$)

Priyanka Digal, Bijaylaxmi Biswal*

School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: biswalbijaylaxmi94@gmail.com

Introduction: Strontium Manganite ($SrMnO_3$), a perovskite manganite has gained much attention in the field of energy storage and magnetic sensor devices due to its strong magneto-structural and magnetoelectric coupling effects such as magnetoresistance. The magnetic and the electronic properties of perovskites are strongly controlled by their structure. Hence, the structural phase transition in $SrMnO_3$, achieved by rare earth (Lanthanum) substitution may lead to astonishing magnetoelectric properties.

Materials and Methods: $SrMnO_3$ (SMO) and La substituted $SrMnO_3$ ($Sr_{1-x}La_xMnO_3$) powder samples with x=0.1, 0.2 and 0.3 are synthesized by conventional solid state reaction route at a calcination temperature of 1250ÚC. The structural and optical characteristics of these specimens have been investigated by XRD, RAMAN, SEM, and UV-VIS spectroscopy.

Results and Discussion: At room temperature and ambient pressure condition, $SrMnO_3$ has been formed under hexagonal crystal system with space group *p*63/*mmc***.** However, from XRD analysis a hexagonal (*p*63/*mmc*) → cubic (*pm*3*m*) structural phase transition is observed with substitution of La^{3+} into Sr^{2+} sites of $SrMnO_3$. SEM micrograph of $SrMnO_3$ shows hexagonal shape of grains, whereas, spherical grains are noticed from the microstructure image of La substituted $SrMnO_3$ compounds. This evidence also validates the structural phase transition from hexagonal-to-cubic upon substitution of Lanthanum into A-site of $SrMnO_3$. From Raman spectroscopic study it is evident that Raman signal of cubic-SLMO, on average, is much smaller than that of hexagonal-SMO by roughly one order of magnitude. The Raman vibrational modes corresponding to 434 cm^{-1}, 440 cm^{-1}, 552 cm^{-1}, and 640 cm^{-1} signify the E_{1g} mode frequency due to O displacements, E_{2g} mode for O-bending, O-stretching vibrations and A_{1g} mode frequency for symmetric stretching vibration of Mn-O bond of MnO_6 octahedron in hexagonal-SMO respectively. With La substitution into SMO shows Raman shifts in the Raman spectra which signifies perfect incorporation of La^{3+} into Sr^{2+} site. The optical band gap study analyzed the optical band gap of hexagonal-SMO and cubic-SLMO samples. The band gap estimated from the Tauc plot is found to be 1.76 eV for hexagonal-SMO. The band gap for cubic- $Sr_{0.9}La_{0.1}MnO_3$, $Sr_{0.8}La_{0.2}MnO_3$, $Sr_{0.7}La_{0.3}MnO_3$ compounds is estimated as 1.78 eV, 1.79 eV and 1.8 eV respectively.

Conclusion/Recommendation: Hence, incorporation of Lanthanum into A-site of $SrMnO_3$ promotes structural phase transition from hexagonal-to-cubic phase. The SEM and RAMAN analysis validates the structural phase transition. The host material $SrMnO_3$ and La-substituted $SrMnO_3$ compounds possess band gap between 1-2 eV which indicates the semiconducting behavior of these compounds. Further analysis of electronic and magnetic behavior of these compounds will imply their applications in spintronic devices.

Keywords: Strontium manganite, Phase transition, Raman Vibrational modes, Microstructure, Semiconducting material

Synthesis, and characterization, of spinel ZnFe2O4 nanoparticles by solvothermal method in bulk form by ceramic method

Punyatoya Sahu, Haripriya Rath*, and Samita Pattanayak

Department of Physics, School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India.

* Corresponding author E-mail: haripriyarath@gmail.com

Introduction: Nanostructured metal oxides compared to their bulk counterpart have attracted considerable attention owing to their unique physical and chemical properties. They find many technological applications in the field of electronics, optics, magnetic storage devices, and sensors. Spinel ferrites are one of the important classes of material with a chemical formula MFe_2O_4, where M is any divalent metal ion, and Fe is a trivalent metal ion. Spinel ferrite-based magnetic materials exhibit great interest among researchers due to their exceptional optical, structural and superior magnetic properties and find many applications in gas sensing, transformer cores, batteries, and biomedical applications. Spinel zinc ferrites ($ZnFe_2O_4$)stands out from the other ferrites due to its non-toxicity,good photochemical and thermal stability Owing to the narrow band-gap, Zinc ferrite, has been used as semiconductor photo-catalyst due to its ability to absorb visible solar spectrum. $ZnFe_2O_4$ nanoparticles, have been known as good candidate for biomedical applications, including targeted drug delivery, magnetic hyperthermia therapy (MHT), magnetic resonance imaging (MRI) contrast agents and biosensors. With ever-increasing demand for such functionality of $ZnFe_2O_4$,it is essential to control the composition, structure and microstructures through process parameter used in their method of synthesis. With reduction to the nanometre range, it exhibit interesting properties compared to their conventional coarse-grained counterparts.

Materials and Methods: In this study we report a comparative study of micron sized zinc spinel ferrites synthesized by solid state reaction *i.e*. ceramic method and in nano scale through chemical route, by solvothermal method. Structural studies on the as-synthesized $ZnFe_2O_4$ samples were carried out using X-ray diffraction (XRD). The micro structure, morphological characterizations were done using Field Emission Scanning electron microscope (FE-SEM) and Transmission electron microscope (TEM). Micro Raman measurements were carried out with 632.8 nm He-Ne laser excitation. The optical band gaps were studied using UV–visible diffuse reflectance spectrum (DRS).

Results and Discussion: The produced ferrite nanoparticles were cubic and single phase, according to XRD measurements. The bulk zinc ferrites (by solid state reaction process) showed sharp and intense peaks confirming high crystallinity and larger crystallite size (25nm). Nano zinc ferrites (by hydrothermal method) exhibits peak broadening and shifting attributed to smaller crystallite size (17 nm). A slight peak shift was observed, reflecting a change in the lattice parameter of the synthesized samples. Transmission Electron Microscopy (TEM) and high resolution TEM (HRTEM) analysis were used to determine the structure, and morphology of the particles at the nanoscale, and it corroborate with the XRD analysis. The estimated average particle size obtained from TEM observations (~28 nm), is almost double that obtained from XRD measurements (15 nm). Bulk zinc ferrites displayed well defined Raman modes, confirming the ordered spinel structure. Using UV–Vis diffuse spectroscopy the optical band gap (E_g) values were estimated and also matched with the reported value.

Conclusion/Recommendation: Zinc ferrite ($ZnFe_2O_4$) nanoparticles were successfully synthesized using solvothermal method. Their structural, micro structural and optical properties were compared with the micron sized Zinc ferrite prepared by ceramic method.

Keywords: Spinel ferrite nanoparticles, solvothermal method, TEM, XRD, Raman

Cerium Oxide Nanoparticle incorporated into Chitosan Xerogel as Controlled Release Fertilizer

Ritisma Patra and GaneswarDalei*

Department of Chemistry, School of Basic Sciences and Humanities

Odisha University of Technology and Research, Bhubaneswar, 751029 Odisha, India

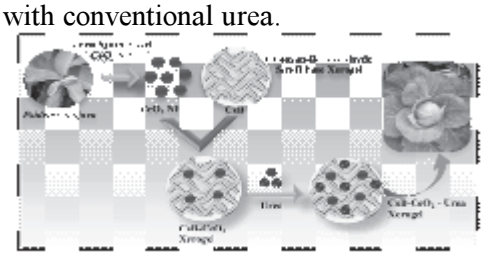
*Corresponding author E-mail: gdalei1988.gd@gmail.com

Introduction: As per the estimates of Food and Agriculture Organization (FAO), the human population might scale 10 billion by the end of 2050. Subsequently, the global food production is likely to shoot up by 70 % to cater to the population thereby ushering a critical challenge for global food security. Cultivation asserts a vital contribution to global food security. However; drought, crop pests and lower efficiency of fertilizers have reduced the targeted yield. The excess and repeated use of agrochemicals increases nutrient loss through volatilization, fixation, precipitation, and leaching from the soil into the environment. With the growing awareness on the adverse effects of conventional fertilizers; the use of sustainable and controlled release fertilizers has garnered much significance. For this, Nanofertilizers (NFs) are now being dubbed as the next generation agrochemicals for sustainable farming systems. For this purpose polymer based nanofertilizer have been groomed. Here, we report the synthesis of chitosan-benzaldehyde Schiff base xerogel incorporated with green synthesized CeO_2 nanoparticle using *Psidium guajava* leaves extract as a sustainable fertilizer.

Materials and Methods: CeO2 NPs were synthesized by green method using guava leaves extract and the formation of NPs were confirmed by UV–Vis spectra, FTIR, FESEM-EDX, DLS and XRD. The Schiff base xerogel was synthesized by the reaction of amine group of chitosan and aldehyde group of benzaldehyde and CeO2 NPs and urea were added for the synthesis of nanofertilizers. Characterization of the materials included UV–Vis spectra, FTIR, FESEM-EDX for surface morphology and elemental analysis, thermal analysis, X-ray diffraction for crystal structure, and particle size and zeta potential measurements of CeO2 NPs.

Results and Discussion: Spherical CeO_2 NPs having an average particle size of 15.3 nm and zeta potential of – 39.9 mV was obtained. The urea-loaded nanocomposite xerogel CsB@U/CeO_2 xerogel was endowed with improved thermal and mechanical properties in comparison to pristine xerogels. The swelling studies revealed lower water absorption capacity of the CsB@U/CeO_2 hydrogel owing to its compact matrix with lower porosity. The water retention capacity of the nanocomposite hydrogel was extended for >2 weeks that implied its efficacy as soil conditioner. The CsB@U/CeO_2 hydrogel-based controlled release positively influenced the cabbage plant growth, improved the photosynthetic rate and enhanced the TPC, DPPH scavenging activity, protein content, total sugar and flavonoid content of fertilized cabbage. The cabbages grown with CsB@U/CeO2 also demonstrated low nitrate content (0.06 mg g 1) in comparison to those fertilized with urea (1.87 mg g 1). Besides, accumulation of Ce in roots (9.02 ìg g 1) and further translocation to leaves (0.004 ìg/ g) could be observed.

Conclusion/Recommendation: The findings imply that the nanocomposite hydrogel not only enhances the plant growth as it is an effective controlled release fertilizer but also aids in mitigating the pertinent environmental issues associated with conventional urea.



Synthesis of ZnO/Si scaffold by microwave method

Sanat kumar Mallick*, Jyoti Prakash Sahoo, K. P. S. S. Hembram

School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

* Corresponding author E-mail: sanatkumarlichi@gmail.com

Introduction: Zinc oxide (ZnO) is a widely studied semiconductor with exceptional optical, electrical, and mechanical properties. Its nanostructured forms, such as nanoparticles, nanorods and thin films, enhance performance through increased surface area and quantum confinement. Integrating ZnO with silicon (Si) substrates benefits applications in electronics, sensors, and biomedical devices. Traditional synthesis methods, including sol-gel and vapor deposition, often require high temperatures and long processing times. Microwave-assisted synthesis offers a rapid, cost-effective alternative, enabling controlled ZnO growth within minutes. This study explores the microwave-assisted synthesis of ZnO on Si scaffolds, aiming for efficient and scalable fabrication of ZnO-based nanostructures.

Materials and Methods: ZnO nanorods were synthesized using zinc acetylacetonate as a precursor and polyvinylpyrrolidone (PVP) as a capping agent. Zinc acetylacetonate (1 g) was dissolved in ethanol (40 mL) and stirred for 15 min. Separately, PVP (0.5 g) was dissolved in DI water (40 mL) and stirred. Both solutions were mixed and stirred. Suitable sized silicon (Si) substrates were put into the mixture solution. Then they were subjected to microwave-irradiation at 800 W for 5 min. White coating was observed on Si substrates, after taking them out of the solution. They were washed with DI water and ethanol for several times. Finally the substrates were dried at 70°C overnight.

Results and Discussion: The samples were characterized using SEM, EDAX, XRD, and UV-Vis spectroscopy. SEM analysis revealed well-defined columnar hexagonal nanorods grown on Si substrate (inset figure). The average diameter of 36 nm and length of 180 nm were observed (inset figure). EDAX confirmed the elemental composition, showing a stoichiometric Zn/O ratio with high purity. XRD analysis indicated a wurtzite hexagonal crystal structure with sharp peaks, confirming high crystallinity. Current-voltage (I-V) characteristics (see figure) shows ohmic behavior near origin for both conditions, *i.e.* under light mode and dark mode. However, they show deviation, away from origin revealing different conduction mechanism. Resistance of $4.701\times10^{5}\dot{U}$ (dark mode) and $1.86\times10^{5}\dot{U}$ (light mode) are observed.

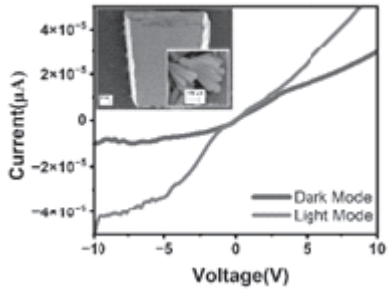


Fig. Current voltage characteristics of ZnO/Si scaffold. (Inset ZnO grown on Si substrate revealing their dimensions).

Conclusion/Recommendation: ZnO nanorods were successfully synthesized on Si substrate using microwave method. The ZnO/Si scaffold shows ohmic behavior both in presence and absence of light under a small window region near the origin. The deviations at far region reveals different conduction mechanism. We aim to use these properties of the ZnO/Si scaffold to make suitable device application. The detail mechanism and prototypes will be discussed in due time.

Keywords: ZnO nanorods, ZnO/Si scaffold, Microwave synthesis, Device applications.

Structural and Optical Properties of Gadolinium modified on $CoFe_2O_4$ Synthesized by Mixed Oxide Method Technique

Satanki Paramguru, Samita Pattanayak*

School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar 751029, Odisha, India

*Corresponding author E-mail: samitaphy@gmail.com

Introduction: Spinel ferrites are described by the chemical formula MFe_2O_4 where M stands for divalent metal ions. The crystal structure of spinel ferrite possess two interstitial sites namely tetrahedral (A) and octahedral (B). A variety of cations can accommodate at tetrahedral A site and octahedral B site enabling wide variation in the properties of ferrites. M can be replaced by other divalent metal ions and we can have number of spinel ferrites. Fe^{3+} ions can be replaced by other trivalent ions like Al^{3+}, Cr^{3+}, Ga^{3+} etc. Fe^{3+} ions can also be replaced by combination of divalent and tetravalent ions. Spinel ferrites particles play a significant role in our everyday lives and used in variety of application such as medical industries, nano electronics, and waste water treatment etc. The substitution of rare earth ions into cobalt ferrite structures has been explored to further modify these properties. The large ionic radii and unique magnetic moments of rare earth elements significantly affect the crystal structure and magnetic characteristics of the ferrite.

Materials and Methods: Polycrystalline samples of Gd^{3+} modified spinel ferrite compound $CoGd_xFe_{2-x}O_4$ were prepared by a high-temperature solid-state reaction method. The resulted powders are reground and pressed into pellets (10mm in diameter) at 4-5 ton pressure. Pellets were prepared and coated with metallic silver coating on its two surfaces which was in a liquid form. Preliminary morphological and structural studies were analyzed by XRD, SEM, RAMAN and UV.

Results and Discussion: From XRD analysis we confirmed that the structures of the materials are inverse spinel structure. X-ray diffraction of the $CoGd_xFe_{2-x}O_4$ (x=0.0, 0.02, 0.04, 0.06, and 0.08) ceramic powders confirmed the FCC structure of the compound. The grain size of the materials reduces with increasing Gd concentration.

Keywords: XRD; SEM; Raman; UV-Vis

Photophysical Properties, Solubility and Stability of Curcumin in Surfactant Media: The Role of the Surfactant Head Group

Satwik Choudhury and Subhrajit Mohanty*

Department of Chemistry, School of Basic Sciences and Humanities

Odisha University of Technology and Research, Bhubaneswar, 751029Odisha, India

*Corresponding author E-mail: subhrajitmohanty48@gmail.com

Introduction: Curcumin, a natural polyphenolic compound, is the major ingredient of the yellow-orange pigment found in the Indian spice plant turmeric. Recently, it has garnered immense research interest globally because of its biological and pharmacological activities.

Materials and Methods: Curcumin, SDS,SLS, DDAPS were obtained from SRL, India and used as such. DTAB, *Coumarin 153, DPPH(*(2,2-diphenyl-1-picryl-hydrazyl-hydrate*) were bought from Sigma.* Absorbance measurements were carried out by using Shimadzu Spectrophotometer (UV-1800). By using the fluorescent probe curcuminthe fluorescence emission spectra were recorded, the intensity and anisotropy value were also measured with the help of Jobin-Yvon Spectrofluorometer (Fluoromax-4P) using a 1 cm path length quartz cuvette. Fluorescence spectra were measured from 430 to 750 nm wavelength range by fixing the excitation and emission slit widths at 5 nm.

Results and Discussion: Although, it has a wide range of physiological and medicinal benefits, its poor aqueous solubility and lack of bio-availability are the two major challenges in the use of curcumin as a potential drug. In addition to that, its lack of stability in the aqueous medium raises further problems in the application of curcumin. Hence, research efforts are being focused to increase the stability and solubility of curcumin by encapsulating it in a variety of carriers such as micelles, reverse micelles, mixed micelles, liposomes, suspensions, hydrogels, conjugates, and emulsions *etc.* Among them, surfactant-based delivery systems have gained much attention as they help in faster and more efficient absorption of drugs. The present work aims at studying the interaction of curcumin with four different conventional surfactants having the same hydrophobic chain length but with different head groups. The role of the charge on the head group of the surfactants in modulating the photophysics, solubility and stability of curcumin under different physiological conditions has been analyzed using UV-visible and fluorescence spectroscopic techniques.

Conclusion/Recommendation: These surfactants have been found to enhance the solubility and stability of curcumin to different extents depending upon the nature of their head groups. Further, the effect of the surfactants on the antioxidant activity of curcumin has also been evaluated.

Keywords: Curcumin, Surfactants, Fluorescence study, Stability, Antioxidant activity

Real Zeros of a Random Trigonometric Polynomial

Sima Rout* & Dr. Prasana Kumar Mishra

School of Basic Science and Humanities, OUTR

Bhubaneswar-751029, Odisha, India.

*Corresponding author E-mail: simarout87@gmail.com

Introduction: - Let (Ù, Pr,A) be a fixed probability space and for $\omega\epsilon\Omega$.Let $\{a_j(\omega)\}_{j=0}^{n}$ and $\{b_j(\omega)\}_{j=0}^{n}$ be algebraic sequences of independent, identically and normally distributed random variables, both with means zero and variances one. Denote by N_n(á, â) the number of real zeros of random trigonometric polynomial T_n (è, ù) = $\sum_{j=0}^{n}\{a_j(\omega)\cos j\theta + b_j(\omega)\sin j\theta\}$.

in the interval (á, â) and by EN_n (á, â) its expected value.

Materials and Methods: Covariance of the number of real zeros which has been extensively studied. The literature includes the original work of Dunnage [3] which was later extended by Das [2] and Wilkins [8] and was reviewed by Bharucha- Reid and Sambandham [1] and recently by Farahmand [7]. They generally show that for all sufficiently large n and for different classes of distributions of the coefficients or in different cases, for example, the level crossing case instead of zero crossings, $EN_n(0,2\delta)$ is asymptotic to 2n/”3. In particular the above work of Wilkins is of interest as it shows that the error term involved in the asymptotic estimate is small and in fact is O (1). However, finding the variance of the number of real zeros involves a different level of difficulties. There have been several attempts, for instance, see [4] or [6], to obtain the asymptotic value for the variance of $N_n(0,2\delta)$ for P_n(è). So far, the results are only in the form of upper bounds. As far as the expected number of zeros is concerned the asymptotic value of $EN_n(0,2\delta)$ for T_n(è) and P_n(è) is the same.

Results and Discussion: This can be seen by evaluating its covariance function as

T_n (è, ù) = $\sum_{j=0}^{n}\{a_j(\omega)\cos j\theta + b_j(\omega)\sin j\theta\}$.

Therefore, it is natural to seek to evaluate the variance of number of zeros of T_n(è) which possess the above stationary property instead of P_n(è) given in (1.2). We, however, are unable to make any substantial progress in this direction. Instead, we obtain the covariance of the number of real zeros in the intervals (0, ð) and (ð,2ð). As our main aim remains to estimate the variance of $N_n(0,2\delta)$ we will present our results and discussions in such a way that they could be used to be generalized for variance. Although we are considering two intervals (0, ð) and (ð,2ð) our proof is also valid for any two disjoint intervals. For random trigonometric polynomial $T_n(\varphi)$ given in (1.1) we prove the following Theorem. Theorem: With the above assumption of independent and Gaussian distribution of the coefficientsand,the expected number of real zeros of polynomial (1.1) is 4n+O (1).

Conclusion/Recommendation: The Expected umber of real zeros of T_n (è, ù) in two disjoint intervals (0, δ) and (δ,2δ) is equivalent to order 4n+O (1).

Keywords: Independent identically distributed random variables, random algebraic polynomial, random algebraic equation, real roots.

Unveiling the potential of natural plant-based therapeutics to target Plasmodiumfalciparum and Plasmodium knowlesi: An In-silico approachBottom of FormU

A D Shobhanam Shobhana, Soumya Ranjan Mahato, Achyutananda Acharya MaheswataMoharana*

Department of Chemistry, *School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India*

*Corresponding author E-mail: moharana.sweta@gmail.com,

Introduction: Malaria remains one of the deadly infectious diseases globally, with millions of cases and hundreds of thousands of deaths each year. *Plasmodium falciparum* and *Plasmodium knowlesi*account for the most severe form of malarial disease in humans. The emergence of parasite resistance to antimalarial drugs and the high cost of currently available drugs threatens the possibility of malaria eradication especially in malaria endemic areas. While synthetic drugs like artemisinin have been crucial in treatment, the search for more effective and sustainable alternatives has led to a growing interest in natural phytocompounds.

Materials and Methods: The crystal structure of the targets *Plasmodium falciparum* and *Plasmodium knowlesi* was retrieved from RCSB PDB Databank. The present study utilizes computational approaches like molecular docking, quantum chemical calculations through Density Functional Theory (DFT), molecular dynamics simulation to evaluate the inhibitory properties of plant-based compounds derived from Indian antimalarial plants. The physiochemical properties, such as molecular weight (MW), partition coefficient (Log P), water solubility coefficient (Log S), hydrogen-bond acceptors, hydrogen-bond donors, number of rotatable bonds and total polar surface area were studied for each of the above said phytochemicals.

Results and Discussion: ADMET studies established the drug candidacy of the phytochemicals through Lipinski's filtration. Molecular docking was carried out in AutoDock tools to estimate the binding affinity of twenty-five compounds against *Plasmodium falciparum* and *Plasmodium knowlesi*. The phytocompounds akuammicine, ursolic acid echitamine showed maximum binding efficacy of -7.7, -7.6, and -7.6 kcal/mol with *Plasmodium knowlesi*and the compounds campesterol, akuammidine, and akuammicine showed binding efficacy of -9.8, -9.0, and -8.4 kcal/mol with *Plasmodium falciparum*. This research also focused on a comparison study of the binding efficacy of available drugs with the plant-based compounds. The results showed binding score of -7.5 kcal/mol and -8.4 kcal/mol with *Plasmodium knowlesi*and *Plasmodium falciparum* respectively. The overall score showed the natural compounds exhibit higher binding scores as compared to available drugs.

Conclusion/Recommendation: The findings suggest the plant-based compounds are better inhibitors as compared to the available drugs for the effective and sustainable treatments of malaria diseases especially in developing countries to mitigate human fatalities.

Keywords: Malaria diseases, *Plasmodium falciparum*, *Plasmodium knowlesi,* Molecular docking, ADMET, Molecular Dynamics Simulation.Bottom of Form

Needs Analysis in Engineering English: Concept, Origin, and Relevance in Identifying Workplace Communication Requirements

Smita Mohanty*, Minakshi Prasad Mishra

School of Basic Sciences and Humanities, OUTR,

Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: mohantysmita2024@gmail.com

Introduction: Needs Analysis (NA) is vital in English for Specific Purposes (ESP), particularly in engineering education, to match language instruction with workplace communication demands. Engineering graduates in Odisha face challenges in professional communication as traditional curricula focus on general skills rather than industry-specific needs. While many colleges offer courses in Communicative English and Technical Writing, they often overlook essential Business communication skills. Engineers must develop competencies in technical writing, business correspondence, and digital communication. To meet industry demands for higher communicative competence, it's essential to reassess the linguistic needs of engineering students and improve Business English training.

Materials and Methods: This study reviews needs analysis (NA) frameworks for Business English instruction, focusing on Munby's Communicative Needs Processor (1978) and Hutchinson & Waters' Target Situation Analysis (1987). It explores Present Situation Analysis (PSA), Target Situation Analysis (TSA), and discourse analysis as methods for creating profession-specific English courses. The study also examines research on needs analysis in engineering education in Odisha, identifying gaps between the current curriculum and industry communication needs.

Results and Discussion: Research reveals notable gaps in Odisha's engineering education, particularly in industry-specific business communication skills. Although courses in Communicative English and Technical Writing offer a foundation, graduates often struggle with essential tasks like drafting emails, preparing reports, and engaging with clients, affecting their adaptability to global work environments.

Needs analysis (NA) is recognized as an effective tool for curriculum development, yet its implementation in Odisha's programs is limited. Many institutions lack a systematic assessment of students' communication needs, resulting in inadequate, generic syllabi that hinder job-related language skills and employability. To bridge this gap, it is vital to integrate NA-driven Business English components into existing courses. Aligning with India's National Education Policy (NEP) 2020, institutions should collaborate with industry professionals to develop syllabi that incorporate case studies, role-playing, digital communication training, and targeted writing exercises for the engineering sector.

Conclusion and Recommendation: This study highlights the need for a structured Needs Analysis (NA) framework to enhance Business English instruction in Odisha's engineering institutions. While existing courses in Communicative English and Technical Writing are valuable, they must expand to better address workplace communication demands. By integrating industry requirements into the curriculum, institutions can better prepare engineering graduates for professional success.

Future research should focus on empirical NA studies involving graduates, faculty, and industry professionals to develop targeted, industry-specific Business English modules. Additionally, leveraging AI-driven analytics and real-time industry insights will make NA methodologies more dynamic and responsive to workplace needs. Implementing standardized NA frameworks can greatly improve communication skills, workplace readiness, and employment prospects for engineering graduates.

Keywords: Needs Analysis, Business English, Engineering Communication, Workplace Communication, English for Specific Purposes, NEP 2020

Zinc Metal Nanoparticles: An Accessible Method for Synthesis and Characterization

Smrutisudha Krushna Choudhury, Amit Sahoo, and Achyut N. Acharya*

School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha

*Corresponding author E-mail: aacharya@outr.ac.in

Introduction: Zinc, a crucial mineral for human health, is fragile at room temperature but malleable at 100 degrees Celsius, making it essential for food and overall health. It reacts withoxygen, ammonia, and its compounds and emits a greenish-blue light when burned. Zinc is used in cold lozenges, over-the-counter cold remedies, and denture adhesive creams. Zinc is found in many foods, including red meat, chicken, fortifiedbreakfast cereals, oysters, shrimp, crab, cheese, and legumes. Consuming food or beverages contaminated with zinc can causeacutezinc toxicity, which canlead toabdominal pain, diarrhea, nausea, and vomiting.

Materials and Methods: This is the work to synthesize and characterize zinc nanoparticles (Zn NPs) using some standard techniques. Achemical reduction procedure developed in our laboratory synthesizes Zn NPs. This technique is executed at lowtemperatures. The chemicalreduction ofzinc nitrate is achieved using sodium borohydride in an aqueous medium as the reducing agent and pursuedthereaction at alowtemperature, yielding grayish-white color ZnNPs. The Zn NPs are characterized using XRD, FESEM, UV-visible spectroscopy(solid), and STA.

Results and Discussion: The FESEM showed the sponge-like surface morphology, and the surface particle size was about S 15nm. TheFESEMstudies indicate thatthesynthesized ZnNPs areneedle-shaped zinc metalnanoparticles withanaverageparticlesize ofaround15nanometers. From theTauc plot, the band gap was found to be S 3.21 eV, which confirms the semiconductor properties of the NPs. The TGA curve showed a total weight loss of S 26.43% at about450 °C, attributed to the removal of moisture content, and from the DSC curve, we learned that no significant reactionswere going on.

Conclusion/Recommendation: We have successfully synthesized the zinc nanoparticle bychemical reductionofZn (II). Then, itwas characterized byvarious methods. FromXRD analysis, we learned about the compound's crystallinity, whichhas a hexagonalstructure.

Keywords: Zinc,Chemicalreduction,Sodiumborohydride, Nanoparticles.

Efficient Dye Removal from Wastewater Using Hydrothermally Synthesized Nano Lanthanum Nickel Manganese Oxide (La, NiMnO†) Double Perovskite

Sonali Mohapatra, Ayushman Mohanty, Jyoti Prakash Dhal* and B. R. Das

School of Basic Sciences and Humanities (Department of Chemistry),

Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: jyoti84.chem@gmail.com

Introduction: Industrial activities worldwide have a profound impact on drinking water quality. Water reservoirs are frequently contaminated by heavy metals, fluoride, and various organic pollutants, including synthetic dyes. Wastewater from industries such as textiles, paper, plastics, and paints are a significant environmental concern due to the presence of non-biodegradable dyes. These pollutants pose serious health risks, including liver damage, digestive disorders, and neurological complications. Additionally, dye-contaminated water reduces light penetration, hindering photosynthesis and disrupting aquatic ecosystems.

Materials and Methods: A rare-earth-based double perovskite, Lanthanum Nickel Manganese Oxide (La, NiMnO†), was synthesized hydrothermally at 150°C using lanthanum nitrate hexahydrate, nickel nitrate hexahydrate, and manganese sulfate in a 2:1:1 molar ratio, along with SDS and ammonium carbonate. The obtained product was then calcined at high temperatures for six hours to enhance crystallinity.

Results and Discussion: The structural integrity and phase purity of the synthesized adsorbent were confirmed through X-ray diffraction (XRD) analysis, which revealed a well-crystallized perovskite phase. The material's adsorption efficiency was evaluated through batch adsorption experiments, investigating the effects of adsorbent dose, contact time, initial dye concentration, and solution pH.

- Increasing the adsorbent dose from 0.01 to 0.1 g in 20 mL of a 200 ppm Congo red dye solution enhanced adsorption efficiency from 80% to 99%.
- Adsorption kinetics were studied by varying the contact time from 30 to 150 minutes, with equilibrium achieved after 90 minutes.
- The adsorption behavior at different initial dye concentrations was analyzed using Langmuir and Freundlich isotherm models.
- The effect of pH variations on adsorption efficiency was also examined.

Conclusion/Recommendation: This study demonstrated the potential of hydrothermally synthesized La, NiMnO† as an effective adsorbent for dye removal from wastewater. Its high adsorption efficiency, coupled with favorable isotherm and kinetic properties, makes it a promising material for environmental remediation.

Keywords: La, NiMnO† ; Double perovskite nanomaterials; Wastewater treatment; Adsorption, Congo red dye

Optimizing Business Operations: How Strategic Inventory Management Practices Drives Efficiency and Reduces Cost

Soumya Ranjan Bhukta*, Arin Om Shivon Sahoo and P. K. Mishra

Department of Mathematics,

Odisha University of Technology and Research, Techno Campus Ghatikia, Bhubaneswar-751003, Odisha

*Corresponding author E-mail: soumyaranjanbhukta43@gmail.com

Introduction: Business refers to an occupation in which goods and services are produced and sold in return of money, which in fact is called Profit. Profit is the bottom line of any business and achieving this is one of the primary objectives of business through financial lens. Another major objective of business is Growth, which refers to establishment and expansion of the enterprise. encircling these objectives at a standard level means a good business. To have a good business one needs a USP - Unique Sales Proposition (something that makes you better than your competition). It can be many things such as skills, location. pricing, planning and strategizing, management, etc. Through a strategic point of view, Inventory management & analysis is an essential area and Demand forecasting of inventory provides the essential basis for business planning which combinedly influence the decisions to be made.

Materials and Methods: In today's fiercely competitive business landscape, optimizing operational processes is crucial for maintaining profitability and achieving sustained growth. Strategic Inventory Management plays a pivotal role in enhancing operational efficiency and driving significant cost reductions across industries. By embracing data-driven strategies, businesses can fine-tune inventory levels, streamline supply chains, and ensure the seamless availability of products while minimizing overstocking. Effective inventory management not only uncovers and eliminates inefficiencies but also reduces waste and enhances cash flow. This paper delves into the core principles of inventory management, illustrating the powerful link between inventory optimization and operational effectiveness, while showcasing how these practices lead to substantial cost savings for organizations. Ultimately, integrating strategic inventory management is an invaluable approach for businesses seeking to improve profitability, sharpen their competitive edge, and optimize resource utilization in an increasingly dynamic market landscape. This study seeks to highlight the transformative impact of effective inventory management by coupling some of the targeted selective inventory control techniques which falls under modern strategies for inventory management.

Results and Discussion: Furthermore, advanced forecasting techniques can be employed to accurately predict item demand, enabling business owners to maintain optimal inventory levels. This proactive approach will help prevent both stockouts and overstock situations. The aim is to ensure the continuous availability of high-demand products while effectively minimizing storage costs. By achieving this balance, businesses can significantly enhance their inventory management strategies, driving operational efficiency and boosting customer satisfaction.

Conclusion/Recommendation: Hence by harnessing these methodologies, businesses can significantly enhance their inventory operations, driving superior efficiency, reducing costs, and ensuring the precise alignment of inventory with customer demand.

KeyWords: Strategic Inventory Management, Inventory Optimization, Profitability, Stockouts, Resource Utilization, Unique Sales Proposition (USP), Demand Forecasting, Selective Inventory Control

DNA interaction and protein binding ability of mixed-ligand oxidovanadium(IV) complexes incorporating biologically active ONO donor ligands

Stuti Nanda, Achyuta N. Acharya and Atanu Banerjee*

Department of Chemistry, School of Basic Sciences and Humanities, Odisha University of Technology and Research, Bhubaneswar- 751029 Odisha, India.

*Corresponding author E-mail: atanu.banerjee9@gmail.com

Introduction: The chemistry of vanadium and its complexes has become a fascinating area of research due to the discovery that vanadium is a bio-essential element participating in various enzymatic reactions. This bio element also takes part in various DNA maintenance reactions and thereby prevents genomic instability which otherwise leads to cancer. Keeping these observations in mind, herein we report synthesis, characterization and the protein/DNA interaction study of three hexa-coordinated mononuclear mixed-ligand oxidovanadium(IV) complexes to evaluate the behavior of these species in the biological media with the aim of the possible experimentation as potential metal based drugs.

Materials and Methods: All chemicals were purchased from commercial sources (Sigma Aldrich -India) and used without further purification. Reagent grade solvents were dried and distilled prior to use. Whereas, for testing the biological activity, bovine serum albumin (BSA) and calf-thymus DNA (CT-DNA) were procured from SRL (India) (biochemistry grade). Elemental analyses of the compounds were performed on a Vario ELcube CHNS Elemental analyzer. While FT-IR spectra were recorded on a Perkin-Elmer Spectrum RXI spectrophotometer, NMR spectra on a Bruker Ultrashield 400MHz spectrometer in presence of $SiMe_4$ as an internal standard, and electronic spectra on a Perkin Elmer spectrophotometer. Electro Spray Ionization mass spectra (ESI-MS) were obtained with a SQ-300 MS instrument. Whereas electrochemical data were collected using CH-Instruments (Model No. CHI6003E) using DMSO as a solvent and TBAP (tetra butyl ammonium perchlorate) as the supporting electrolyte at 298K in a dry nitrogen atmosphere using a Pt working electrode, Pt auxiliary electrode, and an Ag/AgCl as reference electrode.

Results and Discussion: The synthesized oxidovanadium(IV) complexes $[V^{IV}O(L^{1-3})(Bphen)]$ **(1-3)** (where $\mathbf{L^{1''3}}$ are ONO donor aroylhydrazone ligands incorporating heterocyclic quinoline derivatives and Bphen is 4,7-diphenyl-1,10-phenanthroline) were successfully characterized through several spectroscopic techniques such as FT-IR, NMR, UV-Vis. spectroscopy and ESI-MS. To evaluate the biological activity of the synthesized complexes **1''3**, their subsequent interaction with proteins was investigated. The interaction of the complexeswith BSA was indicated that the complexes showed moderate binding affinity towards BSA. Further, the complexes were also evaluated for their CT-DNA binding propensity through UV-vis absorption titration and fluorescence spectral studies. These results were consistent with BSA binding affinity (Binding constants K_b, in the range $3.9 \times 10^3$to 5.0×10^5 M^{-1}) and also showed moderate binding affinity towards CT-DNA (Binding constants K_b, in the range $1.15 \times 10^4$to 1.38×10^4 M^{-1}).

Conclusion/Recommendation: Both the DNA/BSA interaction data revealed that the complex **1** possesses highest binding affinity among all with an order of reactivity **1**>**2**>**3**. The outcome of the present study will boost further research on the design of dioxidomolybdenum complexes as metal-based agents for future anticancer studies.

Keywords: Oxidovanadium(IV) complexes, aroylhydrazone, biologically active, DNA interaction, BSA binding.

An alternative synthetic strategy to construct Nirmatrelvir analogues and its highly potent derivatives

Subhash Gole, B.R Das*, Sharad K Pasle

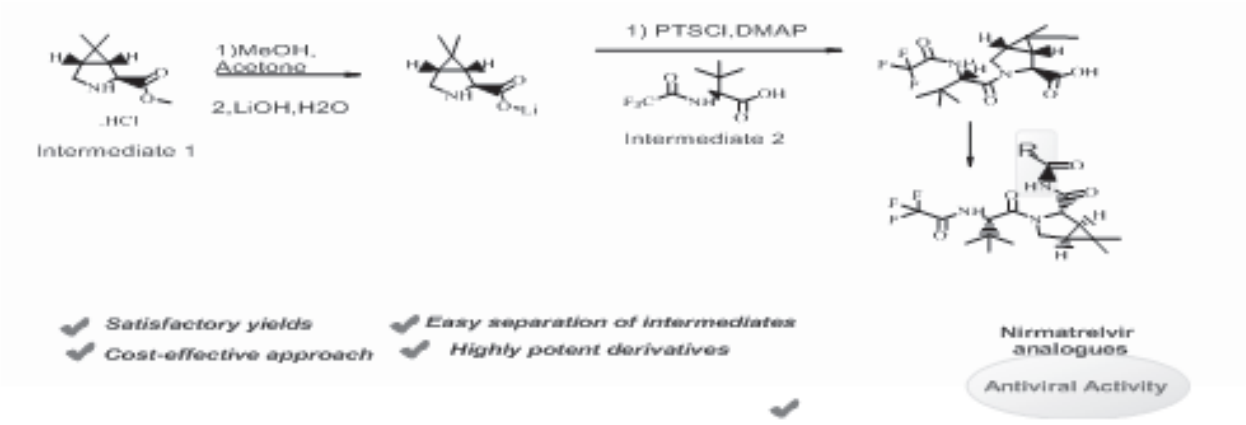
School of Basic Science and Humanities, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: brdas@cet.edu.in

Introduction: Antiviral compound is an important pharmacophore and is widely found in many biologically active compounds. In particular, amino acid peptide is an essential fragment present in pharmacologically important molecules, which include several antiviral drug Such as Nirmatrelvir, Favipiravir, Dolutegravir, Darunavir, Oseltamivir. Although a variety of synthetic methods for the synthesis of these important frameworks have been developed, most of them are limited in scope and require multistep preparation of the starting materials. Accordingly, development of straightforward and general methods for the synthesis of Amino acid peptide from easily available precursors is highly warranted. Herein, a general and efficient synthesis of Nirmatrelvir scaffold is depicted in below scheme

Materials and Methods: An alternative synthetic approach has been developed to access novel Nirmatrelvir analogues, providing a practical and cost-effective route to construct this privileged scaffold along with its amide derivatives, which may possess promising antiviral properties. This strategy employs less expensive reagents, readily available precursors, and a streamlined pathway with fewer intermediary steps, ensuring high yield and efficiency. This expanded functionality may increase the therapeutic versatility of the Nirmatrelvir analogues, contributing to broader antiviral potential. Compared to previous methods, this synthesis is notable for its simplicity, reduced reagent costs, and fewer reaction steps. In summary, this innovative synthetic route provides an accessible and efficient pathway to produce high-quality Nirmatrelvir analogues with promising biological applications.

Results and Discussion:



Conclusion/Recommendation: In summary, we have designed an alternative synthetic route to access a series of novel Nirmatrelvir derivatives. The method demonstrates easily affordable multi-step procedures that involve less expensive and readily available reagents and catalyst, leading to the targeted Nirmatrelvir analogues in good yields. In comparison to the other synthetic procedure

Keywords: Nirmatrelvir analogues, Antiviral synthesis, Cost-effective method, Amide Derivatives.

Molecular Modeling of Novel Thiophene Derivatives

Tapaswini Panda, Bijnyan Ranjan Das, Achyuta Nanda Acharya, and Rojalin Pradhan*

School of Basic Science and Humanities (Chemistry), Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: rojirojalin23@gmail.com

Introduction: Cancer remains a leading cause of mortality worldwide, necessitating the continuous exploration of novel therapeutic agents. Heterocyclic compounds containing sulfur, particularly thiophene derivatives, have gained significant attention in medicinal chemistry due to their diverse biological activities, including anticancer, anti-inflammatory, and antimicrobial properties. The introduction of a phenyl substituent to thiophene can enhance its pharmacological efficacy by improving lipophilicity, bioavailability, and metabolic stability.

Materials and Methods: AutoDock tools used to predict the binding interactions between small molecules (ligands) and target proteins, assisting in drug discovery. The docked complexes were analyzed in Biovia Discovery Studio to visualize ligand-protein interactions, including hydrogen bonding, hydrophobic, pi-pi interactions. The binding pose with the highest docking score (lowest binding energy) was selected for further analysis.

Keywords: Molecular docking, thiophene derivatives, phenyl substituent, HCT protein, anticancer, Molecular docking.

Results and Discussions: The molecular docking results revealed that the phenyl-substituted thiophene derivative exhibited strong binding affinity toward the HCT Protein. The ligand achieved a binding energy of -7.8 kcal/mol, indicating a stable interaction. The Root Mean Square Deviation (RMSD) values of the receptor-ligand complexes were within acceptable limits, further validating the accuracy of the docking results. The clustering histogram analysis of different ligand conformations demonstrated that the most populated cluster corresponded to the lowest energy conformation, confirming the binding preference.

Conclusion/Recommendation: Molecular docking analysis of the phenyl-substituted thiophene derivative with the HCT protein demonstrated strong binding interactions, highlighting its potential anticancer activity. These findings suggest that the phenyl-substituted thiophene derivative has significant potential as an anticancer agent against colorectal cancer, warranting further in vitro and in vivo studies to validate its therapeutic efficacy. Future work should focus on experimental validation to assess its pharmacokinetic and pharmacodynamic properties.

Keywords: Cancer cell, AutoDock tools, Thiophene, Bioactivity, Protein-ligand interaction.

Organic Disulfides: Synthesis, Characterisation and Their Application

Umakanta Pradhan,[1]Bijnyan Ranjan Das*[1], Swagat K. Mohapatra[2]

[1]School of Basic Sciences and Humanities, Odisha University of Technology and Research, Bhubaneswar, Odisha

[2]Department of Industrial and Engineering Chemistry, Institute of Chemical Technology-Indian Oil Campus, Bhubaneswar, Odisha

*Corresponding author E-mail: brdas@outr.ac.in

Introduction: Disulfides are chemical compounds containing two covalently bonded sulphur (-S-S-) linkage atoms. This linkage is formed by the oxidation of compounds containing thiol (-SH) groups, in presence of common oxidising agent as permanganates, sodium perborate, ferric chloride, Hydrogen Peroxide, chromate and dichromate etc . The major applications of these compounds are as a catalyst in [4+2] cycloaddition reaction, chemosensors(for thiols and metallic ions), prodrugs, hydrogels, nanocarriers and dopants of organic semiconductor for organic electronic devices such as organic photovoltaics (OPVs), organic field-effect transistors (OFET) etc, Tetrathianapthacene (IE-6-8ev) is used as n-dopant because of its high ionizational potential value. In this work, we have made an effort to synthesise, characterise and apply the compounds containing S-S bond as an efficient charge transport material. In order to enhance their efficiency as charge transportation, the structures were tuned. The synthesiseddisulphides are stable to air and can be utilized to dope organic semiconductors through both solution and vacuum process.

Materials and Methods:A mixture of thiols (1 mmol) and H2O2 (0.5 mmol) was stirred at 40ÚC in EtOH (5 mL). The reactions were monitored using TLC. After completion of the reaction, the volatile compound was removed under reduced pressure. The disulfides products were isolated in 93–97% yield.

Results and Discussion: The structure of the disulfides was established by NMR, IR and Single Crystal XRD technique. The thermal stability of each disulphide was analyzed by STA study. The major weight loss was observed within 250–350°C, leaving a minimum residue after 375°C. The DSC result reveals an endothermic transition at ~250°C. The Cyclic Voltametry analysis was performed in presence of ferrocene as reference. A reduction peak was observed at ~ -1.5 V leads to their n-dopant behaviour.

Conclusion/Recommendation: The synthesis of the above four disulphides in presence of simple oxidising agent are proved to be thermally stable within a range of 250–350°C and behave as n-type of dopants.

Keywords: Organic Semiconductor, OFETs, OPVs, Dopants.

Unravelling Social Learning and Influence: A Network Analysis of Information Diffusion and Migration Dynamics

Aditya Raj Dash*

Introduction: This working paper delves into the sophisticated world of social network analysis to investigate learning mechanisms and influence processes in groups of connected individuals.

Materials and Methods: The paper analyses in detail learning in such networks using conceptual models such as the Aggregation Model, DeGroot Model, and Bayesian Model. The models illuminate how individuals learn and combine knowledge from their counterparts, thereby influencing collective knowledge and possibly leading to the emergence of a consensus.

Results and Discussion: To enhance analysis, causal inference approaches isolate cause-and-effect in social interactions to distinguish between correlation and actual peer influence. Structural Causal Models (SCMs), Instrumental Variables (IV), and Propensity Score Matching approaches isolate the direction of influence to provide concrete conclusions of social learning processes. Natural Language Processing (NLP) is also employed to process patterns of communication, sentiment, and themes in social interactions to provide more detailed analysis of diffusion of opinion and information.

Conclusion/Recommendation: To bridge theory and application, the paper undertakes a case study of social networks' effects on patterns of migration. The empirical analysis uncovers the dynamic between individual decisions to migrate and social structure around it, pointing to the multifaceted nature of individual desires and pressures of peers.

Keywords: Social Network Analysis (SNA), Network Theory, Causal Inference, Structural Causal Models (SCMs), Learning Dynamics

Comparative Analysis of Newtonian and non-Newtonian Rheology Models for Patient-specific Coronary Blood Flow Simulation

Ashutosh Mohapatra, and Ranjan Kumar Pradhan*

Cognizant Technology Solutions, Pune, Department of Biotechnology, School of Electrical Sciences, Odisha University of Technology and Research,

Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: rkpradhan@outr.ac.in

Introduction: Coronary heart disease is the leading cause of death in the world and is primarily due to blockage in the left or right coronary arteries, which continuously supply blood to the beating heart. Patient-specific computational fluid dynamic models of coronary blood flow have emerged as a clinically important technology in recent years, to aid in the diagnosis and treatment of heart diseases. However, the assumption of blood rheology in computational fluid dynamic models has been subject to extensive debate and criticism in literature. Although blood exhibits shear-thinning non-Newtonian behaviour (where its viscosity increases in the low shear rate regime), its impact on beat-to-beat coronary flow simulation was unclear.

Materials and Methods: In this study, we aimed to investigate the differences of coronary hemodynamic metrics quantified in computational fluid dynamic simulations of blood flow with Newtonian and non-Newtonian fluid assumptions, in realistic coronary arterial tree. Three-dimensional idealistic and patient-specific coronary arterial models were constructed from 3D quantitative coronary angiography data obtained from open-source libraries. Input flow conditions and output pressure boundary conditions were prescribed for numerically solving the models using COMSOL multi-physics platform. Both steady-state and transient simulations were conducted to predict velocity and wall shear stress distributions across a left and right coronary arterial segments. We compared velocity and wall shear stress values in CFD models derived withNewtonian, Casson, and Carreau-Yasuda fluid assumptions.

Results and Discussion: In both steady-state and transient simulations, the Newtonian and non-Newtonian model difference on velocity was negligible. In the steady-state simulations (idealistic/patient-specific), the shear thinning effect was not obvious, but it was observable in low wall shear stress regions. In the non-steady model, the rheological difference of wall shear stress areas with low wall shear was enhanced during diastolic period.

Conclusion/Recommendation: we evaluated the effects of non-Newtonian rheology on coronary flow hemodynamic in coronary arterial tree under physiological conditions. It was demonstrated that most shear-thinning non-Newtonian models overestimate the rheology effects. Our preliminary results showed that activating shear-thinning behaviour only in regions of high flow stagnation produces qualitatively similar haemodynamic and quantitatively closer to a Newtonian model.

Keywords:Computational fluid dynamics; Coronary blood flow; Patient-specific modeling; Numerical simulation; COMSOL multi-physics.

Role of Extra-cellular Potassium in Regulating Neural Bursting: A Biophysical Modelling Study

Harapriya Biswasroy and Ranjan Kumar Pradhan*

Department of Biotechnology, School of Electrical Sciences, Odisha

University of Technology and Research, Bhubaneswar - 751029, Odisha, India

*Corresponding author E-mail: rkpradhan@outr.ac.in

Introduction: Abnormal oscillatory patterns are frequently observed in several brain tissues, and are hallmark of epileptic seizures and spreading depression. *In vivo*, neural oscillations are mainly generated by synaptically interconnected neuronal networks, whereas rhythmic bursting behavior is often induced *in vitro* by increasing extracellular potassium concentration. Although extra-cellular potassium ion is known to affect the reversal potentials of single neuron, it remained unclear whether elevated potassium triggers and propagates abnormal neuronal activities or plays a secondary role in disease.

Materials and Methods: Motivated by the *in vitro* observations of altered electrical activities in experimental models of brain slices, this study used a biophysical model neuron of neural bursting to explore the influence of extracellular ion dynamics on neural bursting. Both conductance and biophysical models of single neurons were used to elucidate the interaction between various non-synaptic factors and their roles in the transition from quiescence to rhythmic bursting. The model was modified by including a potassium ion component in the leak current, and the model behaviours were examined in response to varying concentrations of extra-cellular potassium. Specifically, the present model takes into account its effect on delayed rectifier potassium current responsible for post-spike hyperpolarization.

Results and Discussion: The simulation results indicate that (i) experimentally observed bursting behavior with elevated extra-cellular potassium may occur due to attenuation of the delayed rectifier potassium current and (ii) oscillations are supressed with physiological levels of extracellular potassium. These results indicate that, neurons that naturally burst in *in vitro* preparations may not be able to burst *in vivo*. Thus, rhythmic neural activity *in vivo* may depend more on nonsynaptic and other potential mechanisms.

Conclusion/Recommendation: To define effective drugs and therapies for neuronal diseases, it is important to better understand the underlying causes of altered neural rhythms not only in disease state, but also in normal conditions. The present modeling study offers considerable insights into how the cellular mechanisms may produce abnormal oscillatory patterns in spreading depression and other diseases.

Keywords: Biophysical Model; Neural Excitability; Bursting; Extracellular potassium; Spreading depression; epileptic seizures; Neurovascular-coupling.

Parameter Uncertainty and Sensitivity Analysis of Windkessel Model of Blood Pressure Waveform

Nishant Panda, Sudeshna Sutar, and

Ranjan Kumar Pradhan*

Department of Biotechnology, School of Electrical Sciences, Odisha

University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: rkpradhan@outr.ac.in

Introduction: The Windkessel model (WK) has been extensively used to mathematically represent human systemic circulation and outflow boundary conditions in computational fluid dynamic simulations. While WK model is useful for studying blood flow dynamics in various tissues, it often suffers from inaccuracies or uncertainties that need to be considered when using it for physiological or pathological predictions. Although several WK models have been proposed, their efficacy in accurately representing blood pressure waveforms in different vascular regions was not explored earlier.

Materials and Methods: In this study, three different WK models (e.g., 2-element WK, 3-element WK and 4-element WK) were selected to examine their effects on accurate representation of experimentally observed blood pressure distribution in coronary vasculature. Model parameters were estimated from experimental data on aortic blood pressure waveforms from various studies. We proposed an efficient uncertainty quantification and parameter sensitivity analysis framework to analyze data from various experimental conditions. Model parameters were used as outflow boundary conditions in a 3D model of coronary arterial tree where inlet velocity data were used as initial conditions. Performance of these models were evaluated to capture realistic pressure waveforms.

Results and Discussion: The simulation results revealed, the arterial blood pressure waveforms are successfully simulated and achieve acceptable agreement with the previous study. The effect of varying peripheral resistance and changes in blood pressure were captured accurately as that was observed in experiments. The present analysis suggests, compared to 2-element and 3-element WK models, the 4-element WK model seems more reliable in predicting the arterial blood pressure waveform associated with cardiovascular diseases.

Conclusion/Recommendation: This study provides a comprehensive assessment of the uncertainty quantification of blood pressure waveforms generated by the WK model and flow waveform, which has important implications for improving cardiovascular risk assessment and healthcare.

Keywords:Windkessel Model; Arterial blood pressure, Uncertainty quantification, Sensitivity analysis; Mathematical modeling; Computational fluid dynamics.

A Deep Learning-based Segmentation Framework for Efficient Detection Red Blood Cells Morphology in Thalassemia

Satabdi Mishra, and Ranjan Kumar Pradhan*

Department of Biotechnology, School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: rkpradhan@outr.ac.in

Introduction: Thalassemia is a genetic blood disorder characterized by abnormal hemoglobin with varying red blood cell (RBC) morphology. Early detection and accurate segmentation of RBC morphologies from peripheral blood smear images have been crucial for efficient diagnosis of this multifactorial disease. Because traditional manual examination of RBC morphometry is time-consuming and prone to error, automated image segmentation techniques using machine learning have been extensively applied in recent years showing reliable computer aided diagnosis. However, accuracy of these models is largely affected by several factors including, model over fitting, lack of adequate data from same patient, large computational time, making image-based diagnosis highly challenging. More recently, deep neural networks are widely used in biomedical image analysis, showing promising direction to improve image guided diagnosis.

Materials and Methods: This study focuses on the application of deep learning method for efficient segmentation of RBCs showing varying degree of morphological changes in their shape, size and density, observed experimentally in blood smear of patient with thalassemia. Various image pre-processing methods including morphological operations, watershed transformation, and Distance Angle Signature features were used to characterize the RBC shapes and features. Both traditional machine learning algorithm (Support Vector Machine, SVM) and deep learning algorithm (Convolutional Neural Network, CNN) were used to classify cell types to distinguish normal RBCs from abnormal RBCs. Blood smear images were obtained from publicly available databases and several preprocessing techniques ere explored (such as grayscale conversion, contrast enhancement, and noise reduction using a median filter) before applying segmentation algorithms. Watershed algorithm is applied to separate overlapping cells. Morphometric features, texture, color intensity was extracted for each image and SVM and CNN are employed for classification of abnormal RBCs, and model performances were evaluated.

Results and Discussion: The proposed deep learning framework is able to detect seven different abnormal shapes of RBC observed in thalassemia and found to outperform classical SVM-based segmentation demonstrated in this study. However, for overlapping cells, Otsu's thresholding and watershed transformation-based segmentation was found to be effective, specifically for cases with greater Dice Similarity Index indicating a high overlap between segmented images and ground truth images. The CNN model achieved an impressive classification accuracy of around 96.00% compared to that of SVM classifier that shows ~92.00% accuracy. The confusion matrix showed most of the abnormal RBCs were correctly identified, and only a few normal RBCs were misclassified, demonstrating the robustness of the framework.

Conclusion/Recommendation: While classical segmentation techniques are powerful to analyze small size data, the deep learning-based RBC morphology detection framework proposed here provide promising direction to apply for classification of large-scale blood smear images of patients with thalassemia.

Keywords:Thalassemia detection; feature extraction; image segmentation; support vector machine; convolutional neural networks; classification.

Experimental Determination of the Effect of Mechanical Haemolysis on ATP Release from Erythrocyte: A Pilot Study

Satabdi Mishra and Ranjan Kumar Pradhan*

Department of Biotechnology and School of Electrical Sciences,

OUTR, Bhubaneswar - 751029, Odisha, India

*Corresponding author E-mail: rkpradhan@outr.ac.in

Introduction: Mechanical deformation of human erythrocytes (red blood cells) plays crucial role in determining the rheological properties of the blood, and efficient passage through capillaries for meeting tissue metabolic needs. Although numerous physical and chemical stimuli are known to initiate ATP release from erythrocytes, the extent to which mechanically-induced damages to red blood cell influence the membrane ultrastructure and oxygen sensing function remained unclear. Furthermore, mechanical hemolysis is frequently observed during blood transfusion and heart valve surgeries, which is often life threatening. Thus, a quantitative understanding of mechanical factors (*in vitro* and *in vivo*) modulating the efflux of ATP is key to understand the mechanism of oxygen sensing by erythrocytes in exercise and disease states (e.g., haemolyticanaemia, valvular disease).

Materials andMethods: In this work, we have experimentally evaluated the influence of key mechanical forces on erythrocyte membrane fragility and morphology. Specifically, three different techniques (micro pipetting, centrifugation and vertexing) were used to induce membrane deformation in isolated erythrocytes, and haemolysis was quantified by measuring supernatant haemoglobin spectrophotometrically. Hemoglobin calibration was done using the cyan-methaemoglobin method and ATP release was measured using luciferin-luciferase assay.

Results and Discussion: It was found that the healthy erythrocytes are highly susceptible to mechanical stress irrespective of the experimental conditions (pH, Temperature and buffer composition) and source of blood. Centrifugation was found to act as a strong stimulus for hemolysis and can potentially alter the measurement of haemoglobin absorbance in clinical settings and laboratory studies, *in vitro*. This experimental study provides a novel means of controlling mechanically-inducedhaemolysis in a variety of biochemical assays that are basically aimed at defining the role of erythrocyte ATP release in controlling oxygen delivery to match tissue metabolic demands in health and disease.

Conclusion/Recommendation: This preliminary study suggests, mechanical hemolysis due to laboratory procedures can significantly confound the ATP measured *in vitro*, to various chemical stimuli, and hence must be minimized for successful interpretation of oxygen sensing role of red blood cells through ATP release and membrane permeability of erythrocytes.

Keywords: Erythrocyte; Mechanical Hemolysis; Centrifugation; ATP Transport; Bioluminescence Assay.

Evaluating the Performance of Pam-Tompkins Algorithm for QRS Detection in Arrhythmia from Noisy ECG Signals

Subhashree Behera and Ranjan Kumar Pradhan*

Department of Biotechnology, School of Electrical Sciences,

Odisha University of Technology and Research, Bhubaneswar - 751029, Odisha, India

*Corresponding author E-mail: rkpradhan@outr.ac.in

Introduction: Detection of QRS complex in clinical electrocardiogram (ECG) signal is a fundamental step in ECG-based cardiac health monitoring. The Pan-Tompkins algorithm has been the most widely used QRS complex detector in arrhythmia monitoring in many ECG devices. It is generally believed that this method could provide good detection accuracy for large-scale ECG analysis using advanced machine learning or deep learning-based arrhythmia diagnosis. However, numerous types of noise and artefacts exist in an ECG signal resulting in very low-quality signal data. Therefore, a thorough analysis and testing of the performance of Pan-Tompkins-based QRS detection is necessary for noisy ECG signals of arrhythmia patients, before one implements it for practice.

Materials and Methods: In this work, we have used MIT-BIH arrhythmia data to estimate single heartbeats from the continuous ECG signals (with a sampling frequency of 125 Hz) using the Pam-Tompkins algorithm. The algorithm uses a number of steps in finding R-peaks in the signal, including edge recognition and search steps for identifying R-peaks and implemented in MATLAB. Specifically, detecting every R-peak is the same as obtaining a single heartbeat. Noisy test data were also analyzed for verifying the QRS waveform detection accuracy and obtaining the P, R, and T-peaks for individual ECG signal.

Results and Discussion: From the present analysis of these signals, it was found that the algorithm can manage a signal with noise up to 12 dB signal-to-noise ratio (SNR). For SNR higher than 12 dB, results with a minimum level of noise were increasingly attained, and for SNR values lower than 6 dB, the Sensitivity decreased depending on the amount of noise in the signal.

Conclusion/Recommendation: The present analysis verified the performance of the Pan-Tompkins algorithm in the detection of QRS complexes in noisy ambulatory ECG data with varying signal-to-noise ratios and standard arrhythmia data. This method may be suitable for automatic arrhythmia detection in noisy environments where signal recordings are done using portable ECG devices.

Keywords: Electrocardiogram; Noise Filtering; QRS Complex; Signal Processing; Pam-Tompkins Algorithm; Arrhythmia.

Development and Characterization of Starch-Chitosan based Bioplastic: A Sustainable Alternative to Synthetic Polymers

Supriya Dash*, Rutuparna and Anil K Gouda
Department of Biotechnology
Orissa University of Technology and Research (OUTR)
Bhubaneswar
*Corresponding Author Email: dashsupriya08@gmail.com

Introduction: The growing use of petroleum-based plastics poses environmental concerns due to their non-biodegradability and accumulation as waste. Although recycling efforts exist, they face challenges in maintaining the quality of recycled plastic. Biodegradable plastics offer an eco-friendly solution, with starch-based bioplastics gaining attention due to their availability and renewability. Research focuses on blending starch with natural polymers like chitosan to enhance mechanical properties. The study investigates the influence of starch concentration and process conditions on bioplastic performance, particularly in terms of tensile strength, biodegradability, and water resistance.

Material and Methods: The study used boiled rice water starch, chitosan, and additives to synthesize bioplastics. Starch was extracted from boiled rice water, dried, and powdered. Chitosan was dissolved in 5% acetic acid and mixed with starch, urea, and plasticizers, then heated to 75°C to form bioplastic films.The bioplastics were tested for tensile strength, water absorption, and biodegradability. FTIR, XRD, and SEM analyses were conducted to examine chemical structure, crystallinity, and surface morphology.

Results and Discussion: Bioplastics were synthesized using different concentrations of starch and glycerol. The composition significantly affected stability and strength, with 10% starch and 3% glycerol providing the best balance. The tensile strength of the bioplastic films was tested, with results indicating that higher starch concentrations increased brittleness, while glycerol improved elasticity. Solvent Uptake Test indicates that hydrophilic nature of the bioplastics led to rapid water absorption. Chitosan-reinforced films absorbed less water compared to pure starch-based films. Biodegradation Test indicates weight loss of bioplastics increased with burial time, indicating degradation. Chitosan-reinforced films degraded more slowly due to their antimicrobial properties. The presence of functional groups in FTIR in the bioplastics was confirmed, indicating interactions between starch, chitosan, and glycerol. Crystallinity of the films was analyzed in XRD study, showing that glycerol molecules disrupted the starch's crystalline structure. In SEM Analysis Morphological analysis revealed voids and incomplete dissolution of chitosan, which affected tensile strength. Results confirmed successful bioplastic formation with promising properties.

Conclusion/Recommendation: In this study successfully synthesized bioplastics using boiled rice water and chitosan, forming thin films. The optimal composition (10% starch, 3% glycerol, and 0.5% chitosan) exhibited good mechanical properties, with a tensile strength of 5.001 mPa and 30% elongation over 71.4 seconds. Higher starch content increased brittleness, while lower starch led to poor formation. The bioplastic absorbed water (41%), acid (35.5%), and base (39.5%). It showed biodegradable properties, degrading over 30 days. Hence the present study confirmed towards utilizing low cost or no cost feedstocks, as sustainable raw material for bioplastic production.

Keywords : Bioplastic, Chitosan, Fish scale, Boiled rice water, FTIR, SEM

Computational Fluid Dynamics Analysis of Carotid Artery Hemodynamics in Atherosclerotic Occlusive Disease

Wrootchit Mishra and Ranjan Kumar Pradhan*

Department of Biotechnology and School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar - 751029, Odisha, India

*Corresponding author E-mail: rkpradhan@outr.ac.in

Introduction: The hemodynamic environment of the human carotid bifurcation plays a critical role in the initiation and progression of the atherosclerotic occlusive diseases, where complex flow patterns and variations in localized shear stress have been shown to contribute to vascular and pathology. Traditional computational studies often assume Newtonian blood flow which, neglects the true rheology of the blood (e.g., shear-thinning and viscoelasticity properties), which significantly affects flow profiles, wall shear stress, and severity of disease. Therefore, numerical simulations using the computational fluid dynamics approach provide an alternate platform to study the complex pathophysiology of carotid stenosis and aneurysm.

Materials and Methods: In this study, we used both idealistic and patient-specific models of carotid bifurcation to assess the impact of non-Newtonian blood rheology on the internal carotid artery, carotid sinus, and carotid apex hemodynamic.Simulations were performed in ANSYS Fluent with four different non-Newtonian viscosity models to identify most efficient representation of physiological and pathological hemodynamics.

Results and Discussion: The present simulation results indicate, (i) compared to the Newtonian model, the non-Newtonian Carreau-Yasuda model seems more accurate in describing hemodynamic indices used for diagnosis, (ii) non-Newtonian effects lead to lower viscosity and higher velocity gradients in high-shear regions, (iii) while low wall shear stress zones are more prone to stenosis formation, as apparent from non-Newtonian cases compared to the Newtonian assumptions analyzed in this study, (iv) the carotid sinus and carotid apex show the complex shear distribution in patient-specific models of carotid bifurcation compared to idealistic representation.

Conclusion/Recommendation: This study provides important insights into carotid hemodynamics in cerebral aneurysm and provides a basis to develop whole body hemodynamic models of cerebral circulation.

Keywords: Atherosclerotic Occlusive Disease; Computational Fluid Dynamics; Non-Newtonian blood flow; Carotid bifurcation; Aneurysm formation.

Insights into Feed-forward Regulation of Glycolysis in Human Red Blood Cell by Flux Balance Analysis

Victor Pradhan and Ranjan Kumar Pradhan*

Department of Biotechnology, Centurion University of Technology and Management, School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar - 751029, Odisha, India

*Corresponding author E-mail: rkpradhan@outr.ac.in

Introduction: Regulation of cellular biochemical networks and glycolytic enzymes are key to understanding the mechanisms of several diseases. Glycolysis has been the primary metabolic pathway for glucose metabolism in human red blood cell that is extensively studied in terms of its enzyme kinetics. Defects in glycolytic enzymes are known to be associated with hemolytic anaemia, hereditary diseases and several metabolic functions of circulating red cells. Although a number of kinetic modelling and experimental approaches have been proposed to study the factors affecting glycolytic fluxes *in vivo*, there remains gaps in our understanding of how different regulatory enzymes (HK, PK, PFK etc.) may interact to enhance ATP synthesis in health and disease. Recently, constraint-based modelling have been successfully applied to various tissues to elucidate complex biochemical network functions and regulatory enzymes. However, interpreting experimentally observed kinetics in isolated enzymes remains challenging in terms of their actual roles in intact cells.

Materials and Methods: in this work we have used a robust metabolic modelling platform JWS Online to explore potential feed-forward and feedback control pathways of glycolysis and examined their effects on oxygenation-dependent flux distribution and changes in intracellular metabolites. Dynamic models of erythrocyte glycolysis (one without involving pentose phosphate and nucleotide metabolism pathways and with contribution from PPP and nucleotide metabolic pathway) are simulated to compare their efficacy in capturing experimentally observed phenomena on glycolysis flux control, at constant pH, temperature and under normal physiological state. Both metabolic control analysis and flux balance analysis were conducted to see if fee-forward control has any significance on resulting changes in metabolites, observed in LC-MS/GC-MS experiments under stress.

Results and Discussion: Flux balance analysis of glycolysis revels, in the absence of forward activation, increase in level of PG23 could compromise ability of hemoglobin to carry oxygen.The present study clearly demonstrated that the normoxic glycolysis is significantly influenced by the activation of PK by FBP, the inhibition of HK by F6p, and the activation of PFK by 2,3 BPG.

Conclusion/Recommendation: Comparison of simulation results with experimental data gives important insights about how steady-state metabolite concentrations may alter as a result of enzyme-enzyme interactions in disease state. The insights obtained from present flux balance analysis is useful to develop detailed model of red cell metabolism and in designing suitable experiments to study the mechanisms of glycolysis control in hemolytic anaemia and other diseases.

Keywords: Metabolism; Glycolysis Control**;** Flux-balance Analysis; JWS Online; Red blood Cell.

Estimating Cognitive Load Using Thinking Ability and Emotional Resilience: A Fuzzy Logic-Based Approach

Bichitra Mandal, Subasish Mohapatra and Subhadarshini Mohanty*

School of Computer Science, Odisha University of Technology and Research,

Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail:sdmohantycse@outr.ac.in

Introduction: Cognitive Load (CL) is a key determinant of cognitive performance and Working Memory (WM), influencing attention and information retention. This study presents a fuzzy logic-based approach to estimate CL using two fundamental cognitive parameters: Thinking Ability (TA) and Emotional Resilience (ER), derived from EEG signals. By integrating AI-driven fuzzy modelling with real-time electroencephalography (EEG) data, this research provides an adaptive framework for assessing cognitive states under varying task complexities.

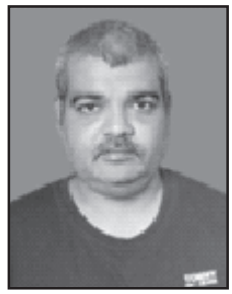
Materials and Methods: The study reported that EEG data were collected from targeted electrode pairs Fz-Cz, T4-T6, P3-O1 while participants engaged in cognitive tasks such as mathematical problem-solving, reading, and decision-making. Features related to TA and ER were extracted using signal processing techniques and used as inputs for a fuzzy inference system (FIS). The FIS employed a set of expert-defined rules to classify CL into low, medium, and high levels, evaluating its impact on Working Memory (WM) efficiency.

Results and Discussion: It has been discovered that fuzzy logic models can reliably estimate CL based on the analysis of EEG signals, thus well representing task difficulty and performance of participants. It has been noted that high CL adversely affects WM, whereas high TA and ER individuals experience low CL, which results in improved WM performance. Conversely, individuals with low TA and ER are more likely to experience cognitive overload, reducing WM capacity. Fuzzy logic has been said to offer a flexible and interpretable model for real-time CL evaluation, responding to cognitive dynamics. The models have been shown to categorize CL according to TA and ER, reflecting individual differences in cognitive and emotional states. It has been proposed that the combination of fuzzy logic with EEG analysis provides an integrated understanding of cognitive and emotional interaction, enabling personalized interventions to control CL. The efficacy of fuzzy logic in real-time estimation of cognitive state has been confirmed by comparative studies, emphasizing its excellence in subtle CL evaluations. Its interpretability has been observed to increase applicability in educational and workplace environments, guiding task design to maximize performance. In conclusion, it has been determined that fuzzy logic and EEG combined offer a strong method to estimate CL with the ability to accommodate the sophistication of human cognition and emotion as well as provide useful information about factors affecting WM performance.

Conclusion: The study emphasized the utility of fuzzy logic in estimating CL based on TA and ER, providing insights into its impact on WM. The proposed model was suggested to offer a foundation for optimizing cognitive performance and mental well-being.

Keywords: Cognitive Load (CL), Working Memory (WM), Emotional Resilience (ER), Thinking Ability (TA), Electroencephalography (EEG), Fuzzy Logic

Programmable and Customized Intelligence for Traffic Steering in 5G Networks Using Open RAN Architectures



Chittaranjan Panda, Jibitesh Mishra* and Sanjit Kumar Dash

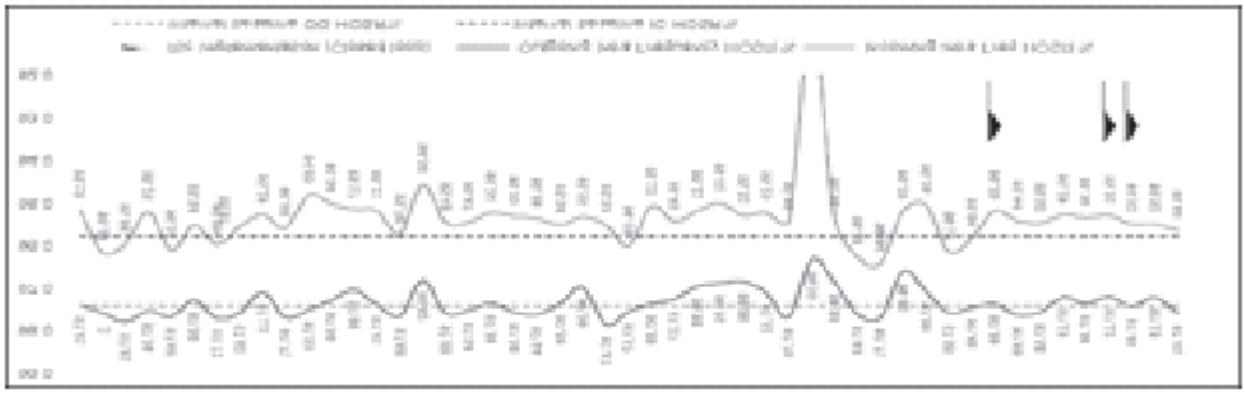
School of Computer Science, OUTR,, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: jmishra@outr.ac.in

Introduction: As 5G networks become integral to the advancement of modern communication systems, the challenge of optimizing network performance while ensuring high user experience (UE) becomes increasingly complex. In particular operators must maximize cell spectral efficiency—the ability of the network to transmit data relative to the spectrum it utilizes—while minimizing issues such as Radio Link Failures (RLF) and Radio Connection Establishment Failures (RCEF), which can significantly degrade the network's overall performance. This study aims to address these issues by employing an innovative Deep Reinforcement Learning (DRL) [1] technique based on a Deep Q-Network (DQN) [2] to optimize essential network parameters in 5G environments.

Materials and Methods: The dataset for our study comprises 10 million samples collected from MAVENIR IT Company, encompassing a comprehensive set of Key Performance Indicators (KPIs) and traces essential for in-depth network analysis. The Performance Metrics (PM) dataset includes RSRP level distribution, RSRQ level distribution, RACH usage, power utilization, CQI distribution, UE power headroom, RRC connection-related statistics, E-RAB related statistics, PRB usage, radio link failure data, and UL interference power measurements.

Results and Discussion: To evaluate the performance of our Deep Reinforcement Learning (DRL)-based model, we conducted a comparative analysis with the Self-Organizing Network (SON) [19] model. The DRL-based model demonstrates superior accuracy in predicting configuration metrics such as maximum transmission power, reference signal transmission power, P_a and P_b, and antenna tilt. Additionally, it exhibits better adaptability to dynamic network conditions compared to the SON model. The graphical representations highlight the DRL model's capability to learn optimal parameter settings efficiently while maintaining higher prediction precision and stability compared to the SON model. These insights underscore the robustness of our proposed approach in handling complex network optimization tasks



Conclusion/Recommendation: In conclusion this study demonstrates the successful application of Deep Reinforcement Learning (DRL), specifically a Deep Q-Network (DQN), for optimizing critical network parameters in 5G environments.

Keywords: DRL , RACH, RSRQ,RRC,E-RAB, Deep Q-Network (DQN)

Underwater Image Enhancement using Real-ESRGAN

Debi Prasad Mishra, and Subham Swain*

School of Computer Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: subham2swain@gmail.com

Introduction: This paper presents a novel underwater picture improvement method based on Real-ESRGAN (Enhanced Super-Resolution Generative Adversarial Network). A modified Real-ESRGAN architecture has been employed to solve the degradation of underwater images caused by light absorption and scattering effects in aquatic environments. The suggested technique effectively reduced various underwater image distortions, such as color cast, low contrast, and blur effects. A large collection of underwater photos was used to train the network, and the experimental results showed notable gains in visual quality in various underwater conditions. Standard metrics like PSNR and SSIM were used for quantitative evaluations, and the results showed higher performance when compared to modern improvement approaches.

Materials and Methods: To provide complicated training and, consequently, achieve better testing outcomes, some real-world photos were required. Therefore, the DIV-2K dataset which includes 100 photos for testing and 800 images of 2K resolution was selected for training. A Residual-in-Residual Dense Block (RRDB block) was utilized in the generator for effective training under complex conditions. A U-Net discriminator with spectral normalization was additionally employed to eliminate unnecessary complicated computations and stabilize the training process. The size of the training Higher Resolution (HR) patch was set at 128.PyTorch was used to implement all the degradation processes using Cuda acceleration. A batch size of 12 was selected and NVIDIA RTX 4070 Super GPU was used to train the models. Real-ESRGAN was trained for 400K iterations and 2666 epochs.

Results and Discussion: For testing, the USR-248 dataset, which consists of 248 real underwater images of varying resolutions, was used. This dataset includes four categories of lower-resolution (LR) images. The test images were selected from the folder containing LR underwater images with a resolution of 320 × 240 pixels. For comparison, the higher-resolution (HR) images, stored in a separate folder, had a resolution of 640 × 480 pixels. The trained model generated HR underwater images with an enhanced resolution of 1280 × 960 pixels, effectively upscaling them by a factor of four. The average Peak Signal-to-Noise Ratio (PSNR) calculated across all 248 images was 32.61 dB, while the average Structural Similarity Index Measure (SSIM) was determined to be 0.88.

Conclusion/Recommendation: An RRDB block was used in the generator and U-NET discriminator was used in network architecture. As a result, more intricate and challenging-to-restore real-world underwater photos can be processed by this method. This model is founded upon super-resolution and restoration principles. Ground truth photos with a resolution of 128 x 128 pixels were used by this model. This result could be significantly enhanced by higher resolution ground truth photos.

Keywords: Underwater Image; Real ESRGAN; Generative Adversarial Network; Image Enhancement

Comparative Analysis of Feature Selection Methods and Ensemble Learning Models for Heart Disease Prediction

Dipak Kumar Sahoo*, Subasish Mohapatra and Subhadarshini Mohanty

School of Computer Sciences, Odisha University of Technology and Research, Ghatikia, Kalinga Nagar, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: dipak.dksahoo@gmail.com

Introduction: The Internet of Medical Things (IoMT) integrates smart healthcare devices to facilitate real-time monitoring, predictive analytics, and improved clinical decision-making. Cardiovascular disease remains a leading cause of mortality worldwide, necessitating the development of advanced predictive models for early diagnosis and effective intervention. This study utilizes IoMT-driven data alongside feature selection techniques, including Principal Component Analysis (PCA) and Random Forest (RF), to optimize classification accuracy. A comparative analysis of ensemble learning models and deep learning techniques is conducted to evaluate the effectiveness of the proposed approach in heart disease prediction. By leveraging IoMT and advanced machine learning algorithms, this study demonstrates that integrating smart healthcare technologies with predictive modeling enhances early detection, providing significant potential for improving cardiovascular healthcare outcomes and reducing mortality.

Materials and Methods: This study leverages IoMT-generated physiological data, including heart rate and blood pressure, for cardiovascular disease prediction. Principal Component Analysis (PCA) is employed for dimensionality reduction, optimizing feature selection. An ensemble learning approach integrates Random Forest, XGBoost, CatBoost, AdaBoost, and LightGBM to enhance predictive accuracy. The Firefly Algorithm is utilized for hyperparameter tuning. Deep learning further refines classification performance. Model evaluation is conducted using a confusion matrix, analyzing precision, recall, F1-score, and accuracy. This methodology ensures robust, scalable, and efficient disease prediction, facilitating proactive patient care through real-time monitoring and data-driven interventions.

Results and Discussion: The study evaluates the impact of Principal Component Analysis (PCA) on fetal health classification using multiple machine learning models. The results indicate that applying PCA significantly enhances model performance by reducing dimensionality and eliminating redundant features, leading to improved classification accuracy and computational efficiency. Without feature selection, models suffer from increased complexity and overfitting, particularly in high-dimensional spaces. Among the evaluated models, XGBoost achieves the highest accuracy with PCA, outperforming other classifiers such as Random Forest, Gradient Boosting, and Deep Neural Networks. Notably, the PCA-transformed dataset exhibits higher F1-scores and ROC-AUC values, confirming its effectiveness in distinguishing fetal health conditions. In contrast, models trained without feature selection demonstrate fluctuating performance due to irrelevant attributes impacting decision boundaries. The study highlights PCA's ability to retain critical variance while mitigating noise, making it a suitable pre-processing technique for clinical applications. However, its linearity assumptions may limit effectiveness in capturing nonlinear patterns, suggesting the need for hybrid approaches incorporating nonlinear dimensionality reduction. Future research should investigate deep feature extraction methods and ensemble learning strategies to further enhance diagnostic accuracy. These findings emphasize the role of feature selection in optimizing predictive models for fetal health monitoring, supporting informed decision-making in prenatal care.

Conclusion/Recommendation: This study demonstrates PCA's effectiveness in enhancing ML model performance for fetal health classification. Future work should explore advanced feature selection techniques and hybrid models to improve diagnostic accuracy and robustness.

Key words: IoMT; Internet of Medical Things; Cardiovascular Disease Prediction; Feature Selection; PCA; Ensemble Learning; Deep Learning; FireFly.

Enhanced Alzheimer's Disease Classification Using a Hybrid ResNet50 and Visual Transfer Learning Model

Kumar Janardan Patra, Jibitesh Mishra* and Sanjit Kumar Dash

School of Computer Science, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: jmishra@outr.ac.in

Introduction: Alzheimer's disease (AD) is a progressive neurodegenerative disorder and one of the leading causes of cognitive decline worldwide. Early and accurate classification of AD is crucial for effective treatment and management. The main objective of the study was to classify Alzheimer's disease using a hybrid deep learning model that combines ResNet50 and Visual Transfer techniques for improved accuracy and robustness.

Materials and Methods: The study was conducted using an open-access dataset containing MRI scans of subjects diagnosed with Alzheimer's disease and healthy controls. The hybrid model leveraged the feature extraction capability of ResNet50 and enhanced classification performance through Visual Transfer learning. The dataset was preprocessed to normalize intensity values and augment training samples. The model was trained using a stratified k-fold cross-validation approach. Accuracy score, specificity, sensitivity, precision, and recall were evaluated to assess model performance.

Results and Discussion: The proposed hybrid model achieved an accuracy of 98.39%, demonstrating superior classification performance. The specificity and sensitivity values were 0.93 and 0.92, respectively, indicating high reliability in distinguishing AD cases from healthy controls. Precision and recall values were 98.01 and 97.89, respectively, confirming the model's ability to accurately identify true positive cases. The ResNet50 backbone effectively extracted critical features, while Visual Transfer learning enhanced generalization across different subjects. The model exhibited robust performance against variations in MRI scan quality and patient demographics. Additionally, comparative analysis with existing classification methods revealed significant improvements in both accuracy and interpretability. Feature visualization demonstrated that the hybrid approach could capture subtle structural changes associated with AD, which are often challenging to identify. The use of Visual Transfer learning contributed to better feature discrimination, improving classification reliability. Furthermore, statistical analysis of model predictions indicated a low misclassification rate, enhancing confidence in automated AD diagnosis. These results underscore the potential of deep learning in medical imaging applications and highlight the importance of integrating transfer learning techniques for improved classification performance.

Conclusion/Recommendation: Hence, the hybrid ResNet50 and Visual Transfer model demonstrated exceptional performance in classifying Alzheimer's disease. Future research should explore further optimization techniques, including ensemble learning and domain adaptation, to enhance model robustness across diverse datasets.

Key words: Land Alzheimer's disease; Deep learning; ResNet50; Visual Transfer; Classification accuracy

A Novel IOT Based Efficient Waste Management System

Manjit Kumar Nayak*, Kajal Shaji and Debasis Gountia

School of Computer Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: manjitcsa@outr.ac.in

Introduction: Waste is generated in bulk from household, industries and other commercial places. In present scenario one of the major problem is waste management due to which the entire world is suffering in some way or the other. And the most important problem in each and every place is the dustbins placed in public areas becomes overflow before next removal of waste and leads to various health hazards by spreading various kinds of diseases. To handle this problem, we propose an efficient IOT enabled waste management system.

Materials and Methods: In our proposed methodology we have used an ultrasonic sensor which indicates the level of waste accumulated and transmits the position timely to waste monitoring unit and the corresponding unit which is in charge of this will be taking immediate action to clean it. Ultrasonic sensor senses the dust level and passes the information to the Arduino Controller to read the distance that displays the percentage of garbage in the bin. The Adruino sends percentage of waste to Ethernet shield which transmits the data to LAN server. After every 5 second dustbin levels are updated . The percentage of waste in the waste bins is detected by the Sensors, through GSM it is communicated to the authorized control room. Micro controller acts as an intermediary beweensensors and GSM.

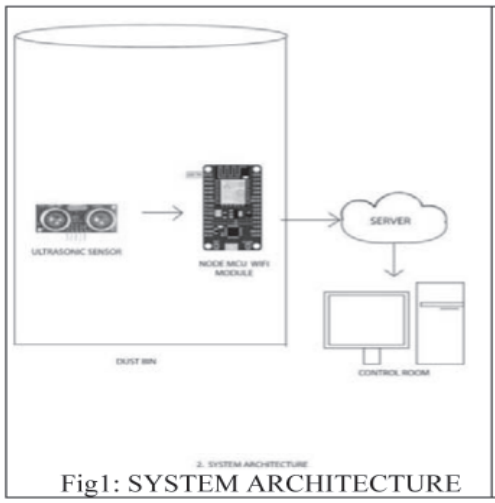


Fig1: SYSTEM ARCHITECTURE

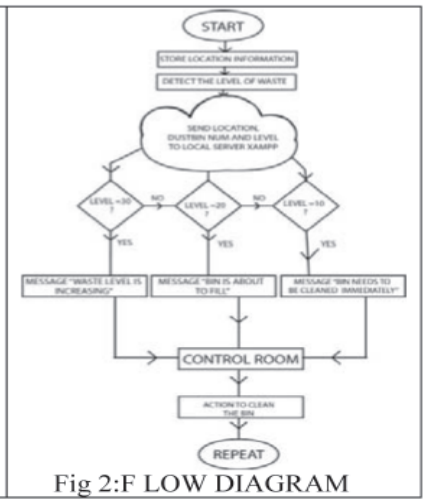


Fig 2:F LOW DIAGRAM

Fig3:SYSTEM

Results and Discussion: In our proposed model automatic Waste filling and cleaning system is implemented using IoT equipments like Ultrasonic Sensor and Node MCU. This proposed IOT model promises the washing of waste bins as soon as possible when the garbage level reaches its maximum. In the due course it maintains hygiene in the environment and helps the waste maintenance more efficiently.

Conclusion/Recommendation: In future we aim for real time implementation of the proposed model .The efficiency and robustness of the proposed model may be improved and the researchers can focus on multiple implementation of the proposed model at a reduced cost .

Key words: Waste management, IoT, Dustbin.

EFL: An Efficient Federated Learning-basednSmart and Secure Healthcare System

Rabinarayan Mohanty and Ranjan Kumar Dash*

School of Computer Science, Odisha University of Technology and Research,

Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: drranjandash@gmail.com

Introduction: Secure machine learning solutions are crucial for efficient analysis of information for current healthcare system without compromising private patient data. Federated Learning (FL) is a secure infrastructure that allows several institutions to work together on model training without exchanging raw data. To improve healthcare ecosystem, this proposed Efficient Federated Learning (EFL) model offers a powerful FL architecture that integrates cross-device and hierarchical federated learning in a multi-hospital network.

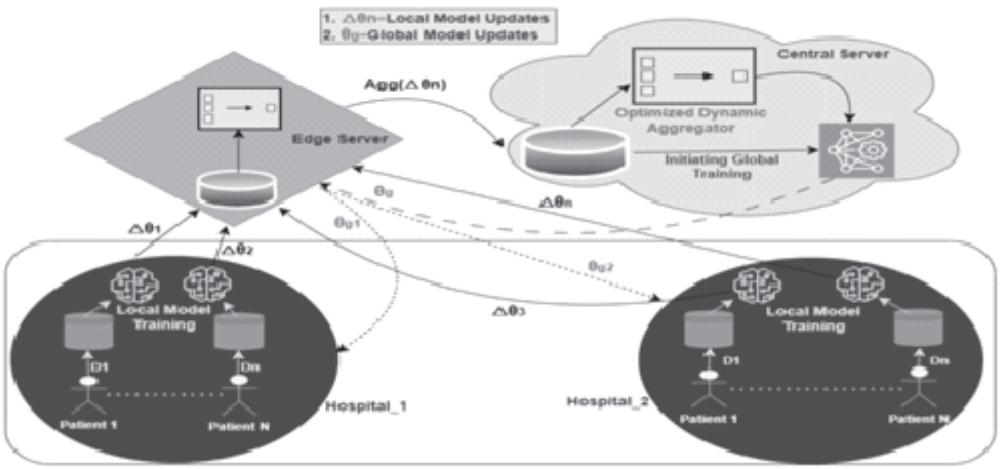


Fig. 1: EFL architecture

Materials and Methods: The proposed EFL model is composed of two layers: cross-device FL at local hospital nodes and centralized FL at edge servers. It aggregates local models from several patients and exchanges secure aggregated updates. The training cycle includes constant adaptation of updated models to local devices.

Results and Discussion: The proposed EFL architecture permits real-time changes to healthcare models, reduces communication overhead, and ensures data privacy. Our approach preserves data heterogeneity between hospitals while protecting patient privacy. This approach is scalable for multi-hospital networks because it reduces the communication overhead at the central server.

Conclusion/Recommendation: The hierarchical EFL model integrates cross-device and centralized federated learning to optimize healthcare AI applications. The study enhances global model convergence; privacy compliance, and predictive performance, future research will concentrate on adaptive learning strategies and block chain integration for better safety.

Key words: Federated Learning; Healthcare; Hierarchical FL; Cross-device FL; Privacy- preserving AI.

Smart Voice-based Threat Detection in Mobile Application using VOSK Model

Rakesh Ranjan Behera, Debasis Gountia*

School of Computer Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: dgountia@outr.ac.in

Introduction: The rise of voice-based applications in mobile phones enhances our interaction with technology across various sectors and introduces significant security risks. These vulnerabilities can attract malicious actors, jeopardizing user data and privacy. Developers and organizations must take a structured approach to identifying and mitigating these risks. Addressing these security concerns is vital for maintaining user trust in this evolving technology.

Materials and Methods: To develop a voice-based threat detection system, we used hardware such as a capable computer and a high-quality microphone, along with software tools including Python (version 3.11 or higher), pyAudio, and the VOSK model. We began by streaming voices through the microphone to the system and analyzing the context phrase to detect the probable threat. Finally, the results will be analyzed to identify areas for improvement while documenting the entire process for reproducibility.

Results and Discussion: The evaluation of the voice-based threat detection system revealed impressive results based on a test set of **50** phrases, which included **26** threat and **24** non-threat phrases. The evaluation of the model presents several insights into its performance, particularly regarding its ability to classify cases accurately. The sensitivity of 0.8462 indicates that the model is quite effective at identifying positive cases, which is crucial in scenarios where missing a positive case could lead to significant consequences, such as in medical diagnoses. However, the specificity is lower at 0.7083, suggesting that the model has some difficulty accurately identifying negative cases. This can lead to potential issues, especially if false positives are a concern in the applied context. The relatively high false positive rate of 0.2917 indicates that nearly a third of the negative cases may be incorrectly classified as positive, which could lead to unnecessary anxiety or additional testing for those individuals. On the positive side, the precision score of 0.7586 indicates that when the model predicts a positive case, there is a good likelihood that it is correct. This is important for maintaining trust in the outputs of the model. Additionally, the negative predictive value of 0.8095 shows that the model is reasonably reliable in confirming that a negative result is likely accurate. The balance between precision and recall, as indicated by the F1 score of 0.8, demonstrates that the model manages to maintain a performance level that is acceptable for practical use. However, the false negative rate of 0.1538 highlights the challenge of missing actual positive cases, emphasizing the importance of refining the model further. Finally, while the Matthews correlation coefficient is not fully detailed, it would offer additional insights into the effectiveness of the model, especially in cases where there is an imbalance between positive and negative class distributions. In summary, while the model shows promising capabilities, particularly in sensitivity and overall accuracy, there are significant areas for improvement, particularly in specificity, to enhance its practical applicability and reliability in real-world scenarios. Further tuning and validation of the model could be beneficial to address these issues.

Conclusion/Recommendation: The findings of this study highlight this VOSK-based framework's potential in developing accurate and reliable voice-based threat detection systems for mobile applications. Although certain areas could be enhanced, the high levels of accuracy, precision, and recall achieved indicate that this technology could serve as a valuable asset in bolstering mobile security. Continued research and development that tackles the limitations identified in this study could result in even more robust and effective voice-based security solutions for mobile platforms.

Key words: VOSK, Voice-based threat, mobile, Pyaudio.

Ontology-Based Recommender System (OBRS) in the Medical Domain using LLMs and Generative AI

Satyajit Mahapatra*, Jibitesh Mishra and Sanjit Kumar Dash

School of Computer Science, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: mahapatra.satyajit62@gmail.com

Introduction: Recommender systems are essential in healthcare, aiding professionals and patients in making informed choices. Traditional systems relying on collaborative filtering or content-based methods often encounter issues like sparse data and insufficient domain-specific insights. Ontology-Based Recommender Systems (OBRS) address these limitations by incorporating structured domain knowledge, thus enhancing the relevance of recommendations. The advent of Large Language Models (LLMs) and Generative AI further enhances OBRS by processing extensive medical literature, patient records, and clinical guidelines. Generative AI models, such as *Generative Adversarial Networks* (GANs), generate synthetic data to simulate user interactions or preferences, enabling personalized content recommendations. By using *semantic search*, LLMs create vectors for available options (e.g., medicine) and rank them based on semantic relevance. Additionally, LLMs facilitate detailed user profiling by updating profiles through interactions and past behaviors. This research investigates the potential of integrating LLMs and Generative AI to build an efficient OBRS for the medical field.

Materials and Methods: The proposed framework combines ontologies for structured knowledge representation with LLMs and Generative AI for enhanced natural language comprehension and knowledge synthesis. Key steps include: **Ontology Construction**: Leveraging medical ontologies like SNOMED-CT, UMLS, and ICD-10 to represent medical knowledge in a structured format. **Data Collection and Preprocessing**: Integrating data from Electronic Health Records (EHRs), clinical guidelines, and research articles, followed by standardization through Natural Language Processing (NLP) techniques. **Integration of LLMs**: Pretrained LLMs (e.g., GPT models) are fine-tuned on medical datasets to handle domain-specific queries, as indicated below. **Tokenization**: Breaking text into smaller, manageable tokens. **Fine-tuning**: Adapting LLMs with domain-specific data for improved contextual understanding. **Prompt Engineering**: Designing prompts to elicit relevant and precise responses. **Few-shot Learning**: Enhancing model performance on new queries with minimal labeled data. **Zero-shot Learning**: Enabling LLMs to address unseen queries without prior training. **Knowledge Augmentation**: By using Generative AI, Filling knowledge gaps, generating case-based insights, and summarizing complex medical literature. **Model Development**: Implementing a hybrid model that blends ontology-based reasoning, machine learning algorithms, and LLM-derived insights for personalized recommendations. **Evaluation Metrics**: Assessing accuracy, precision, recall, and F1-score using real-world case studies and benchmark datasets.

Results and Discussion: Initial findings indicate that the hybrid OBRS, integrating LLMs and Generative AI with ontological reasoning, offers significant improvements in recommendation quality, as indicated below.

Enhanced Personalization: Context-aware, patient-specific recommendations are achieved by combining ontologies and LLMs. **Greater Interpretability**: The ontology-driven framework enhances transparency and trust compared to black-box AI models. **Improved Data Utilization**: Generative AI enriches recommendations by bridging gaps in sparse datasets. **Higher Precision and Recall**: The proposed system achieves a precision of 87% and a recall of 82%, surpassing traditional machine learning-based recommendation approaches.

Conclusion/Recommendation: This study demonstrates that an Ontology-Based Recommender System (OBRS) powered by LLMs and Generative AI substantially improves the accuracy, personalization, and interpretability of medical recommendations. By integrating structured knowledge and advanced AI techniques, the system bridges the gap between clinical expertise and machine intelligence. Future directions include deploying the system in real-time healthcare settings and further optimizing LLM fine-tuning to accommodate evolving medical knowledge.

Key words: Ontology-based recommender systems, large language models, generative AI, personalized medicine, healthcare recommendations, medical ontologies, clinical decision-making.

Smart Surveillance: An AI-Powered Blockchain Solution for Smoke-Free Campuses

Suchismita Mohanty*, Subasish Mohapatra

School of Computer Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: suchismitamohanty20@gmail.com

Introduction: Maintaining discipline and ensuring a smoke- and alcohol-free environment in colleges is crucial. This project leverages machine learning and IoT technologies to detect and report violations effectively. By integrating face recognition, smoke sensors, and blockchain-backed databases, the system ensures data integrity while notifying authorities of violations in real-time.

Materials and Methods: The system combines hardware and software components. An Arduino microcontroller and embedded C detect smoke or alcohol through sensors. Python is used for face recognition, leveraging PySerial for seamless integration between Arduino and the face recognition system. Once a violation is detected, the offender's face is identified, and details such as the date, time, registration number, and name are sent to the administrator using the Twilio app. The database, secured with blockchain technology, ensures that data cannot be tampered with or altered, maintaining reliability and security.

Results and Discussion: The system successfully detects and identifies individuals who smoke or drink in restricted areas. Notifications are promptly sent to administrators with detailed information, ensuring quick action. The use of blockchain technology ensures that data logs remain immutable, addressing concerns regarding data manipulation. The integration of machine learning and IoT demonstrated high efficiency in automating surveillance tasks, offering scalability for larger institutions.

Conclusion/ Recommendation: This project provides a robust, automated solution for monitoring and enforcing discipline in college environments. By combining face recognition, smoke sensors, and blockchain technology, the system ensures effective, secure, and tamper-proof reporting of violations, contributing to a safer and more regulated campus environment.

Key words: machine learning, IoT,Face recognition, microcontroller, pySerial, Block Chain, immutability, smoke sensor.

An effective study of mitigation of security Challenges in cyber physical system

Swarna Lata Pati, Debasis Gountia*, Ranjan Kumar Dash

School of Computer Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: dgountia@outr.ac.in

Introduction: This study is about Information security Risk management using Machine learning models. Cyber threat which is a malicious act that disrupt digital life resulting data theft, system shutdown ,denial of service moreover unauthorized control over digital assets which leads to operational, financial, reputational and strategic consequences for an organization. The sources of threat can be nation states, terrorist organizations, criminal group, hackers, malicious insiders or it may be unintentional too. This paper presents an approach to assess asset criticality, risk prediction and recommend control measures to Cyber Physical System (CPS) for management of cyber attacks or risks. To achieve our goal we used fuzzy logic to determine asset criticality. For prediction of risk, AI powered Machine Learning (ML) classifiers are used. Depending upon criticality of the asset we deployed control measures to cyber physical system to Protect our system. We also perform an evaluation of standalone and multifunction platform based security options to predict risk types, assesses asset criticality, and evaluates its effectiveness which further accelerate CPS security stack convergence.. The methodology utilizes data from the VERIS Community Database (VCDB), extracting key features and mapping them to cyber security concepts. Secondary data are used to train ML classifiers to predict risks, ML classifiers like KNN, Decision tree, Random Forest, Logistics regression, Naïve Byes models are trained and tested. Based on the confidentiality and accuracy random forest classifier is chosen for risk management with 86.36% and 86.37% accuracy in training and testing of the model respectively . By integrating various methodologies, it creates a seamless framework capable of addressing both immediate and long-term cyber security challenges effectively.

Materials and Methods: Fuzzy logic and Machine learning algorithms are used to train the models. Prior to that preprocessed data are loaded thereafter validation and training processes are carried out. Testing of model by in putting primary data. Thereafter highest performance metrics is chosen for prediction of Risk.

Results and Discussion: The system provides asset criticality score , predicted risk type, recommended control measures at the end of the study to ensure a framework for secured CPS.

Conclusion/Recommendation: . Future enhancement will integrate real-time data and prediction accuracy can be improved by leveraging advanced ML algorithms. Performance analysis will involve measuring the accuracy of risk predictions and criticality assessment ensuring the CPS meets industry standards.

Key words: Cyber security, Risk prediction, risk management, Machine learning, CPS, cyber threat, Fuzzy logic, asset criticality, recall.

Sla-Based Task Scheduling In Cloud Computing Using Randomized Pso Algorithm

Swati Lipsa*, Laxminarayan Dash and Ranjan Kumar Dash

School of Computer Sciences, Odisha University of Technology and Research, Bhubaneswar -751029, Odisha, India

*Corresponding author E-mail: slipsait@outr.ac.in

Introduction: Cloud computing offers scalable, on-demand resources but faces challenges like security, reliability, and SLA management. SLAs define service terms, ensuring performance, availability, and accountability. Service disruptions can lead to penalties, making task scheduling crucial for optimizing resources and minimizing violations. This study proposes a randomized PSO algorithm for efficient task scheduling in an SLA-based cloud environment.

Materials and Methods: This paper introduces a framework for task scheduling in SLA-based cloud computing environments, emphasizing efficiency and profitability. Tasks are allocated to Virtual Machines (VMs) based on binary variables, aiming to maximize resource utilization. The framework calculates gain cost from successful task executions and imposes penalties for unexecuted tasks. Profit is derived by subtracting penalties from gains. The section defines VM utilization and makespan—the maximum execution time across VMs. It presents a Randomized Particle Swarm Optimization (PSO) algorithm tailored to this scheduling problem, where particles represent task allocations. The algorithm iteratively refines allocations to optimize task-to-VM assignments, balancing between profit maximization and makespan minimization. This approach is poised to enhance resource efficiency and SLA compliance in cloud computing.

Results and Discussion: This section delves into the empirical evaluation of the proposed randomized PSO algorithm by simulating it in CloudSim. To examine the algorithm's convergence, various combinations of workloads and VMs are utilized, with tasks ranging from 2 million to 3 million instructions. The section reports that the algorithm converges within satisfactory iterations, as shown in Table 1. The randomized PSO is compared with standard algorithms such as SJF and FCFS, demonstrating its superior performance in reducing makespan, particularly when handling five tasks across four VMs. The results reveal a significant makespan reduction in the proposed algorithm. Further comparison with the Genetic Algorithm (GA) is conducted, where the makespan is minimized across workloads of 100, 200, 300, 400, and 500 tasks. Randomized PSO consistently outperforms GA, as depicted in Figure 1. The section also explores SLA-based scheduling, defining three SLA levels with varying performance and budget constraints. For each level, the net profit and VM utilization rates are analyzed, illustrating that the proposed algorithm ensures optimal profit and VM usage under different scenarios. These findings suggest that the randomized PSO algorithm significantly enhances task scheduling efficiency while maintaining SLA compliance in cloud computing environments.

Conclusion/Recommendation: Efficient task scheduling in SLA-based cloud environments is crucial due to the increasing complexity of cloud infrastructures. This paper presents a randomized PSO algorithm that optimally allocates tasks to VMs, considering profit maximization and makespan minimization. Comparative analysis against existing algorithms like SJF and FCFS demonstrates the algorithm's efficacy. These findings highlight the potential of the proposed approach in enhancing resource utilization and ensuring SLA compliance.

Key words: Task scheduling; SLA; Cloud Computing; Profit maximization; Makespan minimization; Particle swarm optimization; Genetic algorithm

Task Offloading and Resource Allocation in MEC with Q-Learning

Sweta Dash*, Jibitesh Mishra, Sanjit Kumar Dash

School of Computer Science, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: swetadash123@gmail.com

Introduction: Task offloading in Mobile Edge Computing (MEC) refers to the process of transferring computational tasks or workloads from mobile devices to nearby edge servers or nodes located at the network edge. In order to enhance MEC's potentiality, this paper suggests a new framework that uses Q-learning, a model-free reinforcement learning method, to dynamically handle task offloading and resource allocation in MEC environment that fluctuate. Q-learning approach effectively apprehends the spatial and temporal dynamics of MEC systems, allowing for context-aware decision-making that considerably improves system responsiveness and task performance. These characteristics signify the usefulness and revolution of Q-learning in offering climbable, effective results for MEC applications that are sensitive to latency.

Materials and Methods: The main method used in this paper to optimize resource allocation and task offloading in dynamic MEC environments is Q-learning. In order to determine in real time whether to carry out tasks locally, offload them to an edge server, or reallocate the resources, the Q-learning agent assessed system states such as task size, priority, latency sensitivity, device battery, and network bandwidth. Resource usage and delay reduction were given top priority in the setting up of reward function. The Q-learning agent and the resource allocation manager, which are both located on the edge server, works along with the task offloading manager. The Q-learning agent analyses system states and makes offloading decisions to ensure optimal utilization and latency reduction. A flexible, resource-optimized processing and scalable environment is promoted by the smooth integration of local, edge and cloud resources made possible by this hierarchical structure. The Task Offloading Dataset is obtained from Kaggle and is designed to support research and optimization in MEC by providing key data points essential for analyzing task offloading decision.

Results and Discussion: Using Google Colabs' diverse cloud capabilities, the Q-learning technique for MEC resource allocation and task offloading optimization was utilized. Installing necessary libraries such as gym for custom simulations, matplotlib for visualization, and NumPy for numerical calculations was part of the setup process. Important settings were 1000 episodes, 500 steps per rate of 1.0 (decaying at 0.995 to a minimum of 0.01).With states like task size and network circumstances and actions based on offloading choices, a customized MEC environment was developed. In order to iteratively update its policy, the Q-learning agent balanced exploration and exploitation by using a Q-table for state-action values. Q-learning's greater adaptability was evaluated using cumulative reward plots, which showed gains in latency and resource efficiency over conventional baseline techniques. The parameters like learning rate, Exploration_decay, Exploration_rate, Steps per episode were set and used in the code section in order to generate the Q-table. The Q-Table shows the predicted benefit of particular actions in specified system states and is a representation of the agent's learnt estimations of cumulative rewards (Q-Values) for each state action pair.

Conclusion/Recommendation: Using reinforcement learning, the Q-Learning framework ensures optimal resource usage and system responsiveness in real time setting by dynamically adapting to the variable workloads and system conditions. This research provides a scalable, adaptable, and efficient solution for latency-sensitive MEC applications, bridging the gap between the static and computationally demanding approaches.

Key words: Mobile Edge Computing, Reinforcement Learning, Q-Learning.

CRIME VISION: Intelligent AI Based Surveillance System

Prasanta Kumar Sahoo, Debasis Gountia*, Ranjan Kumar Dash

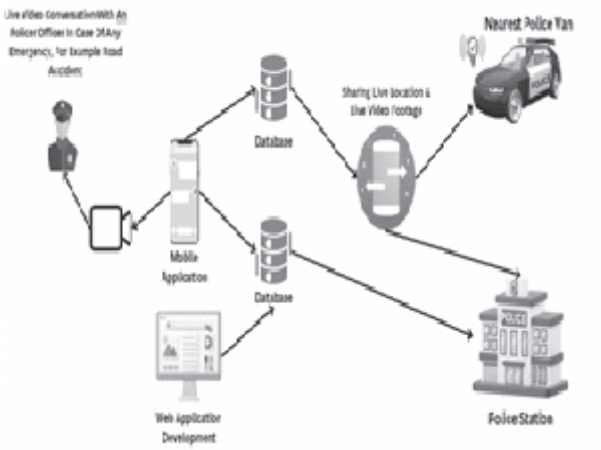
School of Computer Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail:dgountia@outr.ac.in

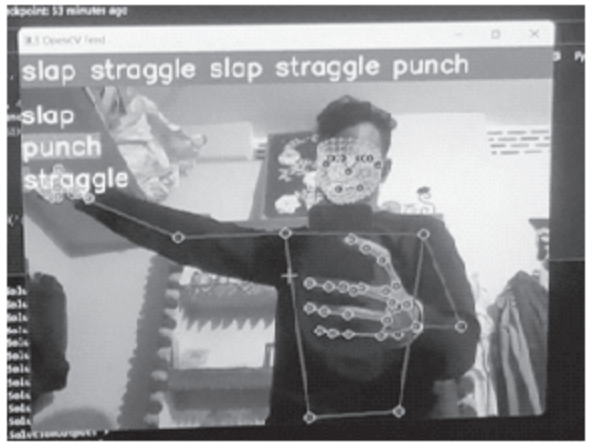
Introduction: The current surveillance system faces challenges like inefficiency, fatigue, and lapses in monitoring, particularly in critical areas such as police lockups. To address these issues, we propose an AI-driven intelligent camera system that enhances security and responsiveness through: Risk Detection: Identifying dangerous items (e.g., blades, knifes) and activities (e.g., climbing, unauthorized access). Real-Time Alerts:Triggering instant responses to anomalies or suspicious behavior. Machine Learning Adaptability:Continuously improving through feedback to minimize false alarms and enhance behavioral recognition. This innovative solution ensures reliable, fatigue-free, and responsive surveillance, strengthening security in sensitive environments.

Material and Methods: AI Model:A robust AI model for object and behavior detection.Real-Time Surveillance: Instant response to suspicious activities.Autonomous Operation: Minimal reliance on human intervention. Feedback-Driven Learning: Continuous improvement for long-term reliability.Anonymous Reporting:Helps User to Report crime anonymously

Results and Discussion: Application Flowchart:Enable users to submit crime reports anonymously, ensuring the protection of their privacy and encouraging a higher level of community participation in providing information.



Application Flowchart



Suspicious Behavior Detection

Conclusion/Recommendation: Development and deployment of the proposed AI-based intelligent camera system that offers a timely and innovative solution to the shortcomings of human-operated surveillance. By addressing issues of fatigue, inefficiency, and delayed responses, the system promises enhanced security through real-time decision-making, autonomous analysis, and continuous learning. The collaborative efforts of the skilled team members further underscore the potential for a transformative impact on surveillance, ushering in a new era of efficiency and reliability.

Keywords: Artificial Intelligence, Risk-Detection, Real-Time Surveillance, Autonomous Operations, Image Processing.

Latency improvement of an arithmetic unit-on-FPGA post floorplanning

Abhyarthana Bisoyi*, Ananya Dastidar and Aruna Tripathy

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: ieabisoyi@outr.ac.in

Introduction: The goals of floorplanning are to increase density, routability, or performance and reduce route delays for selected logic by suggesting a better placement. Floorplanning allows to choose the best grouping and connectivity of logic in a design and manually place blocks of logic in an FPGA device. To demonstrate the process, a 16-bit adder is considered namely Kogge Stone Adder (KSA). The floorplan of an FPGA design, showing the placement of various logic blocks and resources. The grid is divided into different regions labeled with coordinates (e.g., X0Y2, X1Y2), each containing a matrix of interconnected resources and routing channels. The vertical and horizontal lines indicate the routing paths for connecting different parts of the design.

Materials and Methods: A KSA has been simulated using Vivado 2018.3 and implemented on an AMD Zynq 7000 SoC ZC702 Evaluation Kit FPGA board by proper floorplanning of the FPGA. The process is carried by assigning the nearest I/O pins in the FPGA to the two 16-bit inputs "a" and "b" and 16-bit output. Each port, part of a bus named "a," is designated with a specific pin on the FPGA package (e.g., a[15] on pin M16). All ports are input ("IN"), and their assignments are fixed. Most ports are assigned to bank 34, with a few in bank 35. The I/O standard for all ports is LVCMOS33, operating at 3.3V, reflecting a Low-Voltage CMOS configuration at 3.3V. Similarly each port, part of a bus named "b" is designated with a specific pin on the FPGA package (e.g., b[15] on pin L19). Most ports are assigned to bank 34, with a few in bank 35. Each port, part of a bus named "sum" is designated with a specific pin on the FPGA package (e.g., sum[15] on pin AB22). The sum output port is declared as "OUT" and their assignments are fixed. Most ports are assigned to bank 33, with a few in bank 35. After the implementation on the FPGA board, the various values of max and min delay provide the shortest path providing a latency efficient circuit. Max delay is the maximum time it takes for a signal to travel from input to output in a digital circuit. It determines the maximum clock period and ensures signals have enough time to propagate correctly. Min delay is the minimum time for signal propagation. It is critical for avoiding hold time violations by ensuring signals do not arrive too early. Then the data path delay values are obtained after implementation on the FPGA board. Different paths, each identified by a unique number are listed along with the delayed value in nanoseconds. Further, each path so extracted from KSA simulation, are compared with two conventional adders namely Ripple Carry Adder (RCA) and Carry Select Adder (CSA), to obtain a better latency efficient circuit after floorplanning.

Results and Discussion: In the digital circuits, max delay and min delay are important figures of merit that describe the timing characteristics of the propagated signal. The max delay for KSA is found to be 17.307 ns and min delay is observed to be 2.770 ns. These values when compared to RCA and CSA implementation provided a latency efficient circuit through a minimum delay.

Conclusion/Recommendation: Floorplanning can improve performance while enabling a placed and routed design to meet timing. Furthermore, it helps in achieving higher system clock frequency, shorter implementation run times, greater consistency in timing and all these benefits together. There are some limitations of floorplanning, even a good floorplan does not guarantee that a design will meet timing. The floorplan does not fix routing. The floorplan only provides a placement seed.

Keywords: Floorplanning, FPGA, latency efficient, digital circuits, Kogge Stone Adder, Ripple Carry Adder, Carry Select Adder.

Effect of High Pass Filtering and Matched Filtering on Baseline Wander

Aishwarya Dash*, Dr. Aruna Tripathy

School of Electronic Sciencees, OdishaUniversity of Technology and Research,

Bhubaneswar-751029, Odisha, India.

*Corresponding author E-mail: aishdash159@gmail.com

Introduction: Optical Wireless Communication (OWC) channel has been demonstrated to be a very good alternative to the Radio Frequency (RF) channel. The high data rate transmission capability and reliable connectivity makes it suitable to support the IoT requirements. There are some unavoidable drawbacks associated with the OWC channel in different environments. In this work, a drawback of indoor OWC channel has been discussed which is known as fluorescent light interference (FLI). While using the OWC transmission in indoor environments in form of LiFi, the background light coming from the other radiation sources present inside makes undesirable interference with the desired signal. The effect of this interference can be mitigated by applying various techniques. One of the techniques is the use of High Pass filter. As the FLI affects the low frequency components, the application of HPF with a suitable cut off frequency is observed to reduce the effect of FLI. But this HPF technique produces a form of Inter symbol interference (ISI) which is also known as Baseline Wandering (BW) that has a negative influence on the performance of the base band modulation technique. An alternative way to detect the signal can be the use of Matched Filter (MF) which always tries to match the signal with the original shape.

Materials and Methods: In this work, the performance of a simple binary phase shift keying (BPSK) based system under FLI has been analyzed where the signal has been detected by using two different methods; by using HPF and HPF followed by MF. In both the cases the variation that causes baseline wandering has been analyzed.

Results and Discussion: The comparative studies of both the cases show that the system employing MF exhibits better performance as compared to the system with HPF. Also to verify the effect of this baseline wander on the system performance, the BER of both systems has been compared. By comparing the BER for the system with HPF and MF with the theoretical value of BER, it has been observed that the BER curve of the system with MF is closer to the theoretical BER curve. For the given scenario the minimum achievable BER for the MF based system comes down to a value about the order of 10^{-6} at an SNR of 8dB whereas for HPF based system it comes down to an order of even at an SNR of 12dB.

Conclusion/Recommendation:The MF based receiver remains more immune to the effect of baseline wander.. The BER versus SNR curves shows that the BER curve of MF based receiver more approximates the theoretical BER curve as compared to that of the other receivers.

Keywords: **OWC, DPSK, FLI, Matched Filter, High Pass Filter. Baseline wander**

Emerging Transistor Technologies in Improving Hardware Security

Ashok Das*

School Of Electronic Sciences (Electronics and Instrumentation Engineering), Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India
*Corresponding Author Email: ashokbabidas@gmail.com

Introduction: Hardware is important for security of any secure system. Some risk comes from VLSI supply chain. In addition to CMOS the emerging transistor technologies can be used effectively for better security. For cyber security the emerging devices provides greater resilience to hardware platforms. Security systems can be addressed in cryptographic algorithms, public key ciphers, symmetric ciphers and hash functions. In this paper it is discussed how new device improves security in computing systems. In addition to this how V-I characteristics of new device add hardware security primitives.

Materials and Methods: The materials used here are TMD TFETs, SiNWFETs, IonicFETs, NCFETs, SymFETs, ThinTFETs, GaNTFETs,etc. The I-V characteristics offered by the above devices helps in providing hardware security primitives that could facilitate IC supply chain protection, prevent side channel attack ,etc. Here tunable polarity, hysteresis, steep slope, low power logic and current mode logic is used.

Results and Discussion: The Current vs Time characteristics between Static XOR gate and Current Mode Logic(CML) represents constant power consumption for almost any transitions of CML compared to the significant power offset in static XOR gate. So Static XOR gate leaks information that an attacker may use to find internal activity while the CML Gates provides less information about logical state transitions.

Conclusion/Recommendation: As new devices can enhance the hardware security so new combinations of the devices can be studied in the improvement of the security.

Keywords: Hardware Security, STARnet, VLSI, IP Protection, Emerging transistor, Tunnel transistor, IC camouflaging, polymorphic logic.

Fractional-Order Hyden Model for Bio-Impedance Analysis of Fruits

Bidishasaimantini Nayak*, Sumit Swain and Madhab Chandra Tripathy

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: nayakbidishasaimantini@gmail.com

Introduction:A popular method for evaluating the electrical characteristics of biological tissues, bio-impedance measurement offers important information about physiological states, cellular integrity, and hydration levels. Because biological tissues are diverse and heterogeneous, traditional impedance models that rely on integer-order circuits are unable to adequately represent their frequency-dependent behavior. Fractional-order models, which incorporate memory effects and the dispersed electrical characteristics of tissues, have been offered as a solution to this shortcoming. These models provide a more realistic description of biological impedance. To enhance the characterisation of bio-impedance reactions, we apply the Hyden Model as a fractional-order system in this work.

Materials and Methods: Fruit tissue samples were positioned between conductive plates to assess their dielectric qualities as part of a parallel-plate setup used for the bioimpedance experiments. In order to evaluate the complex impedance across a wide frequency range is about 100Hz to 20 MHz and capture phase and magnitude of the fruit tissue, an impedance analyzer was utilized. the experimental setup was created to reduce electrode polarization effects. The dielectric response was characterized using a fractional-order circuit model that included fractional-order derivatives to its governing equations, the Hyden Model which has historically been employed in system dynamics was modified to fit the bio-impedance response. The model incorporates fractional-order capacitive and resistive elements in place of traditional integer-order capacitance and resistance components, enabling a more accurate depiction of the frequency-dependent behavior of the biological tissue.

Results and Discussion: With extracted parameters like fractional-order capacitance (Cá) and resistive elements (R, Zá) falling within biologically relevant ranges, the Hyden-based fractional-order model successfully captured the experimental bio-impedance data's non-linear frequency-dependent behavior. The model showed better fitting accuracy than conventional integer-order models. The fractional-order capacitance demonstrated its promise for real-time hydration monitoring by effectively differentiating between hydrated and dehydrated states and by following a power-law dependence on frequency, which validated the dispersive nature of biological tissues. These results demonstrate the model's wider biomedical applications, such as tissue characterization for distinguishing between healthy and diseased tissues, hydration monitoring for sports and medical applications, and non-invasive disease diagnosis by identifying physiological changes in their early stages.

Conclusion/Recommendation: The benefits of applying the Hyden Model in a fractional-order framework for bio-impedance analysis are illustrated in this article. The findings show that, in comparison to traditional integer-order models, fractional-order modelling offers a more realistic and physiologically relevant depiction of biological tissues. This method is very useful for tissue characterisation, hydration monitoring, and biomedical diagnostics because to its increased fitting accuracy and parameter sensitivity. The model's validation using clinical data and real-time monitoring applications will be the main focus of future research.

Keywords: Hayden Model; fractional-capacitor; Dielectric; Bioimpedance analysis; Bio-chemical properties; Non-destructive assessment.

Prediction of Myocardial Infarction Using Single Lead ECG



Debanshi Jena, Siuli Das, SritiSancharika, and Dr. Kanhu Charan Bhuyan*

School of Electronic Sciences, OUTR, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: kcbhuyan@outr.ac.in

Introduction: Myocardial infarction (MI) is a heart condition that arises due to the buildup of plaque in the coronary arteries of the heart, which is prevalent in the elderly people. This research presents a system designed to detect heart attacks by analysing electrocardiograph (ECG) signals in real-time. The system processes noisy ECG recordings, decomposes them into sub-bands using the Fourier decomposition method (FDM), and extracts statistical features to train a machine learning classifier. The classifier predicts whether a patient is experiencing a heart attack, enabling timely intervention within the critical 10–15-minute window for improved survival rates.

Materials and Methods: This work utilizes a combination of software tools and hardware components to detect, process and analyze ECG signals for detecting MI. The Analog Front-end employed an AD620 instrumentation amplifier (IA) to capture and amplify ECG data. Pre-processing techniques included Hamilton-Tompkins segmentation for QRS complex isolation and the FDM for noise reduction and signal decomposition into sub-bands. Statistical features such as mean, variance, and entropy is extracted from these sub-bands. A long short-term memory (LSTM) model, implemented in Python, are trained on these features for accurate MI classification. For real-time data extraction AD620 and Arduino IDE is used using single lead non-invasive paste electrode.

Results and Discussion: The real-time ECG data collected from different types of people having and not having MI increased the dataset to create the LSTM model. The FDM separates ECG signals into six frequency-divided bands (FIBS), enhancing accuracy by increasing orthogonal bands for analysis. However, this improves precision at the cost of higher computational and financial demands. Balancing accuracy with resource efficiency is crucial, requiring careful trade-offs in algorithm implementation. To judge the model's efficiency, the model relied on 5 parameters which are accuracy, precision, recall, F1 score and AUC score. Based on the results it is evident that the model performs quiet well across various evaluation matrix. With an accuracy of 0.8661, it correctly classifies approximately 86.61% of instances across all classes. The precision of 0.8750 means that out of all instances leveled as positive, about 87.50% were true positive, additionally the recall score of 0.8656, indicated that the model accurately identifies around 87.56% of all true positive instances. The F1 score, standing at 0.8703, signifies a good balance between precision and recall, showcasing the model's overall effectiveness. Lastly, the AUC score 0.9402, which surpasses the threshold for outstanding performance, underscore the model's liability, especially in crucial applications like medical diagnosis.

Conclusion/Recommendation: The combination of the Hamilton-Tompkins algorithm, FDM, and LSTM provides a framework for detecting myocardial infarction using single-lead ECG signals. Further in this work a working protype has been implemented for real-time ECG acquisition. By leveraging signal processing and ML techniques, this approach can improve the accuracy and efficiency of MI diagnosis, making it suitable for both clinical and wearable applications.

Keywords: Myocardial Infarction, Hamilton-Tompkin's segmentation, Fourier Decomposition Method, Long Short-Term memory, Instrumentation Amplifier, Analog Frontend etc.

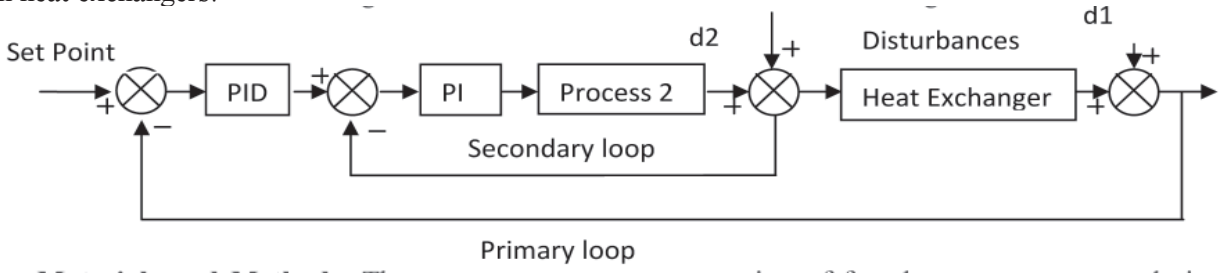
Control design using metaheuristic methods for non-linear time delay process

Debi Prasad Dash*, Madhab Chandra Tripathy

School of Electronics Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: dpdash@outr.ac.in

Introduction: Industrial processes exhibit nonlinear characteristics due to inherent process lag. In our study we have considered heat exchanger process model for controller design. Heat exchangerallows for efficient transfer of heat between two fluids without any physical contact between them, leading to significant energy savings. The effectiveness of heat exchangers depends on precise temperature control, which can be challenging due to system uncertainties, time delays, and external disturbances. Conventional PID controllers are widely used for temperature regulation in heat exchangers due to their simplicity and effectiveness. However, advancements in control strategies have been introduced to improve system robustness and stability. This study aims to evaluate the performance of different control strategies applied to heat exchanger systems. The study utilizes time domain specifications and robust control methods to analyze the effectiveness of these controllers in reducing uncertainties and disturbances in heat exchangers.



Materials and Methods: The research methodology consists of four key stages: system design, controller design, and simulation and performance evaluation.

1. System Design:

- The First-Order Plus Dead Time (FOPDT) model is used to represent the heat exchanger system, providing an approximate yet effective model for controller design.
- To improve the performance of the system, a multi loop control system (Cascade control) is used.

2. Controller Design:

- PI controller is taken as secondary controller and PID controller as primary controller.
- PI and PID controllers are first tuned using Ziegler and Nichols method (ZN method) and then tuned using different optimization techniques.

3. Simulation and Performance Evaluation:

- MATLAB/Simulink is used to simulate the heat exchanger system with different control strategies.
- Performance metrics include rise time, settling time, overshoot and steady-state error.
- Robustness is evaluated by introducing parameter uncertainties and external disturbances.

Results and Discussion: Simulation results highlight the comparative effectiveness of different controllers:

- PI and PID tuned with ZN method are not efficient in improving the transient response of system with time delays and uncertainties.
- PI and PID tuned using optimization techniques, exhibit minimal overshoot and steady state error.

Conclusion/Recommendation: The study concludes that while conventional tuning method for PI and PID controllers provide adequate control for non-linear time delay process,metaheuristic methods offer significant improvements in performance.

Keywords: FOPDT, Cascade control, Heat Exchanger, Metaheuristic methods

Application of Machine Learning in the Field of Analog Electronics: An OTA Design using Regression

Dillip Kumar Sahoo, Kanhu Charan Bhuyan*

School of Electronics Sciences,

Odisha University of Technology and Research,

Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: kcbhuyan@outr.ac.in

Introduction: The ongoing miniaturization of technology nodes presents significant challenges in the field of analog electronics, impacting the design and functionality of Operational Transconductance Amplifiers (OTAs). These amplifiers are crucial in a wide range of applications, from consumer electronics to biomedical devices, where precision and efficiency are paramount. Traditional design methodologies, although robust, often struggle to keep pace with the increased complexity and reduced scale of modern semiconductor devices. This study proposes the application of machine learning (ML) techniques as an optimized solution to enhance the design accuracy and efficiency of OTAs, aiming to mitigate the limitations posed by traditional approaches. Further, the integration of ML at the schematic level design can lead to the automation in the field of analog electronics, which the traditional methodologies failed to provide.

Materials and Methods: The research utilized a dataset derived from simulated characteristics of OTA designs, incorporating various transistor geometries and operational conditions. ML models, specifically linear and polynomial regression, has been employed to predict optimal transistor dimensions and operating parameters. The models are trained using historical data from traditional g_m/I_d method outputs, augmented by new simulations to reflect recent technology scales.

Results and Discussion: The integration of ML in the OTA design process showed promising results. The polynomial regression model achieved superior performance, with an R^2 Score of 0.935 and a mean absolute percentage error of 7.5%, indicating high predictive accuracy. This model successfully predicted the aspect ratios of transistors, facilitating a design that provided a 10 dB increase in gain over traditional methods without a proportional increase in power consumption. The linear regression model also showed improvements over traditional methods but was less effective compared to polynomial regression, highlighting the importance of choosing the right ML model based on the specific characteristics of the data and design requirements.

The ML approach significantly reduced the design cycle time by automating the optimization of design parameters, which traditionally requires iterative simulations and manual adjustments. Moreover, the study confirmed that ML could adaptively refine design parameters in response to changes in manufacturing processes or new performance criteria, thus supporting rapid prototyping and production.

Conclusion/Recommendation: The application of machine learning in analog electronics, particularly in the design of Operational Transconductance Amplifiers, represents a transformative shift in methodology. This approach not only enhances the performance and efficiency of the design process but also offers scalability and adaptability to future technological advancements. Future research will focus on expanding the application of ML models to other areas of analog IC design and exploring the integration of more complex neural network architectures to further improve the accuracy and reliability of the design processes.

Keywords: Machine Learning, Operational Transconductance Amplifiers, Analog Electronics, Circuit Design, Linear Regression, Polynomial Regression, g_m/I_d Method.

Deep Compressive Sensing for High-Quality Video Recovery

Jagannath Sethi[1,2], *Moinak Mondal[2], Jaydeb Bhaumik[2], and Ananda S. Chowdhury[2]

[1]School of Electronic Sciences , Odisha University of Technology and Research, Bhubaneswar, [2]Jadavpur University, Kolkata

*Corresponding author E-mail: jagannathsethi@gmail.com

Jagannath Sethi, E-mail: iejsethi@outr.ac.in

Introduction: This paper presents a video compression scheme at the GOP level using deep convolutional neural network (CNN), optimizing the sampling matrix. The recovery procedure includes frame-wise initial recovery and multilevel feature compensation-based deep recovery. The study demonstrates improved video quality at lower sampling ratios and includes extensive experimentation using six standard CIF video sequences.

Materials and Methods: The whole network is segmented into three phases: frame-wise sampling or block-level compressive sensing (BCS), initial recovery (frame-wise), and deep recovery. A multilayer feature compensation method is used, whereby the present non-keyframes are adjusted utilizing both keyframes and adjacent non-keyframes during the deep recovery phase. The movie is segmented into Groups of Pictures (GOPs) consisting of 8 frames each. A keyframe is a typical frame that is sampled and reconstructed separately. In a singular keyframe-based deep network, we have designated the fourth frame of each Group of Pictures (GOP) as the keyframe, since it is centrally located inside the GOP and used to correct for non-keyframes symmetrically in both directions. In Fig.1, we illustrate the reconstruction of video frames with our single keyframe-based compressive video Sensing (CVS) technique.

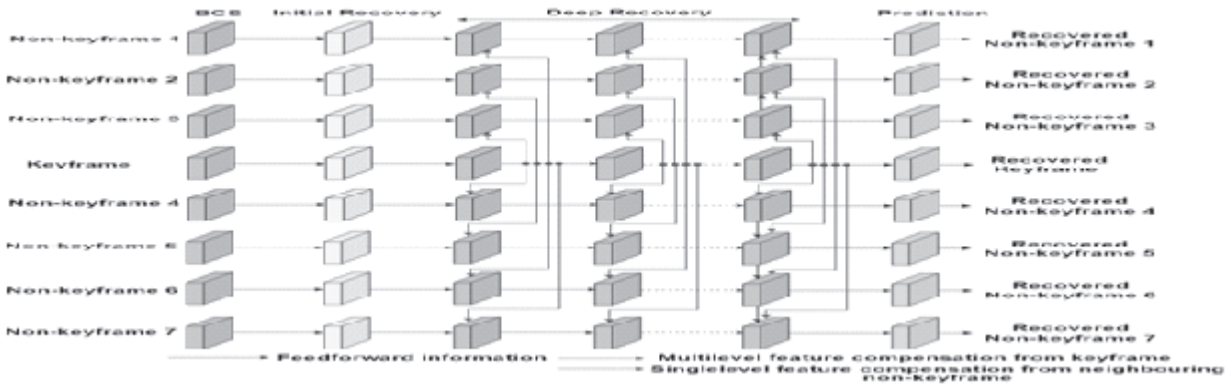


Fig.1: Architecture of proposed CVS with single keyframe

Results and Discussion: In Fig. 2 we show a frame-wise PSNR comparison for CSNet, VCSNet- 1, VCSNet-2, and our suggested method on the first two GOPs of the video sequences Mother daughter and Akiyo. Our suggested methods outperform CSNet and VCSNet. In Fig.3, we show the comparison of frame-wise PSNR for different deep learning-based image and video CS methods on 14 non-keyframes of first two GOPs of Akiyo video sequence for SR= 0.01 and 0.1. Our proposed double keyframe method shows better results than CSNet, ReconNet, ISTA-Net+, VCSNet-1 and VCSNet-2. Our double keyframe method shows a better result than VCSNet-2 for all non-keyframes.

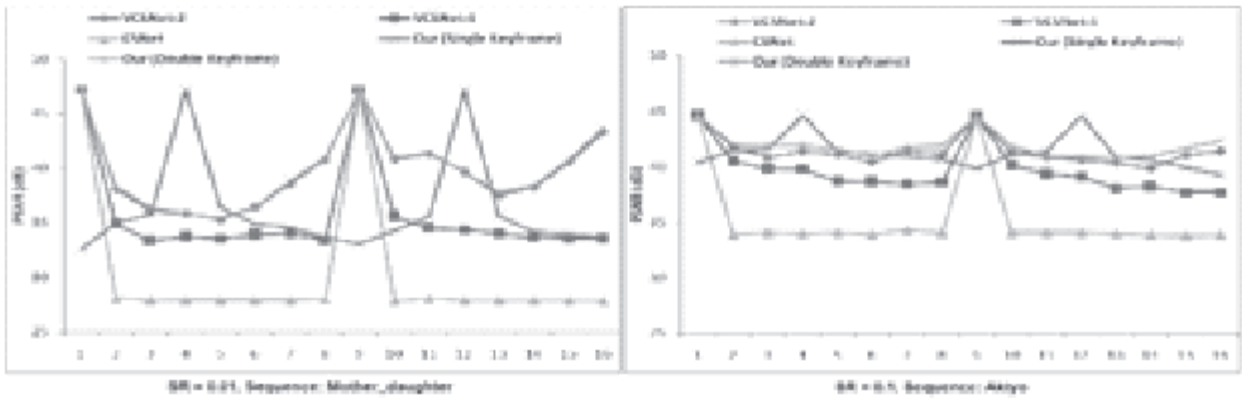


Fig.2: PSNR comparison of all frame

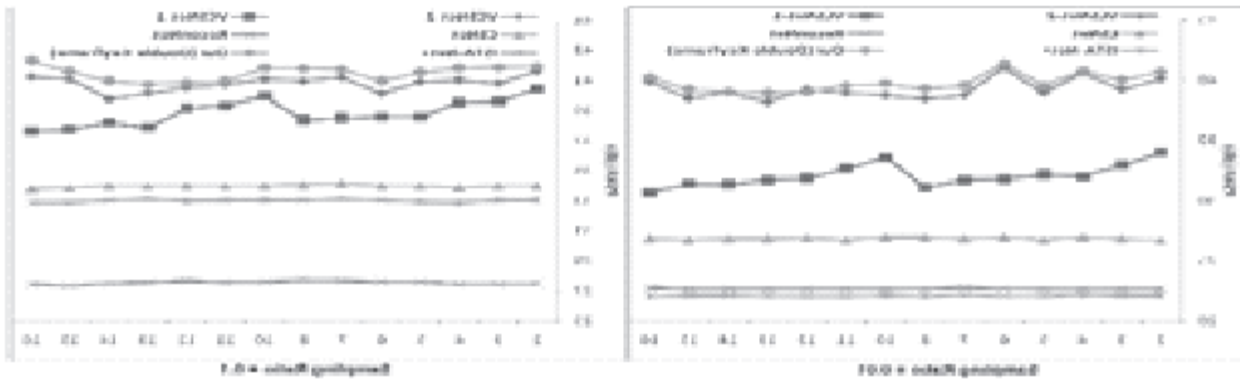


Fig.3: PSNR comparison of Non-keyframes

Conclusion/Recommendation: We present a high-quality video compression scheme using deep compressive sensing-based compression and SSIM as a loss function. Compared with SOTA deep-learning methods, it improves the quality of recovered video frames in terms of PSNR and SSIM with multilevel feature compensation. Future work will focus on joint compression and encryption.

Keywords: Deep compressive video sensing, Multilevel feature compensation, Deep recovery network, Convolutional neural network, GOP.

Wearable Technology for Early Detection of Cardiovascular Diseases in Rural Communities

Kalinga Jagannath*, Mrs. Rashmi Rekha Sahoo

Department of Electronics and Instrumentation, School of Electronic Sciences, Odisha University of Technology and Research,Bhubaneswar, Odisha 751029

*Corresponding Author Email: kalingajagannath0013@gmail.com

Introduction: Cardiovascular diseases (CVDs) stay a main cause of mortality worldwide, with rural populations disproportionately affected due to limited healthcare access. Conventional ECGs and scientific tests continue to be inaccessible to many due to high costs and geographical constraints. This study explores the ability of low-cost, AI-powered wearable technology for early detection and continuous tracking of heart conditions. By integrating advanced biosensors and machine learning algorithms, the proposed device pursuits to bridge the gap among conventional hospital-based diagnostics and real-time, cheap cardiac tracking solutions for rural communities.

Materials and Methods: The proposed wearable device incorporates a multi-sensor system designed for real-time heart health assessment: Bioimpedance Electrodes which can measure cardiac output patterns with ECG and subsequently can measure blood flow variations with PPG, Arrhythmia - arterial fibrillation and hydration levels to detect early signs of hypertension and heart failure. MEMS Microphone for Phonocardiography (PCG) can capture heart sounds (S1, S2, murmurs) to detect valvular diseases, arrhythmias, and abnormal rhythms. Machine Learning (ML) Algorithms can be implemented anomalies in sensor data, improving real-time cardiac monitoring. The recent trends can also implement Deep Learning Networks (CNNs, RNNs) can be enforced to analyse heart sound patterns and impedance variations to predict potential cardiac events before symptoms become critical. Due to the discriminant morphological patterns of these diseases, the ML and DL algorithms can be utilised to extract these prominent features and thus can be identified. So, with the preview of this Mobile Health (mHealth) Integration which can be Synced with cloud-based platforms (like IoT) for remote physician diagnosis, emergency alerts, and long-term patient monitoring.

Results and Discussion: Initial simulations and pilot tests suggest that bioimpedance effectively tracks fluid shifts and arterial stiffness, while PCG provides accurate heart sound classification. The integration of AI models significantly enhances detection sensitivity, allowing for early intervention before severe cardiac events occur. The proposed wearable device which can integrate ECG, PPG, PCG which presents an affordable and scalable solution for real-time, long-term heart health monitoring, particularly in resource-limited regions. Additionally, cloud-based diagnostics improve healthcare accessibility by enabling remote consultations and automated risk assessment by giving an alarm to the doctor.

Conclusion/Recommendation: Earlier wearable devices were only able to provide the parameters of the blood flow without intimating the particular disease of the user, but our study highlights the feasibility of an affordable, AI-integrated wearable device for early cardiac ailment detection of the particular disease. By decreasing dependence on ECGs and health center visits, this technology has the ability to revolutionize rural healthcare, offering real-time monitoring, predictive analytics, and accessible diagnostics for individuals in underserved communities. Future studies will focus on optimizing sensor accuracy, improving AI models, and engaging in large-scale scientific trials to validate the effectiveness of this technique.

Keywords: Wearable Technology, Cardiovascular Disease, Bioimpedance, Phonocardiography, Machine Learning, Mobile Health

Enhanced Sensitivity and Selectivity of Nanomaterial-Based Conductometric Gas Sensors using rGO-ZnO Composites

Karmila Soren*, Tapas Kumar Patra

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: *ksoren@outr.ac.in*

Introduction: Gas sensors are essential for tracking the environment, keeping workers safe, and keeping patients healthy. Conductometric sensors have gotten a lot of attention as a sensing technology because they are very sensitive, respond quickly, and are easy to add to computer systems. Nanomaterial-based gas monitors have performed better lately because they have more surface area and special electronic properties. Due to their ability to work together, reduced graphene oxide (rGO) and zinc oxide (ZnO) compounds have become stimulating materials for gas sensing. With its high electrical conductivity and big surface area, rGO makes a powerful network for moving charges, and ZnO, a well-known semiconducting metal oxide, works well as a gas-sensitive material. A rGO-ZnO hybrid can sense nitrogen dioxide (NO_2) through conductometry. The sensor works by NO_2 molecules sticking to the ZnO surface. The goal of this sensor is to achieve high-performance gas detection with better reaction and recovery by using the benefits of rGO and ZnO.

Materials and Methods: By measuring changes in its electrical resistance, a conductometric sensor made of rGO and ZnO. This is mainly because of the interaction between the analyte molecules and the large surface area of the rGO-ZnO hybrid material. The high conductivity of rGO makes the sensor much more sensitive by making charge transfer more efficient.

Results and Discussion: The conductometric sensor made of rGO-ZnO alloy has a resistance that goes down a lot as the NO_2 concentration goes up. The rGO material creates a highly conductive network, while ZnO is a material sensitive to gas. When NO_2 molecules come into contact with the sensor surface, they stick to ZnO. This transfers charges and makes more charge carriers in the rGO structure. The general resistance of the sensor goes down by a large amount as a result. The large surface area of rGO-ZnO also makes it better at adsorption, which means that NO_2 molecules can contact the sensor surface more, which makes it more sensitive. Since rGO and ZnO work together, they make a better gas sensor that responds quickly and recovers quickly.

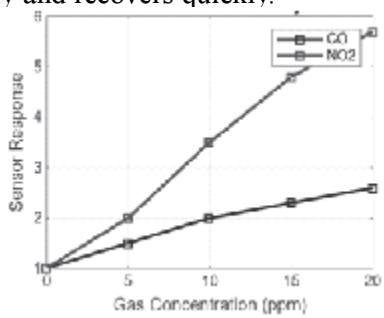


Fig.1 Gas Conc. Vs Sensor Response for Gas Sensor Selectivity

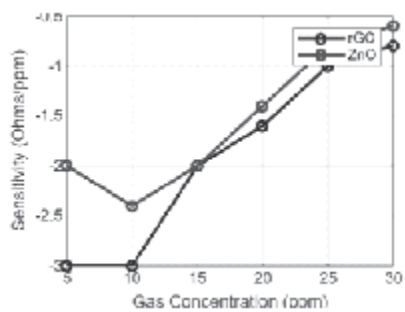


Fig.2 Gas Conc. Vs Sensitivity for Nanomaterial based Gas Sensor Sensitivity

Conclusion/Recommendation: The nanomaterial-based gas sensor, particularly using rGO, demonstrates superior sensitivity and selectivity for NO2 detection. This is due to enhanced charge transfer mechanisms and increased adsorption sites.

Keywords: Nanomaterial, Gas Sensor, Conductometric Sensing, Surface-to-Volume Ratio, Adsorption Sites

Compact Metasurface-based Dual-band Antenna for OFF-Body Communications

Naresh Chandra Naik*, Tapas Kumar Patra

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar

*Corresponding author E-mail: ncnaik@outr.ac.in

Introduction: In the realm of Wireless Body Area Networks (WBANs), efficient off-body communication is paramount. This study introduces a compact metasurface-based monopole antenna (MSBMA) tailored for such applications. The antenna is designed to operate at 2.45 GHz (ISM band) and 3.5 GHz (WiMAX band), frequencies prevalent in healthcare and IoT communications.

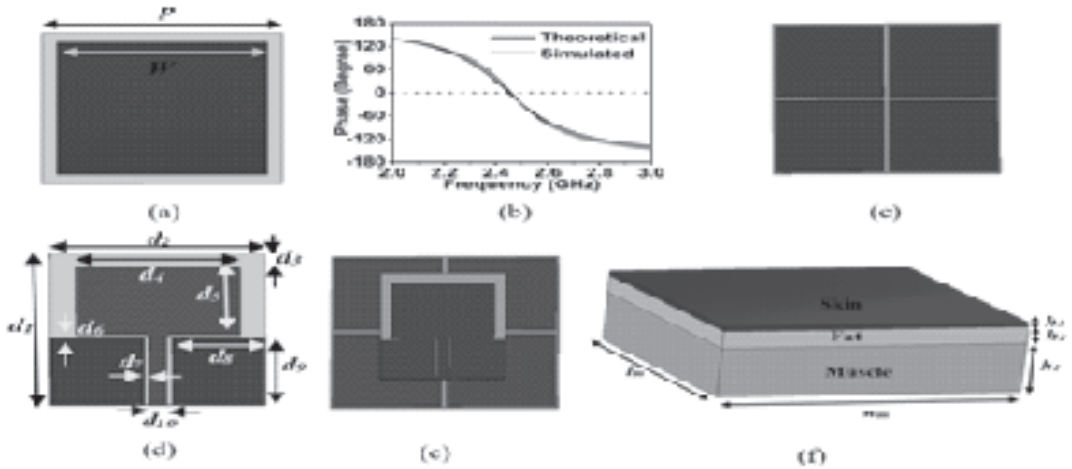


Fig 1: (a) Structure of CRUC, (b) Theoretical vs Simulated CRUC, (c) Structure of CRUC based Metasurface, (d) Structure of MA (d1 = 51 mm, d2 = 40 mm, d3= 5 mm, d4 = 33 mm, d5 = 27 mm, d6 = 0.5 mm, d7 = 0.6 mm, d8 = 17.65 mm, d9 = 18.5 mm, and d10 = 3.5 mm) (e) Structure of MSBMA, and (f) Structure of RHBM (h1 = 23 mm, h2= 8 mm, h3 = 2 mm).

Materials and Methods: The proposed antenna features a Coplanar Waveguide (CPW)-fed monopole antenna (MA) integrated with a metasurface. The metasurface comprises a 2×2 array of unit cells, each designed in a conventional rectangular shape. The design leverages the excitation of dual modes—TM10 mode at 2.45 GHz and TM20 mode at 3.5 GHz—to achieve dual-band operation. The MA and MSBMA antennas are then kept near to human body model to measure the Specific absorption Rate (SAR) value in order to make it useful for off-body communications.

Results and Discussions: The proposed metasurface-based monopole antenna (MSBMA) achieves dual-band operation with frequency ranges of 2.33–2.62 GHz and 3.19–3.62 GHz, unlike the conventional monopole antenna, which operates as a single-band antenna. When placed on a rectangular human body model (RHBM), the MSBMA maintains dual-band characteristics while showing a reduction in radiation efficiency due to body proximity. The MSBMA exhibits an improvement in realized gain compared to the monopole antenna. The Specific Absorption Rate (SAR) values for MSBMA are 0.0246 W/kg at 2.45 GHz and 0.057 W/kg at 3.5 GHz, significantly lower than those of a simple monopole, ensuring compliance with EU safety regulations.

Conclusions: The proposed metasurface-based monopole antenna (MSBMA) achieves compact dual-band operation with improved gain and significantly reduced SAR, making it safer for wearable applications.

Keywords: Off-body communication, Metasurface, dispersion curve, dual-band and SAR.

Adaptive Reinforcement Learning for Dynamic Voltage and Frequency Scaling in Energy-Efficient Computing

Prasanta Panda*, Aruna Tripathy, Kanhu Charan Bhuyan

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: panda.prashant@gmail.com

Introduction: The increasing demand for energy-efficient computing has driven the development of advanced techniques to optimize power consumption in modern systems. While Dynamic Voltage and Frequency Scaling (DVFS) has been widely used for power management, traditional implementations struggle to adapt dynamically to workload variations, limiting their effectiveness. This research introduces an innovative approach that integrates Reinforcement Learning (RL) into DVFS to overcome these limitations. Using Q-learning, a model-free RL technique, the proposed algorithm autonomously learns and applies optimal CPU voltage and frequency adjustments in real time. Experimental results demonstrate a significant 20% reduction in power consumption compared to conventional DVFS methods. The model's adaptability across diverse workloads highlights RL's potential in enhancing energy efficiency. As energy optimization becomes increasingly critical, this study underscores the transformative role of RL in achieving sustainable and high-performance computing systems.

Methods and Material: Optimizing power consumption is a critical challenge in energy-efficient computing. Dynamic Voltage and Frequency Scaling (DVFS) has long been a key technique for managing power, but traditional implementations struggle to adapt to the increasing complexity and variability of modern workloads. To address these limitations, this paper proposes an innovative approach that integrates Reinforcement Learning (RL) into DVFS, enabling intelligent, real-time adjustments of CPU voltage and frequency.At the core of this approach is Q-learning, a model-free RL technique that iteratively learns the optimal policy for voltage and frequency scaling.

Result and Discussion: Unlike conventional DVFS methods with fixed configurations, the proposed system dynamically adapts to workload variations, achieving a 20% reduction in power consumption. Comprehensive evaluations on server data demonstrate the superiority of RL-based DVFS in balancing energy efficiency and computational performance.This research also explores the integration of RL-based DVFS into the Power Management Unit (PMU), covering key aspects such as communication protocols and real-time decision-making. By enhancing adaptability in power management, this research advances sustainable, high-performance computing. The following sections detail related work, the proposed algorithm, architecture, training process, results, and future directions.

Conclusion/Recommendation: This research demonstrates the effectiveness of Reinforcement Learning (RL) in optimizing Dynamic Voltage and Frequency Scaling (DVFS) for System-on-Chip (SoC) environments. The proposed RL-based DVFS system exhibits superior adaptability to workload variations, achieving significant power savings while maintaining or enhancing computational performance. Key findings highlight the impact of exploration-exploitation strategies and learning rates on decision-making, validating RL's potential for autonomous power management in SoCs.

Keywords: RL, DVFS, Energy Efficiency, Adaptive Power Management

Bus Invert Encoding Architecture for Energy Efficiency in Network-on-Chip (NoC)

Ranjan Kumar Samal*, Tapas Kumar Patra

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: samal.ranjan@gmail.com

Introduction: The advancement of System-on-Chip (SoC) technology has introduced challenges in power consumption and communication complexity. Network-on-Chip (NoC) is now the standard for scalable interconnects in multicore SoCs, but dynamic power consumption remains a major concern. This is primarily due to high switching activity in data buses, where each transition between logic states leads to energy dissipation. Reducing these transitions can significantly lower power consumption in NoCs. Various data encoding techniques have been explored to address this issue, with Bus Invert Encoding (BIE) emerging as a promising solution. BIE minimizes switching activity by inverting the entire data bus when transitions exceed half the bus width, effectively reducing power consumption with minimal hardware overhead. This research applies BIE in NoCs, achieving up to 25% energy savings while maintaining low complexity. By optimizing power efficiency, BIE enhances overall system performance in energy-constrained environments.

Materials and Methods: Energy efficiency is a critical concern in the design of modern Network-on-Chip (NoC) architectures. Among various energy-saving techniques, data encoding has emerged as a promising approach. This research introduces an exploration of Bus Invert Encoding (BIE) as a method to reduce dynamic power consumption in NoCs. By minimizing the number of bit transitions on data buses, BIE reduces the switching activity, thereby significantly lowering energy consumption. This research implements the principles of BIE in NoCs, and evaluates its effectiveness through new architecture implementation and power estimation. Results indicate that the BIE achieves up to 25% reduction in energy consumption, with minimal impact on latency and throughput.

Results and Discussion:

Table1: Comparison of power estimation with and without the Bus Inverted Logic

Method	Internal (W)	Switching (W)	Leakage (W)	Total (W)
No Bus Inverted logic	1.903542e-01	4.1602121e-02	1.380955e-03	**2.333372e-01**
With Bus Inverted Logic	1.618354e-01	3.536180e-02	1.394764-03	**2.1699742e-01**

The Power reduction due to switching is 15% and total power reduction is 7%.

Conclusion/Recommendation: This research demonstrates that Bus Invert Encoding is an effective technique for reducing dynamic power consumption in Network-on-Chip (NoC) architectures. By minimizing bit transitions, BIE achieves significant energy savings with minimal impact on performance and hardware complexity. Future work will explore adaptive encoding schemes and their integration with other power-saving techniques to further enhance NoC energy efficiency.

Keyword: ***BIE, NoC, Energy Efficiency, Network-on-Chip***

Prediction of ECG fiducial parameters from PPG signals for the analysis of cardiovascular diseases: A novel Gaussian process regression-based approach

Rashmi Rekha Sahoo*, Saibal Ghosh, Siddharth Mani and

Palash Kumar Kundu

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: rrsahooie@outr.ac.in

Introduction: Cardiologists use 12-lead electrocardiograph (ECG) and prolonged continuous Holter monitoring to detect abnormalities in heart rhythm, which could diagnose or hint at different cardiac diseases. However, the availability of a costly ECG machine and the expertise to interpret ECG is suboptimal in our country. The current state of the art proposes mitigating the cost and easy diagnosis by physicians with the use of low cost photoplethysmograph (PPG), which will deliver ECG information in terms of ECG fiducial parameters.

Materials and Methods: The MIMIC-III matched paired datasets of PPG/ Lead-II ECG signals with the six classes (right bundle branch block (RBBB), hypertension (HYPER), arrhythmia-atrial fibrillation (ARYTH-ATRFAB), dilated cardiomyopathy (DCM), complete heart block (CHB) and NORMAL) associated cardiovascular diseases (CVDs) syndromes of 30 patients with 5 minutes duration eachwere taken from Physionet. The proposed work tested by predicting ECG fiducial parameters (P, Q, R, S and T) through Gaussian process regression(GPR)-based predictor by using the PPG fiducial parameters with a training and testing ratio of 70:30. The performance was analyzed by different performance evaluation parameters e.g., RMSE, rRMSE, etc.

Results and Discussion: Although the shape of the ECG may differ in various ways from that of the normal ECG, the methodology can predict the ECG fiducials from PPG for a variety of CVD patients with a performance accuracy of 95-99% by evaluating through seven performance metrics.

Conclusion/Recommendation: The ECG fiducial parameters can be used to analyze CVDs captured from a low-cost, handy, skin-compatible continuous and non-invasive optical recording device well known as a PPG sensor.

Keywords: Electrocardiograph (ECG), Photoplethysmograph (PPG), Cardiovascular diseases (CVDs), Gaussian process regression (GPR), Pearson's correlation coefficient,Coefficient of determination, Dynamic time warping distance, Scatter plot and Bland-Altman plot.

Disease Prediction in Poultry Farm using IoT-enabled Smart Monitoring System

Sahitya Tripathy, Harshita Prusty and Kanhu Charan Bhuyan*

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: kcbhuyan@outr.ac.in

Introduction: The poultry farming industry has been rapidly expanding over the last few decades due to an increasing demand for protein in food. High-quality protein is an essential nutrient in the diet. Meeting this demand requires not only managing the environmental factors of farms to increase production but also maintaining the health of poultry birds. This project proposes solution by leveraging the Internet of Things (IoT) and Machine Learning (ML). It includes environmental monitoring and regulation of the farm through different sensors like DHT-11 and MQ-135, interfaced with microcontrollers.

Materials and Methods: The environmental monitoring system employs sensors such as DHT-11 and MQ-135 to collect crucial data on temperature, humidity, and gas concentrations, including ammonia. These sensors are connected to Arduino Uno, which regulate environmental factors within poultry houses, ensuring optimal conditions for poultry health and productivity. The microcontroller transmits data to Raspberry Pi, which hosts a web application accessible to poultry farmers. This web application serves as a centralized platform for real-time monitoring of environmental parameters, offering insights through graphical representations. Additionally, it features live video streaming for surveillance and allows poultry farmers to upload images of poultry faeces for disease prediction. The project also focuses on a disease prediction algorithm model for detecting coccidiosis, a common poultry disease. TensorFlow and Keras models are used for model development. The system offers real-time data monitoring, aids in early disease detection, and provides an easy-to-use, user-friendly interface.

Results and Discussion: The disease prediction model effectively classifies poultry health based on fecal images. It correctly detects coccidiosis in affected birds and identifies healthy samples accurately, showcasing its reliability for early disease detection. The environmental parameter analysis reveals cyclic variations. The temperature levels exhibit a periodic pattern, characterized by peaks around midday and late evening, indicating natural diurnal variations. Humidity levels also vary significantly, with sharp dips and rises, possibly due to ventilation or external weather conditions. Ammonia concentration exhibits irregular spikes, indicating waste accumulation and the need for better waste management or ventilation control.

Conclusion/Recommendation: This project aims to assist poultry farmers in increasing production while ensuring poultry well-being. By integrating IoT and ML, the system automates farm monitoring, reducing costs and manual labor. Sensors collect real-time data, while a Raspberry Pi processes it and predict coccidiosis using trained models. Stable changes in temperature, humidity and ammonia gas figures indicate that the control device has good accuracy. Farmers can diagnose infections through a web-based platform. Future improvements include detecting multiple diseases, adding water sprinklers for climate control, and implementing neckbands with PIR sensors and cameras for security. With GSM integration, the system ensures complete farm automation, making poultry farming more efficient, cost-effective, and user-friendly.

Keywords: Poultry Farming, Internet of Things, Machine Learning, Disease Prediction, Environmental Monitoring

Localization in Visible Light Communication LoS System using RSS and PSO

Sagupha Parween*, Aruna Tripathy

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: sagupha.parween@gmail.com

Introduction: Visible Light Communication (VLC) has emerged as a potential alternative to Radio Frequency (RF) technologies for high-speed indoor communication in recent years. VLC system uses a LED as the transmitter that sends data at high speed which is subsequently detected by a photodetector serving as the receiver. Localization is the task to determine the optimum receiver placement for maximum signal reception. Localization is a two-step process: (i) distance estimation and (ii) position estimation, where distance is estimated by the received signal strength (RSS) and position is estimated by particle swarm optimization (PSO). The objective of this work is to estimate the receiver's position using a single transmitter and further increasing the number of transmitters to two. Additionally, the system accuracy has been determined by calculating the mean square error (MSE) between the actual position and the estimated position of the receiver.

Materials and Methods: In this work, we have considered a room of size 3m x 3m to represent a 2D scenario. The transmitter is placed at the top of the room and the receiver can be randomly placed anywhere for a Line-of-sight (LoS) scenario. The communication range is decided by the Field-of-View (FoV) of the transmitter and receiver. The LED used as a transmitter has a Lambertian emission pattern whose angle at half power is known as semi-angle i.e. the FoV of the transmitter. Prior to reaching the receiver, the transmitted power is affected by the channel impulse response that serves as the actual received power. Using the received power, the distance is estimated using RSS. After this distance estimation, the actual position of the receiver has been found out using PSO..

Results and Discussion: All the simulations are done using MATLAB 2022a. In this work four scenarios are taken into consideration for the indoor localization in the VLC LoS system: (a) single transmitter and single receiver; (b) single transmitter and 10 receivers, (c) two transmitters and a single receiver; and (d) two transmitters and 10 receivers. The MSE for the above mentioned four scenarios are found to be 1.295, 2.694, 0.08, and 2.123 respectively. The study also shows the theoretical effect of FoV of receiver and semi-angle of transmitter on the communication distance. The FoV and semi-angle is varied from 10^0 to 80^0 respectively and for lower angles the range is found to be highest.

Conclusion/Recommendation: By increasing the number of transmitters, the communication range is observed to increase and can give full coverage to the room. Increasing the number of transmitters reduces the MSE. By increasing number of receivers the MSE is observed to increase because the receivers are distributed in the whole area of interest and the receiver positions do not necessarily fall within the FoV of the transmitter. To reduce the MSE we need to increase the number of transmitters or we have to increase the FoV of the transmitter.

Keywords: VLC, LoS, Localization, RSS, PSO

FOPID based Feed-Forward Temperature Control of a 100ºC Thermal Reservoir

Satyabhama Dash*, Sumit Swain and

Madhab Chandra Tripathy

School of Electronic Sciences, OUTR,

Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: sdashie@outr.ac.in

Introduction: The temperature control of a heat reservoir is a critical aspect in various industrial and scientific applications where maintaining a stable temperature is essential for system efficiency and process accuracy. A heat reservoir, typically consisting of a large thermal mass with high heat capacity, is designed to absorb or release heat with minimal temperature fluctuations. To achieve precise temperature control, the system is equipped with temperature sensors, such as thermocouples or resistance temperature detectors (RTDs), that continuously monitor the reservoir's thermal state. These sensors feed data to a control unit, which usually employs a PID (Proportional-Integral-Derivative) controller to regulate heat input and output. The use of a feed forward controller in a heat reservoir system enhances temperature regulation by anticipating disturbances and adjusting the heat input or output before deviations from the desired temperature set point occur

Materials and Methods: The overall objective is to derive the system's transfer function and show the combined effects of the FOPID controller and feed-forward mechanism [3-6]. The thermal reservoir system is modelled with a standard first-order transfer function. The input-output relationship between the applied heat and the reservoir temperature is represented by: $G_{res}(s) = \frac{k_1}{t_1 s+1}$, where (k_1) is the system gain, and (t_1) is the time constant of the thermal reservoir. This equation characterizes the dynamics of heat flow and the corresponding temperature change in the reservoir.

Results and Discussion: The analysis of a heat reservoir system with disturbances becomes increasingly complex when conventional control strategies like classical PID (Proportional-Integral-Derivative) face limitations in handling non-linearities, external disturbances, and dynamic variations. In response, the integration of Fractional-Order PID (FOPID) controllers and Feed-forward Control (FFC) offers an advanced solution, combining the robustness of fractional calculus with the predictive capability of feed-forward strategies. This hybrid control scheme improves the system's ability to maintain temperature stability in the presence of disturbances such as fluctuating ambient conditions, variations in heat load, or system inefficiencies.

Conclusion/Recommendation: The integration of a Fractional-Order PID (FOPID) controller with feed-forward control (FFC) significantly enhances temperature regulation in thermal reservoirs, especially under dynamic disturbances like fluctuating heat loads and ambient temperature changes. In the simulations, the FOPID controller with a fractional integral order of 0.8 achieved a settling time of 21 seconds, which is a 40% reduction compared to the 35 seconds observed with a traditional PID controller. The system's overshoot was reduced to 5%, and the temperature deviation stayed within ±2°C of the set point.

Keywords: Fractional order Control, Feed-Forward Control, Temperature Regulation and Thermal Reservoirs.

IoT for Predictive Maintenance in Industrial Automation: A Secure and Scalable Framework

Sruti Ranjan Sahoo and Kanhu Charan Bhuyan*

School of Electronics Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: kcbhuyan@outr.ac.in

Introduction: The integration of Industrial Internet of Things (IIoT) technologies into industrial automation has revolutionized maintenance practices by shifting from traditional reactive and time-based approaches to predictive maintenance. By harnessing real-time sensor data and advanced analytics, predictive maintenance anticipates equipment failures, minimizes unplanned downtime, and significantly reduces operational costs. Despite these benefits, the secure and efficient integration of IoT devices into industrial systems remains challenging due to issues related to data security, scalability, and interoperability. This research seeks to develop a robust, unified framework that addresses these challenges while optimizing maintenance strategies.

Materials and Methods: A mixed-methods approach underpins the proposed study. Initially, a comprehensive literature review will critically assess current predictive maintenance frameworks and highlight gaps in existing methodologies. Quantitative data will be collected from industrial sensors measuring key performance indicators such as temperature, pressure, vibration, and humidity—all vital for early detection of equipment degradation. In parallel, qualitative insights will be garnered through structured interviews and case studies with industry professionals, focusing on practical deployment challenges and security vulnerabilities. Simulation models replicating real-world industrial scenarios will be developed to experimentally evaluate diverse predictive maintenance strategies. Rigorous security assessments, including penetration testing and vulnerability analyses, will further ensure that the proposed framework incorporates robust safeguards against cyber threats.

Results and Discussion: Preliminary findings are anticipated to demonstrate a strong correlation between sensor data trends and machinery performance decline, thus validating the efficacy of predictive analytics in foretelling maintenance needs. Early simulation results suggest that a well-integrated IoT system can reduce unplanned downtime by up to 30%, yielding significant cost efficiencies. Furthermore, the study will propose a dedicated security assessment toolkit specifically designed for IoT applications in industrial settings. This toolkit aims to systematically address risks such as data breaches, unauthorized access, and other vulnerabilities inherent in IoT networks. Comparative analysis of various predictive models will allow for the identification of optimal strategies that ensure early fault detection and timely maintenance interventions. Additionally, the economic analysis component of the study will quantify the cost-benefit dynamics of adopting IoT-based predictive maintenance, thereby offering actionable guidelines for industry investments.

Conclusion/Recommendation: The research is expected to culminate in a comprehensive, scalable, and secure framework for implementing IoT-driven predictive maintenance in industrial automation. By balancing technological innovation with stringent security protocols, the proposed framework will not only enhance operational efficiency and safety but also serve as a strategic blueprint for industries aiming to transition towards digitally empowered maintenance systems. Future work will incorporate advanced machine learning techniques, adapt evolving IoT standards, and investigate industry applications to enhance framework performance.

Keywords: Industrial IoT; Predictive Maintenance; Industrial Automation; Data Security; Mixed-Methods; Predictive Analytics

Fuel Cell-Based Micro-grids for Rural Power Supply

Srutisagar Pattanaik, Kanhu Charan Bhuyan*

School of Electronics Sciences,

Odisha University of Technology and Research,

Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: kcbhuyan@outr.ac.in

Introduction: Rural electrification remains a significant challenge worldwide, particularly in remote areas where conventional grid expansion is economically unfeasible. Fuel cell-based micro-grids present a sustainable alternative, leveraging hydrogen or other fuels to generate clean and reliable power. These systems, when integrated with renewable energy sources such as solar and wind, enhance energy security while reducing carbon emissions. Despite their potential, challenges such as high initial costs, fuel availability, and operational efficiency hinder widespread adoption. This study evaluates the feasibility, performance, and impact of fuel cell-based micro-grids in rural settings, emphasizing system efficiency and economic viability.

Materials and Methods: A fuel cell-based micro-grid model is developed, integrating proton exchange membrane fuel cells (PEMFCs) with photovoltaic (PV) panels and battery storage to optimize energy distribution. A simulation is conducted using MATLAB/Simulink to analysepower output, load management, and system efficiency under varying conditions. Field data from pilot projects in rural regions are collected to assess real-world applicability. Key performance indicators (KPIs) such as energy reliability, fuel consumption, cost-effectiveness, and environmental benefits are evaluated.

Results and Discussion: The study found that fuel cell-based micro-grids significantly improve energy access and reliability in rural areas. The integration of renewable energy sources and energy storage resulted in improvement in power stability, reducing dependence on intermittent renewables alone. Using Controller, the performance of solar PV has risen to 1402 W from 845 W, whichis a rise of 66%. Similarly using controller, the performance of Fuel Cell has raised to 1278 W from 787 W, which is a rise of 62%.Hybridization with solar PV lowered operational costs by 20%, as excess energy generated during peak sunlight hours is stored and utilized during nighttime or low-supply periods. The study also identified key barriers, such as hydrogen fuel availability, which is mitigated by exploring biomass-based hydrogen production in select rural sites. Pilot projects demonstrated that community engagement and financial support mechanisms, such as micro-financing and government incentives, played a crucial role in the success of these micro-grids.Economic analysis revealed that although initial capital costs are 40–50% higher than traditional diesel-based micro-grids, the levelized cost of electricity (LCOE)is reduced by due to lower operational and maintenance expenses.

Conclusion/Recommendation: Fuel cell-based micro-grids offer a promising solution for rural electrification, providing sustainable, clean, and reliable energy. The integration of renewable sources enhances energy stability while reducing environmental impact. Despite high initial costs, long-term benefits in efficiency and cost reduction justify investments in such systems. With strategic investments and policy support, fuel cell-based micro-grids can play a transformative role in achieving universal energy access in rural areas.

Keywords: Fuel Cells, Micro-grids, Rural Electrification, Renewable Energy, Hybrid Energy Systems, Sustainable Power Solutions.

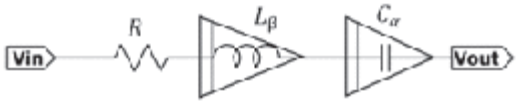
Design of Nano-Particle Based Fractional Capacitors and Fractional Inductors with its Performance Study in a $RL_{\hat{a}}C_{\acute{a}}$ Circuit.

Sumit Swain*, Madhab Chandra Tripathy, Sribatsa Behera, and Achyuta Nanda Acharya

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: 2021110703@outr.ac.in

Introduction: Fractional-order circuit components, including fractional capacitors and inductors, provide unique frequency-dependent impedance characteristics governed by non-integer differential equations. These components exhibit fractance behavior, enabling enhanced modeling capabilities for dynamic systems across diverse applications, such as signal processing, power electronics, control systems, and biomedical devices. Unlike traditional integer-order elements, fractional-order components offer additional degrees of freedom, allowing for more precise control over system dynamics. One of the key advantages of incorporating fractional-order elements in RLC circuits is the ability to achieve improved system stability and adaptability. They enable designers to fine-tune frequency domain characteristics, such as gain and phase margins, with greater flexibility. Moreover, fractional-order components can reduce the speed of response while maintaining efficient energy consumption, which is particularly beneficial in applications requiring smooth and controlled transitions. Their versatile impedance profiles make them ideal for emerging technologies where precise frequency response and stability are crucial design considerations.



Materials and Methods: Carbon nanotube (CNT) and epoxy-based fractional capacitors leverage the constant phase zone and excellent electrical properties of CNTs to achieve enhanced capacitance and fractance stability. Meanwhile, zirconium quantum dots (Zr-QDs) in ethanol embedded in a transverse electromagnetic mode (TEM)-structure provides a promising solution for fractional inductors with robust performance over varying frequencies. These fractional-order elements are connected in series with a resistor and the experimental time and frequency domain analysis has been carried out and compared with MATLAB simulations.

Results and Discussion: This work focuses on the design, fabrication, and characterization of fractional-order circuit components, specifically CNT-epoxy-based fractional capacitors and TEM-based Zr-QDs fractional inductors, evaluating their electrical performance and potential applications. These novel components exhibit superior adaptability compared to traditional integer-order counterparts, making them highly promising for advanced circuit designs and emerging communication systems. The carbon nanotube (CNT)—based fractional capacitor demonstrates remarkable performance, achieving a fractional order of á = 0.35 when 10 mg of CNT is mixed with 100 g of epoxy, providing stable frequency-dependent impedance characteristics. On the other hand, the Zr-QDs-based fractional inductor offers a tunable fractional order ranging from á = 0.2 to 0.4 by varying the concentration of zirconium quantum dots from 100 ppm to 10 ppm in ethanol. Such flexibility and adaptability open up new possibilities in applications including signal filtering, impedance matching, and bioimpedance systems.

Conclusion/Recommendation: Fabricating fractional capacitors and fractional inductors, their validation, and incorporation in improving RLC circuit performance.

Keywords: Fractional capacitor, Carbon nanotubes (CNT), Fractional inductor, Zirconium Quantum Dots (Zr-QDs), Dielectric, and Transverse electromagnetic mode (TEM).

SRAM-Based Statistical Counters in ASICs/SoCs: A Power and Area Efficient Approach

Sudhansu Sekhar Naik *, Patra Tapas Kumar

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: sudhansusekhar@gmail.com

Introduction: Counters play a crucial role in digital circuit design, facilitating tasks such as sequencing, addressing, and event tracking or statistics collection. Traditionally, flip-flops have been the primary choice for implementing counters due to their simplicity and ease of integration. However, the relentless pursuit of performance optimization and energy efficiency in modern ASICs and SOCs necessitates exploration beyond conventional design paradigms. As the requirement of number of counters in the chip increases, the area and power footprint due to the flip-flop-based counters need a relook. In this paper, we propose the adoption of SRAM-based memory counters as a viable alternative, offering several compelling advantages over flip-flop-based implementations. By leveraging the inherent characteristics of SRAM arrays with regard to the PPA, we can get rid of the significant overhead of PPA in traditional counter implementations using dedicated logic circuits using flip flops.

Materials and Methods: This work presents a novel approach to designing statistical counters in Application-Specific Integrated Circuits (ASICs) and System-on-Chips (SoCs) using Static Random-Access Memory (SRAM) instead of conventional flip-flops. Flip-flop-based counters are power-hungry and consume substantial silicon area, especially in high-bit-width applications. By embedding counters within SRAM cells, our method reduces power consumption and silicon footprint while maintaining performance. This integration exploits SRAM's inherent properties to enhance Power-Performance- Area (PPA) metrics. The proposed design minimizes the overhead of dedicated counter circuits and benefits from SRAM's parallelism and density. Experimental results show significant improvements in power efficiency, performance, and area utilization compared to traditional counters. This SRAM-based approach improves scalability and efficiency, providing an effective solution for data collection in modern computing systems. Our findings offer valuable insights into optimizing SoC designs for low-power applications, making them more efficient and scalable.

Results and Discussion:

Table-1: Comparison of power estimation between usage of Flipflops and SRAM

Method	Internal (W)	Switching (W)	Leakage (W)	Total (W)
Flip-Flop Based	2.131137e-03	3.516287e-03	4.815231e-02	5.379973e-02
SRAM Based	2.499200e-02	3.416397e-03	2.641000e-03	3.104940e-02

Total Power Saving = 42%

Conclusion: SRAM-based memory counters offer a promising alternative to flip-flop-based implementations in ASICs and SOCs, delivering superior performance, efficiency, and flexibility. By harnessing the unique properties of SRAM technology, designers can unlock new opportunities for innovation and optimization in digital circuit design. It is obvious that the adoption of SRAM-based counters will become increasingly prevalent in future generations of integrated circuits, driving advancements in both performance and energy efficiency across a wide range of applications.

Keywords: Chip counters, SRAM, PPA, Read latency

An ensemble learning random forest approach for efficient fault detection in AC Microgrid

Amlan Chhotaray*, Shubhranshu Mishra, Abinash Mahapatra, Rudranarayan Pradhan

School of Electrical Science, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: amlanchhotaray3@gmail.com

Introduction: This research discusses the consequences of relying too heavily on fossil fuels, such as pollution, resource depletion, and global warming, as well as the rising need for energy. To reduce these risks, it suggests microgrid as independent energy systems that make use of renewable energy sources like the sun and wind. When dynamic generators are included into microgrid, the bidirectional current flow presents difficulties for traditional fault detection methods. In order to get around this, the research uses the Random Forest methodology, a machine learning method that falls within the ensemble learning category and operates on labelled datasets, for fault classification. Through the combination of many decision tree outputs, ensemble learning optimises resource distribution and raises microgrid efficiency overall. Building a robust and sustainable microgrid is thought to be significantly aided by the incorporation of machine learning. This technique outperforms when compared with other machine learning algorithms.

Materials and Methods: Step1 : Data preprocessing: Data preprocessing vital for ML. Method involves sorting, stats, cleaning, testing. Graphical analysis with Python libraries initiates methodology.

Step2 : Reducing the curse of dimensionality: PCA starts with dataset, computes covariance, sorts eigenvalues for dimensionality reduction

Step3 : Random forest classifier: The Random Forest classifier with Ensemble learning to enhance predictive capabilities in fault detection.

Step4 : Random forest regression: The Regression tree algorithm organizes data, separates nodes using impurity metric.

Results and Discussion: In a Random Forest classifier, decision trees are built recursively, with each tree trained on a random subset of data and features to reduce overfitting. The trees operate independently, contributing diversity, and predictions are made through voting or averaging. A confusion matrix evaluates the model's performance by summarizing correct and incorrect predictions. The ensemble of diverse trees improves generalization, making Random Forests effective for various machine learning tasks. Accuracy and errors in the Random Forest Algorithm for different types of faults L-G 98.69% , L-L 96.83%, L-L-G 97.93%, L-L-L, 98.0%, L-L-L-G 97.8%. Comparison of Different type ML algorithm with Random-forest in terms of Accuracy Random Forest Classifiers 98 %, Naive Bayes 86.2%, KNN 90.0%, Decision Tree 82.1%, Support Vector Machine 89.5%.

Conclusion/Recommendation: This research explores the Random Forest algorithm for fault detection in power systems, combining data mining, analysis, and machine learning. The model achieves fault classification accuracy rates between 96.83% and 98.69%. Beyond technical results, it provides a reliable tool for power system operators, enhancing grid stability and minimizing downtime. The study lays a foundation for future research, incorporating new technologies, adapting to different power system layouts, and real-world scenarios, promoting continuous innovation in fault detection and improving system operations' flexibility, effectiveness, and reliability.

Key words: Microgrid, Machine Learning, Random Forest, Real-Time Digital Simulator

Design and development of battery controller and python based cost optimization of Battery for EV application

Ananya Mishra, Bandan K. Panigrahi*, and Ranjan k. Jena

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: panigrahi91@gmail.com

Introduction: Battery technology forms the backbone of electric vehicles (EVs), serving as their primary energy storage and delivery system. Modern EVs primarily rely on lithium-ion batteries, valued for their high energy density, efficiency, and longevity. As the demand for EVs continues to grow, advancements in battery technology, including innovations in materials, thermal management, and recycling, are crucial. These developments aim to address challenges like range anxiety, charging infrastructure, and sustainability, driving the global transition to eco-friendly transportation solutions.

Materials and Methods:

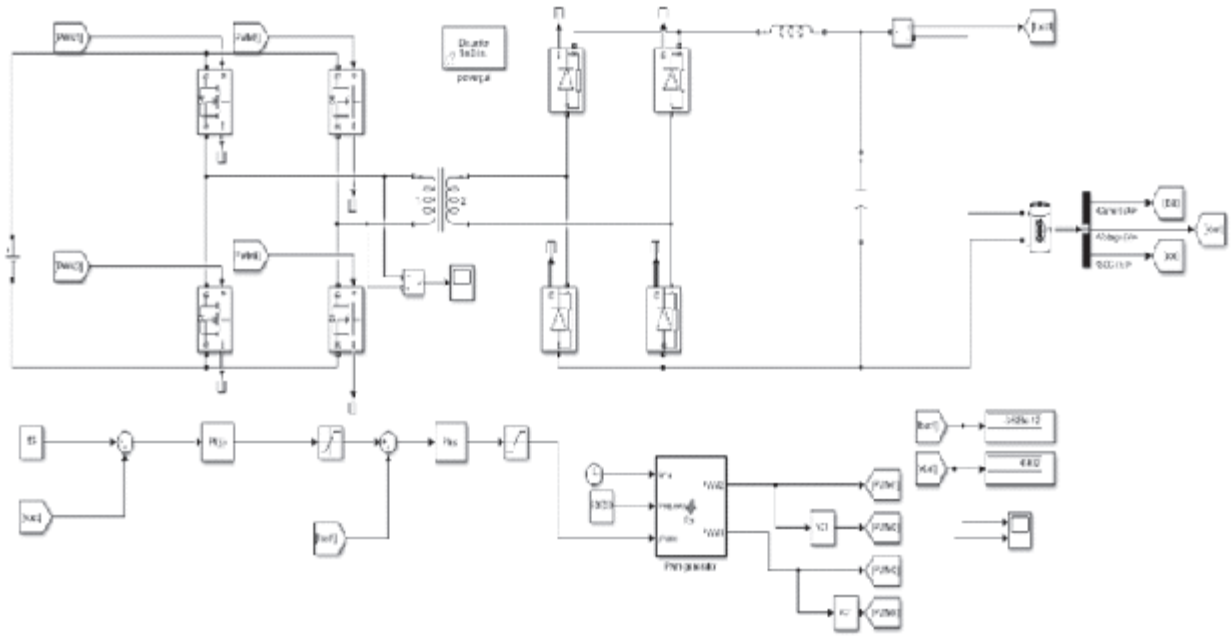


Fig1: Simulink diagram of close loop control of Battery with controller

Results and Discussion: This study presents detail mathematical modelling like Thermal Modelling (TM), State of health (SOH) modelling etc. to identify the parameters which largely contributes for its stability and cost.

Conclusion/Recommendation: This study presents detail mathematical modelling like Thermal Modelling (TM), State of health (SOH) modelling etc. to identify the parameters which largely contributes for its stability and cost. This paper also formulates a cost function by incorporating all the useful; parameters and the cost of the battery optimized by writing a code on Python.

Key words: EV; SOH; TM; MATLAB Simulink

Optimal Power System Operation with Distributed Energy Resources

Asis Kumar Mallick*, Ullash Kumar Rout

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: shriyasrish77@gmail.com

Introduction: Power system control and stability have been an area with different and continuous challenges in order to reach the desired operation that satisfies consumers and suppliers. To accomplish the purpose of stable operation in power systems, different loops have been quipped to control different parameters. For example, Load Frequency Control (LFC) is introduced to maintain the frequency at or near its nominal values, this loop is also responsible for maintaining the interchanged power between control areas interconnected via tie-lines at scheduled values. Other loops are also employed within power systems such as the Automatic Voltage Regulator (AVR). This thesis focuses on the problem of frequency deviation in power systems and proposes different solutions based on different theories.

Materials and Methods: The proposed methods are implemented in two different power systems namely: unequal two-area interconnected thermal power system and the simplified three area power system with one of the areas being a micro grid. Artificial intelligence-based controllers have recently dominated the field of control engineering as they are practicable with relatively low solution costs, this is in addition to providing a stable, reliable and robust dynamic performance of the controlled plant. They proficiently can handle different technical issues resulting from nonlinearities and uncertainties.

Results and Discussion: In order to achieve the best possible control and dynamic system behaviour, a soft computing technique based on the Genetic Algorithm (GA) is suggested for tuning the parameters of the proposed controllers for LFC purposes. Fuzzy PID controller with filtered derivative action (Fuzzy PIDF) optimized by the GA is designed and implemented to improve the frequency performance in the two different systems under study during and after load disturbance.

Conclusion/Recommendation: Further, three different fuzzy control configurations that offer higher reliability, namely Fuzzy Cascade PI — PD, Fuzzy PI plus Fuzzy PD, and Fuzzy (PI + PD), optimized by the GA have also been implemented in the two-area interconnected power system. The robustness of these fuzzy configurations has been evidenced against parametric uncertainties of the controlled power systems. And frequency deviations and/or voltage deviations of any or all three areas are effectively addressed. We have used MATLAB and Opel RT to simulate the results.

Key words: AVR, GA, Fuzzy-PID

Design and development of Lead and lag lead controller for Dc-dc Cuk converter for EV application

Bandan K. Panigrahi*, Ranjan K. Jena and Durgesh P. Bagarty

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: 2022710803@outr.ac.in

Introduction: DC-DC converter makes vital contribution in the field of effective power supplies with ripple free voltage with high quality. The extraction of high amount of sustainable energy from the available renewable energy sources demands highly efficient controlled DC-DC power electronic converters.

Materials and Methods:

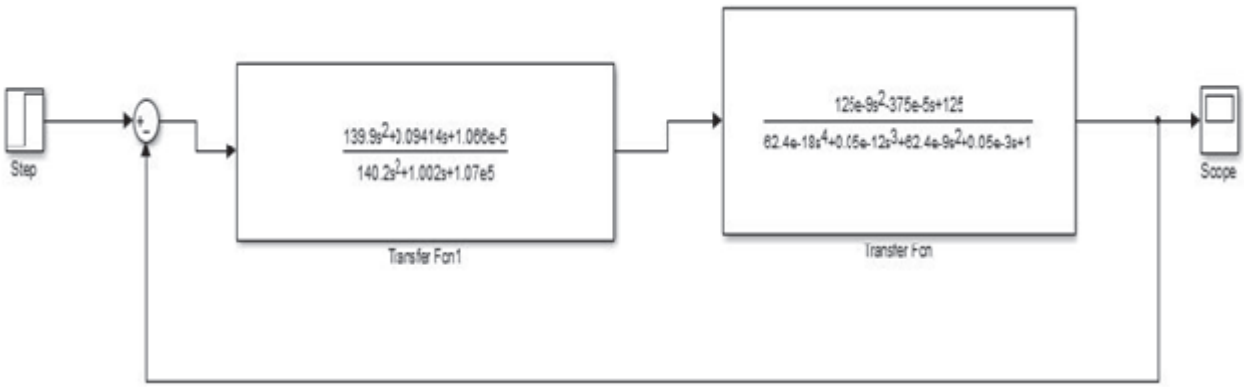


Fig1: Block diagram of close loop control of cuk converter with LEAD –LAG controller

Results and Discussion: In this work the simulation, modeling and of dc-dc cuk converter is being done and the result has been presented in sequential manner. The software platform which has been used is MATLAB. The design of Cuk converter was done by modeling the circuit parameters and calculating the values of L and C. In this context a power MOSFET based power circuit of dc dc Cuk converter has been developed with two inductors and two capacitors. The isolation circuit has been developed by the use of TLP-250 and 4N35 optocouplers in power electronics lab .The firing circuit is validated by both analog implementation (by use of 555 timer circuit) and also by digital implementation (by use of Aurdino). This work presents the design of an optimized LEAD and LAG-LEAD controller for non-isolated DC-DC CUK converter for constant voltage applications.

Conclusion/Recommendation: The efficiency obtained of the cuk converter was closed to 90 %.The results shows that the load and source current are both continuous in nature which is not in the case of other non-isolated dc dc converters. n thesis 555 timer circuit is used as driver circuit for MOSFET because the former will not work beyond 20 kHz. High frequency was used in order to minimize the size, reduce the cost of system and operate the inductor in continuous mode.

Keywords: DC-DC converter; lead controller; lag controller; Cuk Converter; MATLAB

Design of Electrically Heated Biochar Plant to convert agricultural waste into Biochar for effective utilization in Steel Plant for Production of Green steel

Bibhu Charan Swain*, Anil Patnaik, Lokanath Tripathy

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: bibhusir@gmail.com

Introduction: In Odisha huge quantity of Crop Residue, Argo Waste are generated in scattered manner which are managed through burning / open dumping leading to air pollution, GHG emission and global warming. Converting Agro residues into bio energy is crucial for sustainable growth and environmental protection. The main objective of the study is to design an innovative large scale Induction Heating Power Source, digesters to produce Biochar from Crop Residues and Agro Wastes.

Materials and Methods: Based on the survey conducted it is found that around 10 Ton per Day Tender Coconut Husk (Waste) is generated in Bhubaneswar which is dumped in the ground. It is proposed to produce Biochar from the Tender Coconut Husk (Waste) through Induction Heating which is more energy efficient as compared to coal / gas / Biomass Heating or Tungsten filament Heating. Induction circuit Power source shall be directly powered by electricity or in conjunction with electrical systems and solar systems. It is proposed to use Chipped Tender Coconut Husk and implement induction coil heating principle using AC electricity where AC shall produce magnetic field when it is passed through coil, an induced emf shall be generated in the steel tank and thus will create an eddy current and hence shall generate thermal energy in the steel tank. Induction heating circuit shall include a 220 V AC, 50 Hz power supply which shall be fed to the rectifier circuit, which converts the AC voltage to DC power. A large capacitor shall be designed and utilized to smooth out the DC power supply and supply to the IGBT, which acts as a switch to convert DC voltage to AC voltage and produce a current with high frequency. This will drive inductor and a resistor and thus heats the steel tank surface. The system shall be driven by the IC gate driver circuit where a 12 V power supply shall be used to manage the circuit frequency. In the proposed research the -12V to +12 V pulse generator circuit to drive the IGBT switch with high frequency shall also be designed. The design of digestor, its feeding circuit, drier, cooling circuit and associated equipment shall also be designed.

Results and Discussion: We shall construct the large-scale induction heating machine that directly heats the tank and same shall be used in an experiment involving an oven. We shall design the Inductor value, Resistor, Frequency and Current load pull required. The heat energy, temperature, and time needed to heat the oven shall be evaluated. The number of copper coil winding turns, capacitor value shall be designed. The temperature inside and outside the tank shall be checked. We shall measure the heating time, load current, Coil Temperature. During feeding the weight of Biomass shall be measured. After conversion, the weight of Biochar so produced shall be measured. The proximate analysis of the Biomass shall be conducted. The results shall be discussed with various Steel Plants, Aluminum Plants and Ferro Alloys plant and their interest level shall be for substitution of Petroleum coke with Biochar shall be studied in detailed. The process, results obtained shall be patented for commercialization.

Conclusion/Recommendation: Tungsten Coil Heating, Solar Heating, infrared heating are expensive and inefficient and require high power consumption. Biomass/Coal/ Gas Heating pollute the environment. Hence the induction heating and thereby production of Biochar from Agro Waste will be more energy efficient and more valuable. The proposed research if successful shall be commercialized and patent shall be obtained. The design shall be made available to start-up companies and large companies for wide scale production of Biochar in an efficient way.

Key words: Biochar Production; Induction Heating; Sustainable use of Agro Waste and Green Waste; Green Steel; Green Aluminum; Carbon Credit; Sustainable Development.

Transient Monitoring Function Index in AC Microgrids

Devi Prasad Nanda*, Rudranarayan Pradhan, Prasanta Kumar Satpathy

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: devinanda2010@gmail.com

Introduction: Microgrids are localized energy systems that operate independently or in conjunction with the main power grid. They are designed to enhance energy resilience, reliability, and sustainability by incorporating various renewable energy sources like solar, wind, and battery storage. With the ability to isolate from the main grid during outages, microgrids ensure continuous power supply to critical facilities. They are increasingly being adopted in communities, campuses, and industrial areas to promote energy efficiency and reduce carbon emissions. Microgrid failures can occur due to equipment malfunctions, cyber-attacks, or extreme weather events. Therefore, robust protection mechanisms, such as advanced monitoring systems and resilient infrastructure, are essential to maintain operational stability and prevent disruptions. Implementing protection strategies ensures the reliability and security of microgrids, safeguarding them against potential threats. This paper proposes a fault detection method for AC microgrids (MG) using the Transient Monitoring Function Index (TMFI) in a grid-connected mode for efficient fault detection. To validate the proposed method, a test IEEE seven-bus MG system is simulated using the Real-Time Digital Simulation (RTDS) framework, and the effectiveness of the approach is evaluated.

Materials and Methods: For the MG to operate reliably, the fault must be identified and fixed as soon as possible as it appears. Traditional protection solutions are unsuitable for microgrids (MG) because of bidirectional current flow, small fault currents in inverter-based MGs, and variations in their operational methods. The dynamic nature of MG operations leads to changes in the magnitude and direction of fault currents, causing conventional overcurrent protection systems to perform poorly. Therefore, advanced protection mechanisms are necessary to ensure the reliability and security of microgrids. The study utilized the MATLAB software environment to conduct the analysis, leveraging its robust tools and functions for simulating and interpreting data. Through MATLAB's advanced capabilities, the researchers effectively processed and visualized the results, leading to an accurate and comprehensive assessment of the fault detection approach for the AC microgrid system. This ensured the reliability and validity of the proposed methodology.

Results and Discussion: The analysis of the recommended method involves modeling an IEEE seven-bus MG system in an RTDS environment. Various symmetrical and unsymmetrical faults are simulated to assess the strategy's effectiveness. RTDS-based real-time simulation enables connecting physical protection relays to test their functionality in actual microgrid settings. The results are analyzed using MATLAB, with the MG system operating at 60 Hz and a sampling frequency of 6 kHz. Fault data are collected at the relay location, and the threshold (DTH) value is crucial for accurate fault detection. Different fault types and the TMFI index are evaluated, triggering relay signals to isolate faults.

Conclusion/Recommendation: This research introduces an efficient fault detection method for MG using the TMFI. The technique effectively identifies symmetrical and unbalanced faults without requiring a communication network. A seven-bus test MG system is simulated in the RTDS environment to validate the method, offering cost-effective implementation.

Keywords: Microgrid, Fault Detection, Transient Monitoring Function Index, Real-Time Digital Simulation

Optimal Frequency Regulation in Standalone Microgrid using Marine Predator Algorithm

Jasmine Hansda*, Prakash Kumar Ray

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: jasmine.hansda@gmail.com

Introduction: Frequency deviation is a major issue in standalone microgrids (SMGs) due to the intermittent nature of renewable sources and low system inertia. Energy storage systems help mitigate this by balancing generation and consumption. Optimized controllers further enhance frequency management. This study proposes a Tilt Integral Derivative (TID) controller optimized via the Marine Predator Algorithm (MPA) for load frequency control (LFC) in SMGs, demonstrating its effectiveness against conventional methods.

Materials and Methods: The proposed microgrid consists of Solar Photovoltaic (PV), Wind Turbine Generator (WTG), Diesel Engine Generator (DEG), Microturbine Generator (MT), Fuel Cell (FC), and Energy Storage Systems (ESSs) such as Flywheel Energy Storage System (FESS), Battery Energy Storage System (BESS), and Electric Vehicles (EVs). AC-output sources (WTG, DEG, MT) connect via transformers, while DC-output sources (FC, PV) require inverters. ESSs enhance stability, and EV integration helps reduce frequency deviations. The model is analyzed for Load Frequency Control (LFC), as shown in Figure 1. The MPA technique, a recent population-based optimization method, follows a survival-of-the-fittest approach. It operates in three stages: High Velocity Ratio (prey faster than predator), Unity Velocity Ratio (equal velocities), and Lower Velocity Ratio (prey slower than predator).The controller's gains are optimised by applying the objective function of the integral of time multiplied absolute error (ITAE).

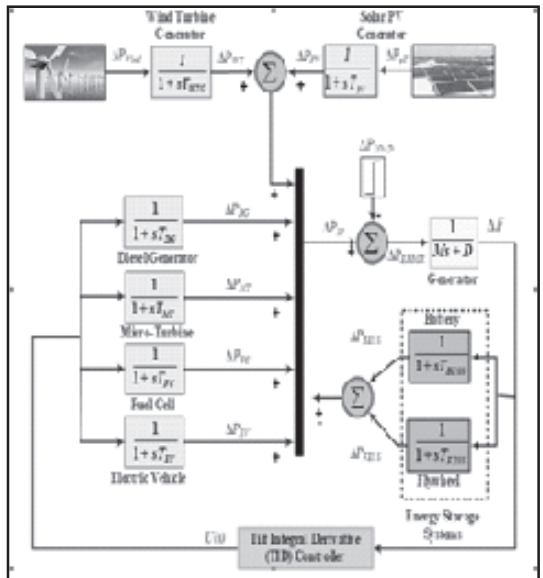


Figure 1: Model for LFC analysis of an SMG

Results and Discussion: The performance comparison is conducted between the proposed MPA-based TID controller and other controllers under four distinct SMG operating scenarios: (a) Wind Power Fluctuation – multiple-step variations at 0s, 20s, and 40s, while other sources remain constant; (b) Solar Power Fluctuation – multiple-step variations in solar irradiation at the same intervals with other sources unchanged; (c) Load Fluctuation – multiple-step load deviations at 10s, 25s, and 40s, keeping other sources constant; and (d) Simultaneous Fluctuation – combined variations in wind power, solar irradiation, and load deviation. Simulation results demonstrate that the proposed MPA-tuned TID controller achieves superior transient response, with minimal settling time and peak overshoot/undershoot, thereby improving overall system stability compared to other approaches.

Conclusion/Recommendation: This study presents an MPA-optimized TID controller for SMG frequency stability, tested under wind, solar, load, and simultaneous disturbances. Compared to traditional controllers, it enhances stability, minimizes overshoot/undershoot, and reduces settling time, ensuring consistent SMG performance.

Key words: Standalone microgrid; Load Frequency Control; Tilt Integral Derivative control; Marine Predator Algorithm; Electric Vehicle

Enhancing Power Quality in Utility Systems Using Adaptive Algorithm Based DSTATCOM

Jogeswara Sabat*, Mrutyunjaya Mangaraj and Ajit Kumar Barisal

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: jogesh.electrical@gmail.com

Introduction: Recently, nonlinear loads and controlling equipment have grown rapidly, which has spurred noteworthy study on improving power quality. Rapid load variation and an undesirable system are the primary causes of the evident research. It is not practical to run the system at base load and peak load to attain system efficiency day and night in order to stabilize the system. It is also more challenging to decrease the quick load variation. Therefore, designing an appropriate custom power device to meet the current needs is one of the primary goals of power quality enhancement. Generally speaking, current-related difficulties account for the majority of load variation issues. The two-level voltage source converter is selected for shunt compensation. However, in accordance with grid code requirements, the converters are employed to maintain improved power quality service at the source side throughout both fluctuating and unvarying load scenarios. The Cohen–Grossberg Least Mean Square (CGLMS) based DSTATCOM is suggested as a solution to the aforementioned issues.

Materials and Methods: Neural networks are generally stabilized or destabilized by specific stochastic inputs. Longer iterations also usually cause time delays, which can cause instability or oscillations. Therefore, it is frequently impossible to ascertain the precise NN parameters in advance. Impulsive perturbations are therefore likely to happen, which will subsequently affect the dynamic behaviors of the system. Numerous disciplines, including biology, health, economics, electronics, and instrumentation, have found applications for the improved NN approach. Thus, temporal delays, variables, impulsive perturbations, and harmonic disturbances should all be taken into account when analyzing the stability of neural networks. Cohen and Grossberg were the first to propose and study it. Inspired by the discussion above, it is used in our research study to determine the power quality solution for the DSTATCOM.

Results and Discussion: This section uses simulation tests with MATLAB/SIMULINK software to evaluate the performance of the CGLMS-based DSTATCOM over ALMS. Two distinct loading states such as steady-state and transient-state are used to mimic the behavior. The two methods' relative performance is shown in terms of PQ improvement for various scenarios. For every type of study, the simulation settings are kept constant.

Conclusion/Recommendation: When compared to the outcomes of both methods, the CGLMS technique can effectively improve power quality. The study's main contributions are the successful development of the CGLMS controlled DSTATCOM, the improvement in source side power factor, and the proposed technique's better THD harmonic reduction of 1.61% in accordance with the IEEE recommended standard.

Key words: ALMS; CGLMS; DSTATCOM; Utility System

Intelligent DG Placement in Power Networks: A Comparative Study of GA, FA, and ALO

Kamalesh Chandra Rout*, Prakash Kumar Ray

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: rout.kamalesh@gmail.com

Introduction: Achieving a sustainable energy future requires the seamless integration of distributed generation (DG) into power distribution networks. This research introduces a powerful hybrid optimization technique that combines Ant Lion Optimization (ALO), Genetic Algorithm (GA), and Firefly Algorithm (FA) with Newton-Raphson load flow analysis to optimize DG placement in an IEEE 9-bus system. The results confirm the efficiency of this approach in reducing power losses and boosting overall system performance, paving the way for smarter and more resilient power networks.

Materials and Methods: The IEEE 9-bus system under consideration is analyzed using predefined parameters such as voltage, current, load angle, active power, and reactive power. The primary objective is to enhance the system's active power and voltage profile. To accomplish this, a load flow analysis is performed using the Newton-Raphson method, which determines essential electrical parameters. Subsequently, optimization techniques, including the Genetic Algorithm (GA), Firefly Algorithm (FA), and Ant Lion Optimization (ALO), are implemented to improve voltage stability and active power distribution. Comparative analysis of these algorithms indicates that ALO provides superior performance over FA and GA in terms of voltage stability and minimizing active power loss.

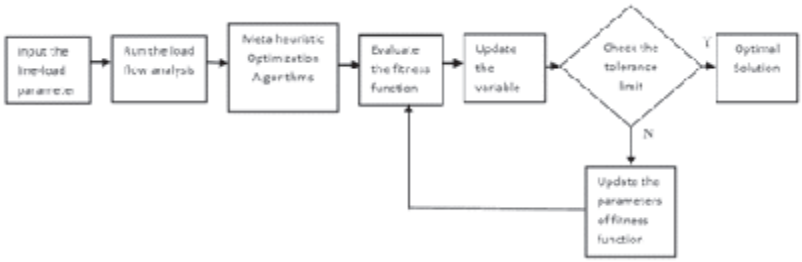


Fig. 1. Block Diagram for Methodology/Algorithm

Results and Discussion: The results have been demonstrated using MATLAB 2022a, where voltage profile and convergence speed are compared before and after DG placement. The proposed approach has been tested on the IEEE 9-bus radial distribution system, validating its effectiveness. Through simulations, the optimal DG locations in the IEEE 9-bus system have been determined to be at buses 4, 5, 6, and 9. The results demonstrate a significant enhancement in the voltage profile after DG integration, leading to a noticeable reduction in voltage loss compared to the conventional system. ALO exhibits the fastest convergence speed, surpassing FA and GA, while all three methods contribute to a net reduction in active power loss. By analyzing the percentage power loss reduction, it is evident that ALO yields the highest efficiency, proving its superiority over FA and GA.

Conclusion/Recommendation: By integrating advanced network flow optimization techniques like ALO, FA, and GA, the decision-making process in power systems becomes more refined. These algorithms play a crucial role in identifying the most efficient DG placement while accounting for critical factors such as voltage stability, minimizing power losses, and achieving proper load distribution in a constantly evolving system.

Key words: Optimal Power Flow, Distributed Generation, Newton Raphson Method, Load Flow Analysis, Firefly Algorithm, Genetic Algorithm, Ant Lion Optimization

Effective Energy Management System for Microgrid System using Grey Wolf Optimization Algorithm

Lalbahadur Majhi*, Ajit Kumar Barisal and Samarjit Patnaik

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: lmajhi@outr.ac.in

Introduction: Microgrids, small-scale power systems, are a promising solution for maximizing renewable energy use and improving grid dependability. However, controlling energy flow, particularly with intermittent sources, is challenging. An effective Energy Management System (EMS) is needed to optimize energy allocation, improve grid dependability, and offer consumer benefits.

Materials and Methods: The proposed Energy Management System (EMS) uses optimization techniques to regulate energy flow in microgrids, improving grid resilience and customer benefits. It uses a hierarchical control system and the Grey Wolf Optimization algorithm. A cost comparison between grid cost and grid usage over a period of 24 hours using heuristic and optimization methods is under study for microgrid with PV without EMS and microgrid with PV and Wind Turbine Induction Generator with EMS.

Results and Discussion: In the beginning, when load demand is below 500 kW, the energy storage system (ESS) stays at 50% capacity, keeping costs low due to cheap renewable energy. When the load is 500 kW, solar power increases while battery power decreases. The battery stores extra energy from the solar system, slowing its charging. By the end of the day, as load rises to 500kW and battery power drops, power demand reaches its peak, which necessitates a higher reliance on the grid. As a result, the grid usage is at its maximum, leading to higher grid costs. The increased demand for electricity during this time is likely to drive up the price of electricity from the grid.

When the microgrid is equipped with PV and Wind Turbine Induction Generator with EMS with load demand below 500kW the solar arrays, wind turbine generators, and batteries do not supply power during this period because the load demand is low. The ESS SOC achieves 35% to 80% nominal battery voltage at 50% initial capacity. During periods of ample sunlight and sufficient wind, the microgrid can harness energy from both sources, resulting in a reduced reliance on the grid. Towards the end of the 24-hour period, when the load reaches 500kW power from wind generators and solar arrays is running low. Additionally, the grid generates a lot of power to meet the demand, and the ESS begins to discharge. Consequently, the total power needed by the loads to meet the demand supplied by the grid is higher compared to ESS, resulting in higher operating costs. The heuristic approach is more expensive than the optimization approach. Consequently, the findings show that the optimization approach consumes less cost, which is a benefit of the approach.

Conclusion/Recommendation: The optimization approach consistently reduces costs in both the standalone system and the hybrid PV-WTIG system. Comparing standalone PV systems to the hybrid system, particularly on clear days, the hybrid system has the lowest total cost. This demonstrates the benefit of utilizing optimization tactics to obtain cost savings and the best performance possible in renewable energy systems.

Key words: Microgrid, Energy Management System (EMS), Grey Wolf Optimization algorithm, Renewable Energy

Redistribution of charge in Unbalanced Lithium-ion Batteries using Active Cell Balancing Method for enhancing battery performance and life-span

Meera Viswavandya*, Manish Kumar Palai, Mrutyunjay Swain and Jagatmay Giri

School of Electrical Sciences, Odisha University of Technology and Research,Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: mviswavandya@outr.ac.in

Introduction: As the need for renewable energy solutions rises, it is becoming increasingly important to integrate solar photovoltaic (PV) systems with efficient energy storage. Variations in the states of health (SoH) and charge (SoC) of battery cells can accelerate degradation and reduce efficiency. Battery management systems (BMS) use passive or active cell balancing techniques to get around these issues. While passive balancing dissipates excess energy as heat, active balancing redistributes energy among cells, improving efficiency and extending battery life. This study explores the role of active balancing using inductive and capacitive topologies to optimize battery performance.

Materials and Methods: This paper consists of designing an Active cell Balancing Circuit which makes the use of both Capacitive and Inductive balancing techniques. The below shown circuit consists of inductors, capacitors, an array of 2/4 lithium-ion batteries, voltage source, resistive load ,etc.

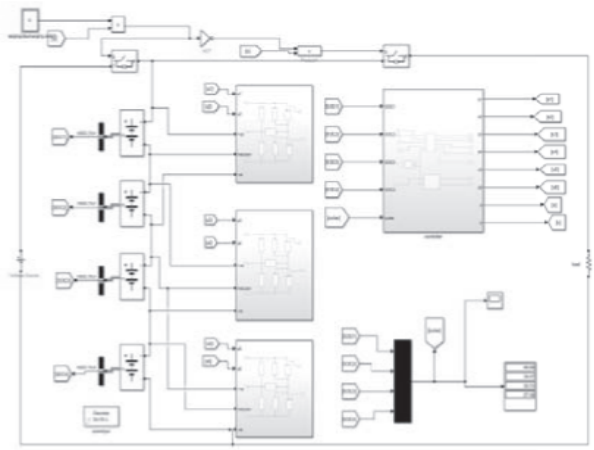


Figure 1:-Active Cell Balancing Circuit

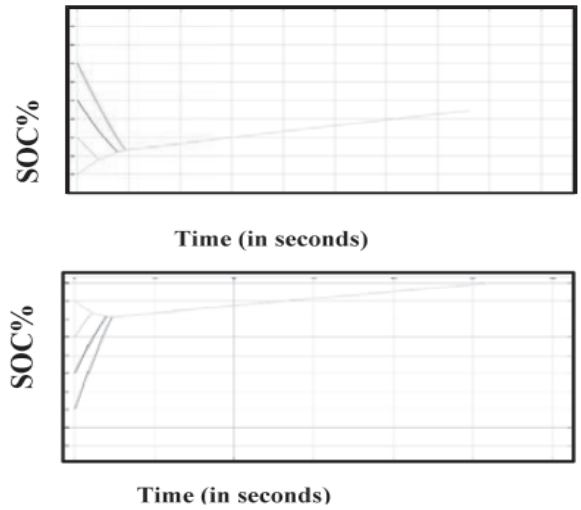


Figure 2:- Output waveform during (a) Charging and (b) Discharging

Results and Discussion: It was observed that

- As the difference between the cell SOC varies, the Charging time varies in accordance to it.
- Discharging Time mainly depends on the type and magnitude of Load given to the system.
- The Charging Time was observed to be less than the Discharging Time.

Conclusion/Recommendation: As we increase the number of cells, the Balancing time increases. According to the findings, active cell balancing successfully reduces charge imbalances between cells, greatly enhancing battery efficiency, prolonging its lifespan, and guaranteeing safer operation.

Key words: Active cell balancing; lithium-ion battery; battery management system (BMS); energy storage; renewable energy; charge redistribution.

Bi-directional Dual Active Bridge Converters using SiC MOSFETs for Electric Vehicle Fast Charging Application

Minakhi Behera* and Ranjan Kumar Jena

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: mbeheraee@outr.ac.in

Introduction: Nowadays, even though Electric Vehicles (EVs) are gaining popularity due to its zero tailpipe emissions, but the lack of proper charging infrastructure is the major obstacle to achieving all-electric mobility. At the present, EV technologies are not fully-matured. The current EV charging technology has limitations and is not ready for the Vehicle to Grid (V2G). Most of the EV chargers adopted in the market are the unidirectional charger type, regardless for slow charging or fast charging. Hence a bi-directional EV charger is required for the implementation of fast charging and also for V2G technology. Isolated Bidirectional Converters can match different voltage levels by adjusting the turns ratio of the primary and secondary sides of the high-frequency transformer. This eliminates the need of heavy and bulky service transformers in the present charging system of EV. The effectiveness of the DAB converter employing wide-bandgap semiconductor devises and soft switching is evaluated using MATLAB/SIMULINK studies.

Materials and Methods: The simulation of DAB converter and LLC resonant converters have been carried out using MATLAB Simulink. LLC resonant converter consists of a switching bridge (half-bridge MOSFET), an LLC resonant circuit, a full-bridge rectifier and an output filter. Its asymmetric structure in reality makes it inferior as compared to a Dual Active bridge converter. A Medium Voltage (MV) DAB converter using 3.3 kV SiC MOSFETs with phase shift modulation is studied to demonstrate the overall MV DAB charging capability and meet the output power requirements.

Results and Discussion: The fast EV charger is composed of multilevel modular like structure with each DC-DC conversion block stacked. This gives a simple structure to reduce the complexity of the conversion system. Simulation results of the EV charger resulted in a Medium Voltage DAB converter using SiC MOSFETS which can be efficiently used to convert 2.5kV to 800 V Electric Vehicle battery charging system.

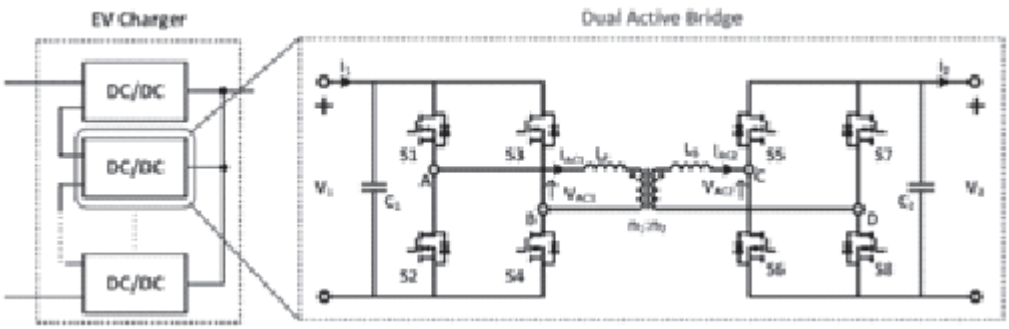


Figure 1: Dual Active Bridge converter for each module of EV Charger

Conclusion/Recommendation: MV LV DAB Converter has single stage and efficient voltage conversion. Also, the use of wide-bandgap semiconductor devices like SiC, GaN helps to develop a compact and efficient high-power, high voltage and fast charging system.

Key words: Dual Active Bridge, SiC, V2G, Isolated bidirectional DC-DC converters, EV charging

Comparison of Fault Detection Technique for AC Microgrid Protection

Pallavi Ray*, Rudranarayan Pradhan

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: raypallavi54@gmail.com

Introduction: Microgrid is the combination of different types of distributed networks (like RES, battery sources etc.) and load sources with well-defined parameters. Microgrid (MG) provides numerous advantages such as reduced transmission losses, low carbon emission, improved system reliability. However, for the proper functioning of the MG, it should be protected from different fault conditions. The main objective of this paper is a signal processing-based technique to determine the faults in the Microgrids and state-of the-art latest research on microgrid fault detection.

Materials and Methods: Several fault detection techniques are explained in various literature for microgrid fault detection. In this research, the phasor estimation technique detects the microgrid fault effectively and accurately.These techniques can be differentiated as follows

- Change in current/voltage significantly
- Sample to sample comparison technique
- Cycle to cycle comparison technique
- Discrete Fourier Transform
- Kalman filtering
- Wavelet transform
- Cosine algorithm

This paper explains S to S comparison technique, C to C comparison technique, and Kalman filtering techniques for microgrid fault detection.

Results and Discussion: In the RTDS/RSCAD environment, the medium voltage test simulation is performed. The MATLAB software is used for the analysis of simulation data. Different types of fault is created in between bus no.1 and transformer (138/13.2kV), and results are provided. It is also noted that different faults are also created at various locations of the seven bus microgrid and the Kalman filtering technique for fault detection is verified for the same. Once the fault current value exceeds a specific value of the threshold, it generates a trip signal, and the faulty section is isolated.

Conclusion/Recommendation: In this work, sample to sample comparison technique, cycle to cycle comparison technique, and Kalman filtering technique for microgrid fault detection are discussed. Though the former two comparison methods are simple and take less memory in the processor, they are unreliable for fault detection in the microgrid. On the other hand, in real-time operations of the LV microgrid, the Kalman filtering technique works effectively for all types of faults. The simulation results show that for satisfactory protection of microgrid, the Kalman filtering technique can be suitably implemented.

Keywords: Microgrids; fault detection; protection techniques; RTDS/RSCAD; sample to sample comparison; cycle to cycle comparison; Kalman filtering; faults.

Reduced Component Transformer Based Multilevel Inverter

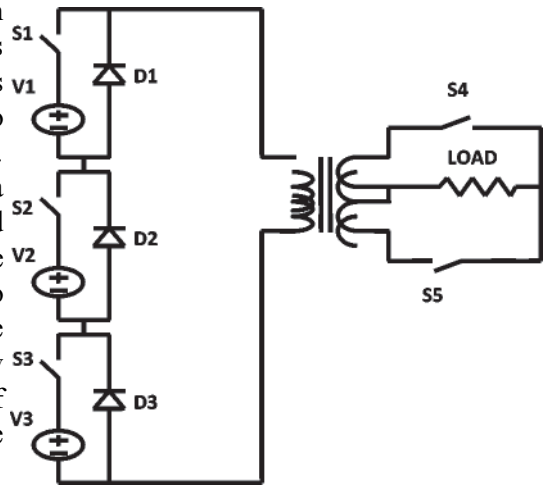
Pratik Kar, Durgesh Prasad Bagarty* and Prakash Kumar Ray

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

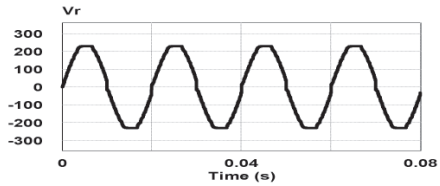
*Corresponding author E-mail: dpbagarty@outr.ac.in

Introduction: This paper deals with the design of an asymmetric multilevel inverter producing maximum level with optimal number of circuit components. The objective of this paper is to design a multilevel inverter keeping all necessary points of interest like overall robustness, lower harmonic distortion, reduced voltage stress, efficiency and simplicity of the circuit. The proposed circuit is designed to generate 15 levels of voltage. A transformer at output is used to boost voltage with a half bridge style circuit at secondary terminal for polarity reversal. Pulses are generated for the proposed configuration using Nearest Level Control (NLC) technique. The proposed inverter is compared with other recent topologies based on various factors such as number of components, voltage stress, overall performance, etc. The simulation with result verification is carried out to validate the proposed circuit.

Materials and Methods: The proposed circuit is an asymmetric multilevel inverter. It consists of 3 voltage sources in ratio of 1:2:4 along with three switches and three bypass diodes. A transformer is used to step up voltage and two additional switches at secondary terminal for polarity reversal. Figure shows the proposed circuit configuration. Each time a switch is made on its bypass diode gets reversed biased and remains in switch off state and if the switch is made off the diode is in on state. So, in this way each block can give zero or voltage of its corresponding source value. The voltage sources are in ratio of V1:V2: V3=1:2:4, and their binary combination can produce a total of seven distinct level of voltages. S4 & S5 make polarity reversal with alternate switch-on during every half cycle.



Results and Discussion: The output simulation result is shown to validate the operation, credibility and claims of the proposed MLI. The simulation is done on PSIM software platform to test the validity of the proposed circuit. For simulation results the input voltage source values are 6V, 12V, and 24V with transformer turns ratio 1:6:6 is considered. The fundamental frequency is 50Hz. Figure shows the output wave of secondary coil in case of a pure resistive load of 100 ohms. The voltage waveform is smoothened due to the inherent filtering effect of the small amount of leakage inductance of the transformer. The THD in case of this resistive load is around 5.67%.



Conclusion/Recommendation: The paper presents the design of a multilevel inverter simple, robust with the use of optimum number of components. Lesser number of switches also means lesser number of gate driver circuits and hence MLI is more simplistic and easier to realize. Transformer provides an isolation between input and output which enhances fault tolerance capability and also a safety means for primary side being on low voltage. It also helps reducing switch stress of level generating switch drastically. The proposed work can be effectively integrated with renewable energy sources as input at primary side and thus can be used in applications like grid integration, electric vehicles, or as a standalone type inverter, etc.

Keywords: total harmonic distortion (THD), voltage boost, polarity reversal.

Intelligent Fault Diagnosis in AC Microgrids: Short Time Fourier Transform (STFT) and kernel based algorithms

Prem Prakash Agarwal, Jyotishree Behera, Sibani Sen and

Rudranarayan Pradhan*

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author Email: rudranarayan@outr.ac.in

Introduction: As the global energy landscape shifts towards sustainability, decentralized power generation through AC microgrids is gaining importance. AC microgrids help reduce transmission losses and integrate renewable energy sources (RES) such as solar and wind power. However, RES are inherently intermittent, posing significant challenges to microgrid stability and reliability. One of the critical challenges is the accurate detection and classification of electrical faults, which is essential for ensuring the efficient functioning of microgrids.

Materials and Methods: Traditional fault detection methods in conventional grids rely on predefined thresholds, which often struggle with the highly dynamic and nonlinear behavior of microgrids. To address this, a fault detection approach combining Short-Time Fourier Transform (STFT) for feature extraction and Support Vector Machine (SVM) classifiers was used. Various kernel-based algorithms, including polynomial and Radial Basis Function (RBF) kernels, were explored to enhance fault classification. The study utilized time-series data of phase currents to train and evaluate the fault detection models.

Results and Discussion: The proposed method effectively classified different fault types in AC microgrids. STFT transformed the phase current data into time-frequency representations, enabling accurate fault identification. SVM models with different kernels were assessed for performance. The RBF kernel-based SVM model demonstrated superior accuracy, achieving 98.14% accuracy in fault classification. This highlights its robustness and suitability for real-world microgrid applications. Compared to conventional threshold-based methods, the proposed approach offers significant improvements in precision and recall, ensuring reliable fault detection even in highly dynamic microgrid environments.

Conclusion/Recommendation: The proposed SVM-based fault detection approach, particularly with the RBF kernel, provides high accuracy and reliability, making it an effective solution for dynamic AC microgrid environments. Its ability to handle nonlinear and time-varying characteristics of microgrid faults makes it superior to conventional techniques. Future research should explore deep learning-based models, such as convolutional neural networks (CNN) and recurrent neural networks (RNN), to further enhance fault classification accuracy and adaptability. Additionally, real-time implementation of the proposed method in actual microgrid systems could provide further validation and improvements for industrial applications.

Keywords: AC microgrids, fault detection, fault classification, support vector machines, renewable energy, short time fourier transform, RBF kernel, machine learning (ML)

Enhancement of Transient Stability of Hybrid Electric Power System

Rabinarayan Rout*, Ajit Kumar Barisal and Dipak Ranjan Swain

School of Electrical Science, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail:erabinarayan@gmail.com

Introduction: In order to make multi-area power systems more efficient and stable, this study aims to create a new intelligent controller design based on adaptive property. The integrated power grid becomes more unstable as renewable energy sources become more prevalent, and system inertia decreases. Resultant, the penetration of renewable and load variance causes frequency changes to be more pronounced. Keeping frequency stable is essential for the electrical energy transmission system to work reliably and efficiently. Power system safety, reliability, and efficiency are all put at risk when frequencies deviate too far from their normal values. The transmission stability of power system plays a critical role to maintain grid reliability during disturbances such as faults, switching operations or system load variations. Hybrid Electric power System (HEPS) which integrate renewable energy sources (such as wind, solar, and hydro) with traditional generation and energy storage systems, introduce unique challenges and opportunities for transient stability of HEPS under various dynamic condition. The main objective of this study is to investigate the transient stability characteristics of HEPS and develop techniques to mitigate instability during system disturbances. First a comprehensive modelling framework for Hybrid systems including renewable sources, energy storage, and conventional generators will be developed. The dynamic behavior of the system under fault condition will be analyzed.Advancedcontrolstrategiessuchaspower systemstabilizers (PSS),flexibleACtransmission systems (FACTS), and energystorage system (ESS) optimization will beexplored.

Materials and Methods: This study introduces an adaptive Tilt Fractional Order Proportional-Integral-Derivative (TFOPID) controller, optimized using the Tunicate Search Algorithm (TSA), to enhance frequency stability in interconnected power systems. The controller's gains are dynamically adjusted by an ancillary TPID controller in response to frequency changes. Implemented in northern and southern regions comprising photovoltaic, wind, redox flow battery, hydro, and thermal power plants, this approach aims to create more resilient and efficient power grids, essential for integrating renewable energy sources and meeting the growing demand for sustainable power solutions.

Results and Discussion: The gains of the TFOPID controller are continuously updated by utilizing the ancillary TPID controller to stabilize the area frequencies within prescribed limit. The suggested control system is implemented in the northern and southern regions, which consist of photovoltaic (PV), wind, redox flow battery (RFB), hydro, and thermal power plants.

Conclusion/Recommendation: This research will contribute significantly to the growing body of knowledge on hybrid power systems and provide essential tools for system operators and engineers to enhance the resilience of future power grids. It will also support the transition to more sustainable, low-carbon energy systems by ensuring the stability of grids with high penetration of renewables.

Keywords:Hybrid Electric Power System,Transient Stability, Energy StorageSystems, Renewable Energy, PowerSystem Stabilizer, AI-based Control, FACTS, Optimization, Faults,GridStability.

A Regenerative Circuit breaker Design for use in DC Microgrids

Rachita R Sarangi, Sambit Kumar Sahoo, Sneha Agarwal, Sagarika Mohapatra, Prakash Kr. Ray*, Ajit Kr. Barisal

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: pkray@outr.ac.in

Introduction: The transition towards more efficient and resilient power distribution networks has accelerated the adoption of direct current (DC) microgrids. Unlike traditional AC systems, DC microgrids simplify power conversion and enhance efficiency but face unique challenges, particularly in fault management due to the absence of natural current zero-crossing. To address these issues, this paper introduces a novel bidirectional DC circuit breaker (NBDCCB) engineered for dependable current interruption and optimized energy recovery from system inductances.

Materials and Methods: The NBDCCB design integrates fast mechanical switches (FMS) for primary fault interruption, supported by auxiliary load switches (LS1 & LS2) to ensure complete electrical isolation when needed. The architecture includes key semiconductor components such as diodes (D1-D4), insulated-gate bipolar transistors (IGBTs Q1 & Q2), and thyristors (T1-T4), working in conjunction with passive elements like capacitors (C1, C2, C3) and inductors (L1, L2). Performance evaluations were conducted through comprehensive simulations in PSIM software for a 400V/400A DC system, supplemented by experimental trials on a 48V/1A lab-scale prototype to validate the findings.

Results and Discussion: The simulation results highlight the NBDCCB's capability to efficiently interrupt fault currents and facilitate energy recovery. The device successfully interrupted source and load currents within 47.05 ms and 29.2 ms, respectively. Notably, it managed to recover 17.07 kJ of energy, outperforming conventional designs in both efficiency and performance. The peak regenerated current reached 231.54 A, with an average value of 148.73 A, while voltage stress across the FMS was contained at 4.356 kV. Experimental results closely mirrored the simulations, confirming the system's reliability with minor deviations due to real-world operational variables. This robust performance underscores its potential for deployment in applications such as data centers, electric vehicle charging stations, renewable energy installations, and maritime power systems, where efficient and resilient power management is critical.

Conclusion/Recommendation: The NBDCCB demonstrates a significant advancement in DC microgrid protection technology, offering effective fault current interruption, low conduction losses, and superior energy recovery. Its bidirectional operation further enhances its suitability for modern DC systems. Future research should focus on refining component specifications to further reduce voltage stress and maximize energy recovery efficiency, alongside integrating advanced fault detection algorithms to improve the overall resilience of larger DC grid infrastructures.

Keywords: DC Microgrid; NBDCCB; FMS; Regenerative current breaking

Decomposition based CNN-RVFLN for load prediction and Congestion management in power system

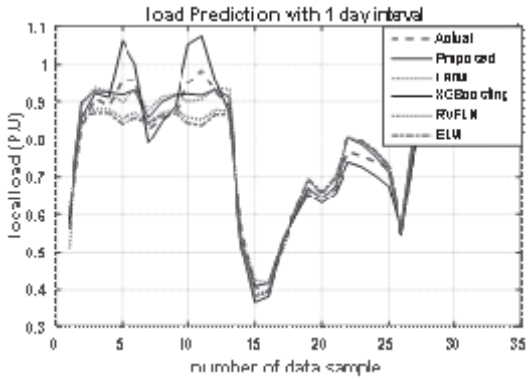
Radhakrishna Das, Ullash Kuma Rout and P K Satpathy*

School of Electrical science and Engineering, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author Email: rups.krishna@gmail.com

Introduction: Load forecasting is commonly employed by electricity market participants to refine their trading strategies and by system operators to maintain a stable grid. Specifically, it helps system operators anticipate potential power imbalances and other critical grid conditions, allowing them to take necessary corrective measures. Forecasting critical grid conditions, such as congestion, is particularly crucial in this regard. This paper introduces a Variational Mode Decomposition based CNN-RVFLN model designed to predict hour-ahead time-series residual loads. Load forecasting is important for significant operation in power system, loads become very uncertain because it is mostly affected by various factors. Disturbances in the load result in congestion in the power system. The new age of intermittent energy sources leads to various system imbalances and congestion. Therefore, faster branch flow estimation is necessary for the security assessment of the power system as the transmission line is exposed to various contingencies. This paper proposes the hybrid model for load forecasting that will help in congestion management by forecasting any overloading condition in the power system.

Materials and Methods: Performance of the proposed VMD-CNN-RVFLN technique is compared with other models based on different performance matrices Table.3. gives the monthly prediction with the comparison parameter of MAPE. The data is examined from January 2022 to December 2022. It is obtained that the average MAPE value obtained for the proposed technique is 5.090 % which is comparatively less than other models like ELM, LSTM, XG BOOSTING AND RVFLN with a MAPE value of 8.76%, 7.148%,5.952% and 7.260%. respectively. The MAE, RMSE and R^2 values also showed similar trends. Weekly analysis of the proposed technique was also performed and the corresponding MAPE value is shown in table.4. It is also observed that the proposed technique outperformed other techniques for weekly prediction also.



Results and Discussion: In this research an approach has been proposed that uses VMD-CNN-RVFLN model for prediction of local load which is the first step in congestion management of power system. The hybrid methodology implements the hidden features of every individual technique and performs in providing more accurate load prediction. Different performance measurement measures showed that the proposed technique outperforms other ML techniques. The MAPE, MAE and R^2 show the accuracy of the proposed model for prediction in different intervals also.

Conclusion/Recommendation: The load prediction results by this proposed method are found to be more correct as compared to the various other techniques.

Keywords: Load prediction, Forecasting, Variational Mode Decomposition.

Fractional Order Harmonic Filter and Its Applications

Samikshya Mishra*, Madhab Chandra Tripathy, Meera Viswavandya

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: samikshya.mishra3@outr.ac.in

Introduction: Fractional order filters (FOFs) are a class of filters where the order of the differential operator is fractional (not necessarily an integer). Unlike traditional integer-order filters (such as Butterworth or Chebyshev filters), fractional order filters offer a wider range of tuneable parameters, allowing more precise control over system dynamics. The order of the filter can be adjusted to improve the system's response, such as its frequency characteristics, transient behaviour, and stability.

Materials and Methods: Designing a fractional-order harmonic filter involves selecting appropriate materials and methods for precise control over filtering performance. The materials commonly used include passive components like resistors, capacitors, and inductors, with fractional-order elements, such as fractional capacitors or inductors, often incorporated. These elements are designed using fractional calculus, which provides greater flexibility in controlling the frequency response.

The design method typically starts with defining the target cutoff frequencies and desired harmonic suppression. Then, fractional-order transfer functions are derived, which involve complex mathematical formulations using fractional derivatives and integrals. Optimization techniques like Genetic Algorithms or Particle Swarm Optimization may be employed to fine-tune component values, ensuring the filter meets the required specifications. Simulation software, such as MATLAB or SPICE, is often used to model the filter behaviour before implementation.

Results and Discussion: Fractional-order harmonic filters find diverse applications across various industries due to their superior performance in handling complex, non-integer dynamics. In power systems, they are used to improve the quality of power by effectively suppressing harmonics in grid-connected inverters, motor drives, and power supplies. Their ability to handle fractional order elements allows for more precise filtering of harmonic distortions, enhancing system stability.

In communication systems, these filters improve signal clarity by reducing noise and unwanted frequency components, making them suitable for data transmission and sensor networks. Fractional-order filters are also applied in control systems to manage dynamic behaviour in systems that exhibit fractional dynamics, offering better performance than traditional filters.

In neuroscience and neuromorphic engineering, these filters emulate complex brain-like behaviours in artificial neural networks, aiding in the development of advanced computational models. Additionally, signal processing and audio applications benefit from their enhanced frequency response characteristics.

Conclusion/Recommendation: The design of Fractional Order Harmonic Filters (FOHFs) involves a combination of mathematical modelling, circuit design, digital implementation, and optimization techniques. The selection of appropriate materials, such as resistors, capacitors, and synthetic fractional-order elements, is crucial.

Keywords: Fractional-order harmonic filter; Fractional-order Inductor; Fractional-order Capacitor

Intelligent Energy Management of DC Micro-grid for Rural Electrification with special focus on Photovoltaics

Santanu Sen*, Meera Viswavandya and Lokanath Tripathy

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: sen.santanu072@outr.ac.in

Introduction: Rural electrification is considered to be the backbone of the rural economy. The electricity generation capacity in India is the fifth largest in the world. India is the sixth largest consumer of electricity and accounts for 3.4 percent of the global energy consumption. The year 2022, has been earmarked for achieving the target of '24×7 Power for All'. Rural electrification has five major facets, a) Setting up of Rural Electricity Infrastructure, b) Providing connectivity to households, c) Adequate supply of desired quality of power, d) Supply of electricity at affordable rates, e) Providing clean, environmentally benign and sustainable power in efficient way. A village is said to be an Electrified Village if Basic infrastructure such as Distribution Transformer and Distribution lines are provided in the inhabited locality as well as the Dalit Basti hamlet where it exists. Electricity is provided to public places like Schools, Panchayat Office, Health Centers, Dispensaries, Community centers etc. The number of households electrified should be at least 10% of the total number of households in the village.

Materials and Methods: The main objectives of this study is to obtain the solution to the current Rural Electrification problems. Firstly, to design a New, Less-Computational Secondary Controller Design for Local Energy Management (Monitoring and Optimal Decision making) for PV based DC Microgrid. Secondly, an Improved BES (Battery Energy Storage) life, decreased grid power dependent operation for economical rural population in India. Thirdly, a proper Scheduling of Microgrid along with the conventional grid for Demand mitigation for remote rural areas. Fourthly, to find some New Scope of Demand Fulfillment under Deregulated Market. In this regard, a Multi-Objective Energy Policy Management/ MOEPM will be targeted to be achieved by a multi-objective stochastic problem, where grid dependency will be compensated by optimal BES based (upto 40% of total generation) compensation. Also, the solution of this stochastic optimization will be achieved by a new On-line Sequential, Multi-objective Metaheuristic algorithm. And it would look into the Coordinated operation among DAD based primary controller, MOEPM based secondary controller. This optimality criterion will be fulfilled by non-cooperative BES charging status (%SoC) and grid electricity price/ unit.

Results and Discussion: The solution of this stochastic optimization will be achieved by a new On-line Sequential, Multi objective Metaheuristic algorithm (e.g. Firefly, Partial Swarm etc. where less computation with accurate global minima will be targeted). The primary controller (Distributed Adaptive Droop/ DAD) will be operating in optimal region for compensation of prediction error profile. This adaptive droop operational region selection will be achieved by probability distribution of those error profile (e.g. Van Rijsbergen's Probability Ranking Principle). The less complexity is another key factor for the proposed PV-BES based DC distribution to be economical towards Indian rural population.

Conclusion/Recommendation: The proposed LEMS (secondary controller based monitoring and optimal decision) will be obtained with local generation scenario, load demand (by prediction algorithm), and protection status. This is needed against effective decision making, as generation or demand data (predicted based on past data from data acquisition system) can get falsify under local faults. Thus, a significant coordination will be required with less computation.

Keywords: Rural Electrification; PV Based DC Microgrid; Battery Energy Storage; Local Energy Management System; Multi-Objective Energy Policy Management

Efficient allocation of battery energy storage and renewable energy systemfor performance and reliability improvement of distribution system

Sudipta Mohanty*[1], Amaresh Gantayet[2] and Manas Ranjan Nayak[3]

School of Electrical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

[2]*Department of Electrical and Electronics Engineering, Siksha 'O' Anusandhan, Deemed to be University, Bhubaneswar-751030, Odisha, India*

[3]*Department of Electrical Engineering, Biju Patnaik University of Technology, Rourkela-769015, Odisha, India*

*Corresponding author E-mail: sudiptamohanty@outr.ac.in

Introduction: Power systems planners are focused on ensuring a reliable and adequate energy supply, which is expected to become a significantsocietal concern in the coming years. In the same way, distribution systems (DS) experts are looking into ways to make electricityproduction from distributed generation (DG) sources like wind turbines (WT) and solar photovoltaic (SPV) generators better.The main goal is to improve grid performance, such as by lowering voltage fluctuations and making the network reliable

Materials and Methods: This study aims to investigate the impact of optimal planning of renewable energy systems and independent battery energy storage systems (BESS) on the performance and reliability of distribution systems (DS). A unique energy management scheme (EMS) controls the charging and discharging schedules of the BESS. The transit search optimization (TSO) algorithm determines the optimal allocation of wind turbine (WT) and solar photovoltaic (SPV) generator units, along with BESS units. The optimization focuses on improving the DS reliability in terms of energy supply, increasing the feeder security margin, and reducing apparent power loss. Multiple case studies are designed to study the efficacy of the problem outcomes and are validated using Bus 4 of the Roy Billinton Test System (RBTS). To obtain results that are close to actual operating conditions, the modeling process takes into account the time-varying load profile and the dynamic power outputs from the SPV and WT units.

Results and Discussion: The results showed that the proposed methodology reduced the average EENS by 4.3% in the presence of wind and solar DGs, while including energy management through BESS units further improved it to 4.8%. The complete network experienced an 11.5% improvement in loss reduction, while the power drawn by the grid was reduced by 6.27% in the presence of DGs. The security margin of feeders containing DGs improved during peak load demand, indicating a decrease in stress on the branch conductors. The security margin of feeders 1 and 4 showed an improvement of 2%, while feeder 2 and feeder 6 showed an improvement of 9.8% and 11.3%, respectively. Additionally, feeder upgrade deferral (FUD) benefits of 7.5%, 21%, 8%, and 14% were observed in feeders 1, 2, 4, and 6, respectively. As a scope for future work, we can expand this optimization problem to investigate a cost minimization approach that includes asset management costs and technical expenditures.

Conclusion/Recommendation: This study employs a multi-objective approach to determine the optimal capacities and locations of SPV, WDG, and BESS units in the RBTS bus 4 DS, a system with multiple supply points and seven different feeders originating from the main substation. Although this system has been widely utilized for reliability analysis in many literatures, it is rarely employed for planning-level operations in conjunction with reliability improvement analysis. In general, the optimization result showed varied responses with each feeder, depending upon the amount and type of support installed in the feeder.

Keywords: Active distribution system; Battery energy storage system; Optimization; Reliability;Solar photovoltaic; Transit search; Wind turbine

Floodplain Inundation Mapping of Mahanadi Basin Using HEC-HMS, HEC-RAS, and Arc-GIS: A Case Study on Delta Areas

Abhijeet Satapathy, Sipra Rani Pradhan*

School of Infrastructure and Planning, Odisha University of Technology and Research, Bhubaneswar, Odisha, India

*Corresponding author E-mail: satapathyabhijeet27@gmail.com

Introduction: The Mahanadi basin is highly flood-prone due to its extensive catchment area and high rainfall variability. Frequent flooding has caused significant losses in Odisha's delta regions. This study aims to develop an effective flood forecasting and inundation model using HEC-HMS and HEC-RAS integrated with Arc-GIS to mitigate flood risks.

Materials and Methods: The study utilizes hydrologic and hydraulic models to simulate flood events in the Mahanadi basin. A Digital Elevation Model (DEM) was employed to delineate catchments and stream networks. Hydrologic modeling was performed using HEC-HMS, incorporating Land Use/Land Cover (LULC) data, soil texture analysis, and historical rainfall data. The discharge output from HEC-HMS was used as input for HEC-RAS to model flood extents and depths. The study considered three major flood events—August 2008, October 2011, and August 2022—for model calibration and validation.

Results and Discussion: Flood inundation maps generated through this framework identified hazard-prone areas within the Mahanadi basin. Simulated results closely matched observed data, demonstrating the effectiveness of the proposed model. The Nash-Sutcliffe Efficiency (NSE) values of 0.862 at Hirakud, 0.867 at Khairmal, and 0.886 at Mundali indicate high model reliability. The integration of hydrologic and hydraulic models enabled precise flood predictions, allowing authorities to implement preemptive measures. The study also highlighted the role of embankments in influencing flood propagation and sediment deposition. While embankments are crucial for flood control, they contribute to higher water levels and sediment accumulation, necessitating periodic maintenance. Further analysis of the three flood events showed that low-lying areas near the Mahanadi delta are highly vulnerable. Flood depth analysis indicated severe inundation in Kendrapara, Jagatsinghpur, and Puri districts, with water levels surpassing critical thresholds during peak floods. The model's accuracy was validated against observed discharge data, confirming its robustness for real-time applications. To improve predictive capability, real-time hydrological data and satellite imagery can be integrated. Machine learning techniques may further enhance forecasting by capturing complex relationships between meteorological and hydrological variables.

Conclusion: This study integrates HEC-HMS, HEC-RAS, and Arc-GIS for flood forecasting in the Mahanadi basin. The model reliably predicts flood extents and hazard-prone areas, aiding disaster management. Further improvements with real-time data will enhance accuracy.

Keywords: HEC-HMS, HEC-RAS, Land Use–Land Cover, Arc-GIS, Flood Inundation.

Impact of Labor Migration on Agricultural Livelihoods in Jharsuguda District, Odisha

Bhabani Shankar Sa*, Falguni Baliarsingh, and Ashis Chndra Pathy

School of Infrastructure and Planning, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: bhabaniplanning@outr.ac.in.

Introduction: Migration has long been an essential factor in shaping rural economies, especially in developing regions like India. In Jharsuguda, Odisha, labor migration has become a widespread phenomenon, affecting agricultural productivity and household incomes. The study aims to investigate the socio-economic impact of labor migration on rural agricultural livelihoods, analyzing both positive and negative consequences. Key aspects explored include migration drivers, changes in farming practices, and household adaptations.

Material and Methods: The research utilized a structured questionnaire to collect data on the impact of labor migration on five livelihood capitals: human, physical, financial, social, and natural. The study focused on households with at least one migrant member, and data was gathered through interviews or surveys. Respondents provided information on specific indicators for each capital, such as improved agricultural skills, household assets, remittance flow, social networks, and agricultural land status. The data was analyzed by assigning scores to each indicator, calculating component-wise totals, and ranking the capitals based on their overall impact.

Result and Discussion: The study examines the impact of labor migration on five livelihood capitals: financial, natural, physical, human, and social.

Capital	Impacts	Assigned Scores	Component-wise Total	Rank
Human	1. Improved skills in agricultural practices	112	261	4th
	2. Enhanced competency in managing farm production	149		
Physical	1. Enriched household gadgets	116	287	3rd
	2. Enriched real property possession	171		
Financial	1. Increased remittance flow	226	450	1st
	2. Increased total household income	224		
Social	1. Enhanced social relationship	110	221	5th
	2. Developed social network	111		
Natural	1. Decreased agricultural land status	186	369	2nd

Conclusion/Recommendations: The study reveals that labor migration has both positive and negative impacts on livelihood capital. Human capital sees moderate gains in skills and farm management, while social capital shows minimal improvement, indicating weak social cohesion. These findings highlight the need to balance the benefits of migration with sustainable resource management and community development.

Recommendations:

1. Promote sustainable land use to protect natural capital and ensure long-term food security.
2. Enhance financial literacy to help migrant families invest in remittances effectively.
3. Provide skill development programs to strengthen human capital and agricultural productivity.

Keywords: Labor migration, rural livelihoods, remittances, agricultural sustainability

Flood Susceptibility Mapping Using Random Forest and Support Vector Machine: A Case Study

Bibhu Prasad Mishra*[a], Deba Prakash Satapathy[a], Dilip Kumar Ghose[b]

[a]*School of Infrastructure and Planning, Odisha University of Technology and Research, Bhubaneswar, 751029, Odisha, India.*

[b]*Department of Civil Engineering, National Institute of Technology, Silchar, 788010, Assam, India.*

*Corresponding author E-mail: bibhumi2121@gmail.com

Introduction: Flooding is one of the most widespread and devastating natural disasters affecting communities worldwide. It occurs when water overflows or inundates land that is typically dry. Understanding the causes, impacts, and preparedness measures for floods is essential for building resilience and safeguarding lives and livelihoods. This study aims to create FSMs for the Lower Mahanadi Basin (LMB) coastal region utilizing machine learning (ML) classifiers. By incorporating geospatial data and evaluating ten flood conditioning factors, the research seeks to determine flood risk to prevent flood damage, mitigate risk, and facilitate decision-making.

Materials and Method: The key factors influencing flood susceptibility in this study include both climatic elements, such as rainfall intensity, and non-climatic elements like altitude, aspect, curvature, drainage density, Land Use and Land Cover (LULC), slope, Stream Power Index (STI), Topographic Ruggedness Index (TRI), and Topographic Wetness Index (TWI). For the analysis, Support Vector Machine (SVM) and Random Forest (RF) classifiers were utilized to calculate flood susceptibility, with flood inventory serving as the target variable. These factors were combined through spatial integration within the ArcGIS environment to pinpoint areas vulnerable to flood risk. The dataset comprised 421 locations, with 70% (286 spots) allocated for training the model to ensure a robust learning process. The remaining 30% (135 spots) were used to evaluate the model's performance. The Area Under the Receiver Operating Characteristic Curve (AUROC) method was employed for this evaluation, which helped determine the model's effectiveness in predicting flood susceptibility.

Results and Discussion: The findings revealed that all SVM models surpassed RF in performance. The AUROC value for the SVM model is 92.9%, while the RF model achieved an AUROC value of 90.3%. Additionally, the created FSMs were categorized into four distinct hazard levels: Very High, Moderate, Low, and Very Low. This classification was determined based on the flood frequency specific to that region. 57 percent of the areas are highly and moderately susceptible to flooding. The recent evaluation demonstrated that drainage density is the most significant conditioning factor, followed by aspect, elevation, slope, and rainfall. In summary, this research produced objective and valuable findings that enhanced the precision of assessing flood vulnerability in the region. The maps revealed that the southwestern areas predominantly exhibited very low and low hazard levels. In contrast, the northeastern regions, which are closer to main streams, displayed significantly higher hazard levels, categorized as very high and moderate.

Conclusion/Recommendation: The suggested approach is flexible and can be readily implemented in different locations for flood management and prevention.

Keywords: Flood susceptibility mapping, SVM, RF, Machine Learning

Assessment of Spatio Temporal Characteristics of Groundwater Quality at Khordha District, India

Chinmayee Biswakalyani*[1], Sandeep Samantaray[2], Deba Prakash Satapathy[1]

[1]*Department of Civil Engineering, Odisha University of Technology and Research, Bhubaneswar, Odisha, India*

[2]*Department of Civil Engineering, National Institute of Technology Srinagar, J &K, India*

*Corresponding author E-mail: chinmayeebiswakalyani.1993@gmail.com

Introduction: Groundwater is the major basis for drinking in various parts of our country. However, it gets contaminated by the toxic materials found in rocks, because of which it becomes unfit for various domestic and irrigation purposes. The objective of present research work is to quantify physicochemical parameters of groundwater and determine the Water quality Index at Khordha district, Odisha, India. Also, GIS based spatial distribution of groundwater quality parameters is done to delineate the study areas by using topological maps.

Materials & Methods: The study area is located at Khordha district, Odisha, India.In this study, the groundwater quality and its availability for various purposes were examined by the parameters such as pH, DO, EC, TDS, temperature, salinity, Alkalinity, Total hardness, calcium hardness, magnesium hardness, chloride, fluoride, nitrate and phosphate during the post monsoon season of 2022 and pre monsoon season of 2023 from 49 sampling locations.The parameters were used for assessing appropriateness of groundwater for irrigation and domestic purposes by comparing them with the Bureau of Indian standards (BIS).The physical parameters were measured by using the instrument called AP-7000 Aquaprobe. While other remaining parameters were measured by the help of titration in the laboratory. Afterwards correlation matrixes of the parameters were calculated by Data Analysis Tool Pak-Excel Building, a Karl Pearson correlation matrix used to measure linear relationships between parameters. Spatial analyses of different physical and chemical parameters were carried out utilizing ArcGIS 10.3 software. Lastly, Groundwater Quality Index was determined to assess the overall quality of groundwater in the specific region.

Results & Discussion: Groundwater of the study area was mostly alkaline during post-monsoon and slightly acidic during pre-monsoon season. With respect to major anions, the groundwater is generally suitable for domestic purposes except for a few locations where the concentration of nitrate or fluoride exceeds the permissible limit of WHO standards. Groundwater is also suitable for irrigation purposes for several locations except for a few locations where salinity is high. Moreover, GIS makes the groundwater quality maps into an easily understandable format. The ground water quality index found in this paper is useful to know the qualities of water in the present study area.

Conclusion/Recommendation: This study can be very helpful to the farmers, builders, researchers, etc. The study of characteristics of this groundwater sample recommends that assessment of water quality parameters and water quality management practices should be periodically carried out for protecting ground water resources.

Keywords: Groundwater quality; BIS standards; Spatial variation; Correlation Coefficient Analysis; Groundwater Quality Index

Design of cementless permeable concrete pavement utilizing waste

Jyotirmayee Dash*, Subhashree Samantasinghar, Deba Prakash Satapathy

Department of Civil Engineering, School of Infrastructure and Planning, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author Email: jyotirmayeeinbox@gmail.com

Introduction: The contradiction between urban water demand and itsreplenishment has gained more attention as urbanization has progressed. Permeable concrete pavement, a low-density concretepavement has many beneficial properties like resistance to freezing and thawing, resistance to scale, and increased workability.Due to these, it may be a useful solution to the issues of urban waterlogging, groundwater level decline, and water scarcity brought on by the water crisis. Small air bubbles in permeable concrete allow water to freeze inside the concrete, lowering internal tensions and facilitating storm water infiltration. Permeable concrete also resists high pressure caused by freezing. Pervious concrete normally made of uniform-sized aggregate bound together by Portland cement, using restrictedly as a pavement material, because of its insufficient structural strength. Current study aimed at developing a new type of pervious concrete with enhanced structural strength.

Materials and Methods: Through experimental work, the current study suggests an improved permeable concrete with different mix proportions.It entails testing permeable concrete prepared with waste-based geopolymer binder for permeability and compressive strength in accordance with IS: 2720 (Part 17)-1986 and IS: 2720 (Part 10)-1991 respectively. To synthesize the geopolymer, wastes such as class F fly ash and ground granulated blast furnace slag are used. The permeable concrete designed with the combination of geopolymer with construction and demolition materiali.e crushed concrete (particle size of about 9 mm) is proposed in order to maximize the usage effect of permeable concrete and enhance its application value in permeable roads.

Results and Discussion: The crushed concrete aggregates were subjected to standard tests of aggregatesand classified as poorly graded gravel with 6% of fine silt sized particles (GP-GM). The specific gravity was found to be 2.69 and water absorption value of 6.6%with crushing value of 19.3%. The geopolymer binder prepared with 40% fly ash and 60% slag when activated by 8M sodium hydroxide concentration with 0.35 ml/g alkali solution to precursor solution was chosen as the consistency and setting times of geopolymers are found to be within theranges that are prescribed for ordinary Portland cement. The synthesized geopolymermortar showed a 28 days compressive strength of about 35 MPa. The geopolymer binder with crushed concrete aggregate showed a compressive strength of about 30 MPa and water permeability of about 5 mm/s.

Conclusion/Recommendation: The test findings show improved permeability and compressive strength of permeable concrete made with geopolymer binder and construction and demolition materials.

Keywords: Permeable concrete; geopolymer cement, construction and demolition materials;compressive strength; permeability

Measuring The Impact of Industries on Surface Water Quality of Brahmani River Basin Effects of Lockdown Period

Rosalin Dalai*, Chitaranjan Dalai, Deba Prakash Satapathy

School of Infrastructure and Planning,

Odisha University of Technology and Research,Bhubaneswar-751029, Odisha, India

*Corresponding Author Email:rosalince@outr.ac.in

Introduction: The COVID-19 pandemic has had a profound effect on different facets of life, notably on environmental conditions. One specific area that has been influenced is surface water quality (WQ), particularly due to the lockdown measures implemented to curb the virus's transmission. Recent studies have highlighted the significant effects of these lockdowns on surface WQ. This research focused on evaluating how the COVID-19 lockdowns affected the surface water quality of the Brahmani River, utilizing an advanced WQ model. This study represents the initial effort to measure ambient water pollution levels during the COVID-19 outbreak.

Materials and Methods: The Brahmani River basin in Odisha is the most urbanized and developed area in the state, yet it faces significant water quality issues due to improper disposal of solid and toxic wastes from industrial discharges, agricultural runoff, and human activities. This study measured eleven variables to evaluate water quality at 18 different sampling sites and used factor analysis to identify correlations in the data relating to underlying factors. Two main approaches have been commonly used in this context. The first approach examines the characteristics of effluents before they are released into water bodies, making it easier to enforce regulations and determine suitable treatment methods. The second approach focuses on maintaining water quality in rivers after effluents have been diluted, which takes into account the rivers' natural ability to disperse and self-purify. This latter perspective complicates decisions regarding wastewater discharge, particularly when various types of effluents are involved in the Brahmani River.

Results and Discussion: Multivariate analysis is an effective method for evaluating surface water quality in a spatial context. Water quality data collected during the lockdown for 15 parameters were analyzed and compared to levels from 2019 (before the lockdown), 2021 (during the unlock phase), and previous years. Spatial distribution maps of all the parameters were generated. The concentration of most of the parameters reported during the lockdown, Conductivity, BOD, DO, Hardness, SAR, RSC, and sulfate all saw reductions of 4–36%. In contrast, pH, electrical conductivity, Sodium, magnesium and fluoride increased by 0.5–21%, indicating a decrease in organic pollution in the river attributed to the halt of industrial and commercial activities. An eleven-year analysis revealed a 0–48% decline in pH, TSS, COD, total nitrogen, sulfates, andnitrates. However, during the unlock phase, there was a notable increase of 5–57% in nearly all parameters, suggesting significant impacts from the resumption of activities along the Brahmani River.

Conclusion/Recommendation: The findings indicated that water quality was significantly influenced by agricultural activities, underscoring the critical need for targeted efforts to address pollution stemming from this sector. Human life came to an unexpected halt as numerous countries around the globe closed their borders and imposed restrictions due to the widespread outbreak of the novel coronavirus disease pandemic (COVID-19), which severely impacted the world during the first quarter of 2020. This unprecedented situation led to a complete standstill across various industries, a significant reduction in vehicular movement, and a dramatic decline in daily human activities, marking perhaps the first time in modern history that such a global shutdown occurred.

Keywords: Land degradation; Carbon sequestration; Carbon management index; Biological activity index

Meteor-Hydrological Factors Variation in Rushikulya River Basin Using Mann Kendall And Pettitt Method

Sambit Parida, Siprarani Pradhan, Falguni Baliarsingh*

School of Infrastructure & Planning, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: paridasambit996@gmail.com

Introduction: Hydro-climatic variability plays a crucial role in sustainable water resource management, particularly in river basins prone to climate-induced changes. The Rushikulya River Basin, located in Odisha, India, has witnessed fluctuations in streamflow, temperature, precipitation, and humidity over the past four decades. Understanding these variations is essential for flood risk management, agricultural planning, and climate adaptation strategies. This study aims to analyze long-term hydro-meteorological trends using the Mann-Kendall test, Sen's slope estimator, and Pettitt's test to detect significant shifts and provide insights into water availability patterns.

Materials and Methods: This research employs 40 years of hydro-climatic data (1981–2021) from meteorological and hydrological stations across the Rushikulya River Basin. The methodology includes:1.Mann-Kendall Test – A non-parametric statistical test used to detect increasing or decreasing monotonic trends in time series data.2.Sen's Slope Estimator – Used to quantify the magnitude of change in hydro-meteorological parameters over time.3.Pettitt Test – A non-parametric test to identify abrupt change points in the dataset, indicating structural shifts in climate patterns.The dataset includes monthly and seasonal temperature, precipitation, humidity, and river discharge values collected from three hydrological stations: Madhabarida, Purushottampur, and Soroda. Statistical computations were performed to analyze annual and seasonal variations in meteorological parameters.

Results and Discussion: The analysis revealed significant spatial and temporal variations in hydro-meteorological parameters:1. Streamflow Trends: A declining trend was observed in several locations, particularly during monsoon seasons, suggesting reduced water availability due to changing rainfall patterns and anthropogenic influences.2. Precipitation Trends: The coefficient of variation for annual precipitation ranged from 9.83% to 24.54%, indicating moderate variability. Some stations showed decreasing monsoon rainfall trends, leading to potential water stress and lower groundwater recharge.3.Temperature Trends: A consistent rise in temperature was detected, especially in the post-monsoon period, which could accelerate evapotranspiration rates, impacting agricultural productivity and water retention.4.Pettitt Test Findings: The test identified significant change points in streamflow and precipitation data, correlating with climate change impacts and regional hydrological alterations. These findings highlight the impact of climate variability on water resources, necessitating proactive planning for water conservation and climate resilience in the region.

Conclusion/Recommendation: The observed hydro-climatic trends suggest a need for enhanced water resource management strategies to mitigate the adverse effects of climate change. The declining streamflow and increasing temperature trends call for improved irrigation planning, groundwater recharge initiatives, and sustainable water allocation policies. Future studies should incorporate hydrological modeling, satellite-based remote sensing, and advanced climate models to better predict and manage hydro-meteorological changes in the Rushikulya River Basin.

Keywords: Mann-Kendall test, Sen's slope estimator, Pettitt test, hydro-climatic variability, Rushikulya River Basin, climate change, water resource management.

Sustainable Rainwater Harvesting and Groundwater Recharge: A Case Study at Trident Group of Institutions, Bhubaneswar

Sanjay Kumar Behera*, and Biswajit Nayak

Department of Civil Engineering, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India& Dept. of Civil Engg. SOA University Bhubaneswar

*Corresponding author E-mail: sanjaybehera.civil06@gmail.com

Introduction: With increasing water scarcity and climate change impacts, sustainable water management has become crucial for educational institutions and urban areas. Rainwater Harvesting Systems (RWHS) offer a viable solution for water conservation by capturing, storing, and recharging rainwater. This study focuses on the feasibility and implementation of RWHS at Trident Group of Institutions, Bhubaneswar, to enhance groundwater levels and reduce dependency on external water sources.

Materials and Methods: The study area spans 45,918 m², comprising 7,550 m² of rooftop area, 4,700 m² of paved surface, and 20,700 m² of open field. The system components include catchments, filtration units, recharge wells, and a disinfection unit to ensure water quality before groundwater infiltration. Hydrological surveys, including rainfall data analysis (annual average: 1,470 mm), runoff coefficient estimation, and recharge potential calculations, were performed. The system was designed based on the Gumbel Distribution Model for rainfall intensity and runoff discharge calculations.

Results and Discussion: The estimated annual rainwater harvesting potential was calculated as 7,075 m³ from rooftops, 8,820 m³ from open surfaces, and 4,145 m³ from paved areas, with a total potential of over 20,000 m³ annually. Implementing RWHS significantly contributes to groundwater recharge, flood mitigation, and reduction in stormwater runoff. The filtration and disinfection units ensure improved water quality, preventing groundwater contamination. This project also aligns with sustainable development goals by promoting water conservation and reducing urban flooding risks.

Conclusion/Recommendation: The study demonstrates that RWHS at Trident Group of Institutions is an effective method for groundwater recharge, flood control, and sustainable water management. With proper implementation, approximately 7,000 m³ of rainwater can be effectively recharged annually, ensuring long-term water security. Future expansions include integrating solar energy, wastewater recycling, and zero-discharge principles to develop a Net Zero Building.

Keywords: Annual Rainfall, Rainwater Harvesting Potential, Net Zero

Mathematical Modelling of Surface Runoff Using SWAT Model and ArcGIS of Upper Baitarani River Basin

Sipra Mohapatra*, D. P. Satapathy

School of Infrastructure and Planning, OUTR, BBSR

*Corresponding author E-mail: bsmohapatra1@gmail.com

Introduction: Runoff is a major and important part of hydrological cycle. Hence exact and accurate estimation of surface runoff of watershed is an area of interest for many hydrologists in recent years. Again improper management and wrong determination of stream flow is a major issue and it may cause flood mostly in the state like Odisha. Till date different methods has been developed by different researchers in order to calculate runoff exactly and accurately. Various hydrological models have been developed by hydrologists for the simulation of runoff of various catchments.

Materials and Methods: In present study Soil and Water Assessment Tool (SWAT) has been used for simulation of surface runoff of Upper Baitarani river basin on monthly time step basic. Digital Elevation Model (DEM), land map, soil map, meteorological data like temperature and rainfall data of the study area has been used for simulation of runoff of the watershed at the outlet point.

Result and Discussion: SCS-CN (Soil Conservation Service-Curve Number) has been employed along with Soil and Water Assessment Tool (SWAT) model to simulate runoff of Upper Baitarani river basin at Anandpur gauging station. The performance of SWAT model has been evaluated using statistical method. It has been observed that SWAT model well performed in simulation of runoff with Coefficient of Determination (R^2) were 0.8068 and 0.9123 on monthly and yearly time step respectively, and Nash-Sutcliffe efficiency (NSE) were 0.672033and 0.763286 on monthly and yearly respectively, and PBIAS (-30.89to 28.77943 in %) on yearly data calculation basic. Land use changes has also been observed for the years 2005, 2015 and 2018 respectively and observed that land use pattern changes leads to decrease in agriculture, forest, Rangeland, barren land and increase in water body, built up which leads to an increase in stream flow for the initial few years but not much significant as there is a variation in precipitation for different years. Trend analysis has been performed for Anandpur Gauging station for different months of year 2020-2030 using observed precipitation and plotted graphically which shows decreasing trend for months January, May, June, November and increasing trend for remaining months of years.

Conclusion/Recommendation: Hence SWAT model with Geographic Information System (GIS) interface could be considered as one of the major mathematical model inorder to estimate surface runoff of various river basins.

Keywords: SWAT, Surface runoff, LULC, Soil map, Temperature, NSE, R^2.

Application of MCDM and Geo-Spatial Techniques in Urban Spatial Pattern Assessment: A Case Study of Bhubaneswar, India

Swapna Sarita Swain[1]*, Deba Prakash Satapathy[1], Janmejoy Gupta[2]

[1]School of Infrastructure and Planning, Odisha University of Technology and Research, Bhubaneswar, Odisha, India

[2]Dept. of Architecture, School of Planning and Architecture (SPA), Vijayawada

*Corresponding author E-mail: sswainplanning@outr.ac.in

Introduction: Urbanization has been the primary driver of city formation, leading to spatial expansion, particularly along urban corridors, and transforming rural fringes into urban areas. In India, rapid population growth and rural-to-urban migration have resulted in unplanned and chaotic urban expansion, posing significant challenges. Identifying suitable locations for urban development is crucial for effective planning and land management.In order to evaluate possible sites for expansion and support well-informed decision-making, land suitability analysis is essential. Techniques like Multi-Criteria Decision Making (MCDM) and Geographic Information System (GIS) are frequently employed for this. However, research on the urban growth of Bhubaneswar has only looked at the city's municipal limits, ignoring the larger Bhubaneswar Development Planning Area (BDPA). This study examines urban growth dynamics across BDPA, identifying key drivers of future expansion.

Materials & Methods: The study area is located in the Khordha district of Odisha, India.For my subject of study, ten criteria have been selected. The primary criteria used for spatial analysis include slope, elevation, soil, geology, geomorphology, road proximity, land use and land cover, distance from streams, built-up areas proximity, and distance from a special protected area map. Both non-spatial (demographic and census data) and spatial (satellite images, topography data, and DEMs) data are gathered. Georeferencing, digitisation, and reclassification are used to generate theme layers, such as administrative boundaries, rivers, slope, LULC and roads etc. Using modelling tools and multi-criteria decision-making methodologies to evaluate land suitability, these layers are superimposed to analyse urban expansion trends.

Results & Discussion: An effective technique for creating land suitability maps for future built-up areas is the combination of the Analytic Hierarchy Process and GIS. With an AUROC value of 0.84, the AHP model exhibits outstanding performance and has been validated using evaluation criteria. By offering an organised way to rank many criteria, the AHP framework successfully tackles the difficulties associated with determining land appropriateness and provides insightful information for planners and urban developers. Additionally, the research's future prospects appear bright, particularly given the possibility of adding more urban growth-related influencing factors and the use of cutting-edge machine learning techniques to improve predictive capabilities.

Conclusion/ Recommendation: This hybrid approach will be instrumental in addressing the challenges of sustainable urban development in a fast-evolving world. This study can be very helpful to the planners, Policy makers and authorities in formulation of strategies/policies and suggesting modelbased approach for guiding future planned development in my study area that accommodate the needs of a growing population while preserving the environment and enhancing overall quality of life.**Keywords:** Land suitability assessment, analytical hierarchy process, Urban Growth, geographic information system, built-up areas.

Dynamic Study of E-glass- CNT Reinforced Polymeric FG Plate with Honeycomb Core

Abhijit Mohanty*, Rati Ranjan Dash

School of Mechanical Sciences,Odisha University of Technology and Research,Bhubaneswar,751029,Odisha,India

*Corresponding author E-mail: abhijitmohanty1212@gmail.com

Introduction: Sandwich-structured composites are commonly used in structural applications due to their excellent damping properties, mainly derived from their viscoelastic or honeycomb core. These materials consist of a viscoelastic core sandwiched between two elastic face sheets, enhancing energy absorption for vibration control. The core is often porous, typically using a honeycomb structure inspired by nature, such as the hexagonal honeycomb used by bees. These structures reduce weight while improving stiffness, impact strength, and energy absorption, making them ideal for civil engineering, aerospace, automotive, marine, and industrial applications.

Materials and Methods: The effectiveness of sandwich structures depends on the geometry and material composition of the honeycomb core. Studies suggest that rectangular or hexagonal honeycomb cores offer superior thermal insulation, while triangular cores provide the highest mechanical strength. Common core materials include polyethylene, polyurethane foam, polystyrene, and epoxy. Functionally graded materials (FGMs) are evaluated using a porosity factor in an isotropic material model, followed by face layer calculations using the rule of mixtures. Theoretical analyses often employ higher-order plate theories (HOPT) to capture interlaminar shear stress distribution.

Results and Discussion: The porosity factor of the honeycomb core is critical to the stiffness and natural frequency of the sandwich plate. This study considers four core structures—square, hexagonal, triangular, and circular—using polystyrene as the core material and carbon fiber-epoxy face layers in a 50:50 weight ratio. It is observed that increasing wall thickness improves stiffness and natural frequency. A 17.5% frequency increase occurs with a 0.2 mm wall thickness increase. Triangular cores show the highest stiffness, while circular cores exhibit the lowest stiffness and frequency.Increasing unit cell side length reduces plate stiffness, with a 50% loss in natural frequency when wall thickness increases from 1 mm to 2 mm. Larger core dimensions lead to increased porosity, decreasing natural frequency. Triangular cores provide the highest mechanical strength, while circular cores show the lowest frequencies. The effect of core thickness ratio (hc/hf) on dynamics is also examined. When hc/hf exceeds 0.8, a balance between stiffness and damping is achieved, stabilizing natural frequency. Polyurethane cores provide the highest frequency, followed by epoxy and polystyrene.

Conclusion/Recommendation: This study investigates a sandwich plate with elastic face sheets and a viscoelastic honeycomb core, focusing on free vibration analysis. The findings show that core unit cell dimensions affect strength, with increased thickness reducing porosity and enhancing stiffness. Triangular cores exhibited the highest stiffness, while circular cores had the lowest. Core material choice also influenced stiffness, with polyurethane cores showing the highest frequency. The damping effect of the honeycomb core impacted natural frequencies, highlighting the need for further research, including real-world validation and exploring static, buckling, and thermal performance for enhanced practical applicability.

Keywords: Composites, Dynamic Study, E-glass- CNT Reinforced Polymeric FG Plate, Porosity

Enhancing Solar Cooker Efficiency: Comparative Analysis of Selective Coatings on Performance

Abhisek Sarangi, Sudhansu S. Sahoo*, Ramesh K. Mallik

School of Mechanical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: sudhansu@outr.ac.in

Introduction: Hot boxed-type solar cookers provide an eco-friendly alternative to traditional cooking fuels, particularly in underdeveloped regions. The absorber tray plays a vital role in converting solar radiation into useful thermal energy. Improving absorption efficiency is crucial to enhancing the overall performance of solar cookers. This study evaluates the impact of selective coatings on the efficiency of box-type solar cookers, comparing Black-Nickel on Nickel-Plated Steel and Black-Chrome on Galvanized Steel against conventional cookers.

Materials and Methods: Both advanced coatings demonstrated high absorptivity (á = 0.95), with Black-Nickel exhibiting lower emissivity (å = 0.07), resulting in superior heat retention. Experimental results revealed that the Black-Nickel absorber plate achieved temperatures of 162–168°C without load and 150–153°C under load, while cooking pot temperatures ranged from 150–153°C (no load) to 142–145°C (with load). Black-Chrome attained slightly lower temperatures, with absorber plate readings of 155–159°C (no load) and 144–147°C (with load), and cooking pot temperatures of 144–147°C (no load) and 132–135°C (with load). Conventional cookers using a matte black finish on aluminum trays recorded significantly lower temperatures: the absorber plate reached 120–122°C (no load) and 117–118°C (with load), while the cooking pot temperatures were 110–112°C (no load) and 108–109°C (with load).

Results and Discussion: Additionally, the performance of a conventional cooker under an 800W Halogen lamp in an air-conditioned environment was analyzed, yielding the lowest temperatures. The absorber plate reached 93–94°C (no load) and 88–89°C (with load), while the cooking pot recorded temperatures of 90–91°C (no load) and 85–86°C (with load). The findings emphasize the crucial role of selective coatings in optimizing thermal efficiency, with Black-Nickel proving to be the most effective material due to its superior heat retention capabilities.

Conclusion/Recommendation: This study underscores the potential of advanced coating technologies in enhancing the viability of solar cooking systems. The use of high-absorptivity, low-emissivity materials can significantly improve cooking efficiency, making solar cookers more suitable for widespread adoption in energy-scarce regions. The results provide valuable insights into the material selection process for solar thermal applications, contributing to the advancement of sustainable cooking technologies.

Keywords: Solar cooker, selective coatings, thermal efficiency, Black-Nickel, Black-Chrome, renewable energy.

Comparative Analysis of Nano fluid Thermo hydraulic Performance in Three-Fluid Helical Coil Heat Exchangers

Asish Sarangi*, Sudhansu S. Sahoo, Ramesh K. Mallik

School of Mechanical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding Author Email: asish919@gmail.com

Introduction: With the growing demand for energy-efficient systems, three-fluid heat exchangers (TFHEs) have gained prominence due to their ability to facilitate simultaneous heat exchange between three distinct fluid streams. This study presents a numerical investigation of a TFHE using three different nanofluids—Aluminum Oxide (Al2O3), Copper Oxide (CuO), and Ferric Oxide (Fe2O3)—as working fluids inside a helical coil configuration. The objective is to assess the heat transfer and pressure drop characteristics by varying volume fractions, flow rates, and inlet temperatures of the nanofluids.

Materials and Methods: A three-fluid heat exchangers (TFHEs) modelling and simulation has been carried out using Computational Fluid Dynamics (CFD) approach. Commercial CFD code, ANSYS has been employed for the analysis. Grid independence study was carried out along with validation before presenting the results using different kinds of nanofluid in considered TFHE.

Results and Discussion: Results indicate that Aluminum Oxide nanofluid exhibits the highest efficacy, being 2.16% more efficient than Copper Oxide and 1.72% more than Ferric Oxide. Additionally, it reduces the friction factor by 9.18%compared to Copper Oxide and 6.05% compared to Ferric Oxide. Copper Oxide, on the other hand, has a 3.34% higher friction factor than Ferric Oxide. The Nusselt number forAluminum Oxide nanofluid shows a 0.87% improvement over Copper Oxide and a 0.24% increase over Ferric Oxide. The numerical simulations highlight that increasing the nanofluid volume fraction enhances thermal performance up to a certain threshold, beyond which increased viscosity negatively impacts heat transfer efficiency. Moreover, higher flow rates improve convective heat transfer but lead to a decline in overall effectiveness due to reduced residence time. This study provides valuable insights into the thermal performance of TFHEs using nanofluids, which can be applied in industrial sectors such as cryogenics, HVAC systems, petrochemical industries, and food processing.

Conclusion/Recommendation: The findings support the potential of Aluminum Oxide nanofluid as the most efficient choice among the three tested nanofluids, making it a strong candidate for optimizing heat exchanger performance.

Keywords: Three-fluidheatexchanger;Nanofluids;ComputationalFluidDynamics;Heattransfer; Helical coil.

Technology Assessment for Waste Heat Recoveryin the Cement Sectors

Jashaswi Supriya Satpathy*, Sudhansu S.Sahoo, Prasanta Kumar Satapathy

School of Mechanical Sciences, Odisha University of Technologyand Research, Bhubaneswar-751029, Odisha, India

*CorrespondingAuthorEmail: jssatpathy27@gmail.com

Introduction: In the cement industry, waste heat recovery (WHR) requires materials that can withstand high temperatures, corrosion, and abrasive conditions. Stainless steel or copper alloys are usedfor heat exchangers. Ceramic materials and moltensalts areusedfor heat storage. High-strength steelalloys areusedfor turbines and heat exchangers in theorganicRankinecycle. Ceramicfibers are also used as insulation. The cooling system uses heat exchangers made of stainless steel and glass fiber reinforcedplastic. Theuseofthesematerialsallowsfor efficient recoveryandrecyclingofwaste heat, reducing energy consumption and emissions in cement production. This study investigates the possibility of using the waste heat fromthe cooling of the high-temperature gas leaving a rotary kiln in a cement plant to dry a wet rawmaterial (limestone) or to generate electricity using an Oraganic Rankine Cycle (ORC).

Materials Required: Mathematical modelling of waste heat recovery system has been developed for cement factory waste heat recovery system. The simulations helped with the equilibrium mass, energy, and energy balance. The conventional exergy-economic analysis method used the investment's net present value (NPV) as a decision criterion.

ResultsandDiscussion:Theresultsshowedthatthebestalternative,NPV=0.37MUSDundermarket conditions of the selling price of electricity and fuel, provides a maximum of 3.77 MW of electricity with a thermal efficiency of 15.96% and an exergy efficiency of 37.52% using cyclo-pentane as the working fluid. None of the drying units achieved a positive NPV and were discarded. However, the highest moisture reduction in the solids stream was 5.68% at T=125^{0}C. The placement option of a drying unit just after the ORC for complete cooling of the gases was economically analyzed for the ORC inthecases withthebest NPV, T= 150^{0}CandT= 180^{0}C.However, nosignificant improvement was found over the use of ORC alone. The possibility to improve the performance of simple ORC is explored through the inclusion ofan internal heat exchanger,such arecovered cycle outperforms itssimpler configuration in terms of thermal and economic performance yielding 4.1 MW of net power with NPV = 0.42 MUSD, rate of return 15.58% and payback period PB = 6.07 years. That's 8.75% more work with 13.51% better economic performance than a simple ORC.

Conclusion/Recommendation: Theenergy-and exergy-optimizedRankinecyclefor therecovery of wasteheat fromthe chimneys of theSabzevar cement plant is designed for usein power generation to improvethe power plant's energy efficiency. It was found that increasing the boiler pressure reduced the amount of energy recovered while increasing the efficiency of the cycle; therefore, an optimum point would be found at 1398 kPa where the highest overall energy and exergy efficiency would be achieved.

Keywords:NPV,ORC,OPC,RotaryKiln,Exergyeconomicanalysis

Machine Learning-Based Computer Vision model for enhancing shrimp farming

Jitendra Naik*, Saroj Kumar Pradhan

School of Mechanical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*E-mail: jnaik@outr.ac.in

Introduction: In recent times, progress in Artificial intelligence (AI) and machine learning (ML) have profoundly enhanced the accuracy of object detection in wide range of domains. In marine world, identification and classification of different under water species using computer vision model have a crucial role in biodiversity monitoring, ecological conservation and productivity. Shrimp farming has become a significant sector in marine aquaculture worldwide. It directly contributes in the financial growth of many countries including India. However, this multi-million shrimp farming industry faces many challenges such as disease out-break, environmental effects and interspecies cannibalism etc. Cannibalism is a major problem in shrimp farming directly affecting the profitability. In the case of cannibalism, dominant larger shrimp prey on relatively smaller vulnerable shrimps. Innovative technologies like AI and ML can directly help in mitigating such challenges.

Materials and Methods: This study explores the application of the You Only Look Once (YOLO) deep learning model for detection and classification of different shrimp species. It is well known for its high-speed processing and single-stage detection architecture is perfectly suited for analyzing large-scale datasets. In this study, a custom YOLOv8 framework was trained on a diverse dataset comprising thousands of annotated images of different sizes of shrimps. Default feature extraction techniques were used for model robustness.

Results and Discussion: The model training process employed transfer learning using a pre-trained YOLO backbone, fine-tuned with domain-specific data to improve accuracy in detecting shrimps. The dataset was split into training (70%), validation (20%), and testing (10%) subsets. The model's performance was evaluated using standard object detection metrics, including mean average precision (mAP), precision, recall, and F1-score. Additionally, computational efficiency was assessed to ensure real-time detection feasibility for deployment in underwater monitoring systems.

Conclusion/Recommendation: Overall, this study highlights the potential of deep learning-based object detection models for shrimp species monitoring, enabling scalable and cost-effective solutions for sustainable shrimp farming.

Keywords: Machine Learning, Computer Vision, YOLO, Marine Species Detection, Object Detection, Deep Learning, Underwater Monitoring, Biodiversity Conservation

IRS Devices for Naval/Cargo Ships- Their Design Features and characteristics

Ramesh C. Mishra[1*], Ramesh K. Mallik[1], Ashok K. Barik[2]

[1] School of Mechanical Sciences, Odisha University of Technology and Research (OUTR), Bhubaneswar, India. [2] Department of Mechanical Engineering, National Institute of Technology, Jamshedpur, Jharkhand, India,

*Corresponding author E-mail: rcm.rcmishra@gmail.com

ntroduction: Infrared radiation suppression (IRS) is one of the methods to protect the ships and fighter jets from external threats such as infrared-guided enemy missiles. Infrared radiations emitted by the hot flue gases from prime movers such as gas turbines through their tail pipe is the major source to detect the presence of Naval or cargo ships. The hotter the flue gas and the tail pipe, the more infrared radiation in the range of 3 μm to 5 is emitted and its source gets detected by the Infrared-guided enemy missiles deployed for destroying such ships. Infrared has to be suppressed by reducing the exhaust gas temperature by way of designing an assembly of different exhaust funnels with openings in between consecutive funnels to suck outside cold air and mix with hot gas to reduce the final outlet temperature. The funnel assembly and design within the overall size restriction has a very great role in reducing the exhaust gas temperature, resulting in low amount of infrared radiation of desired wavelength range. This paper is aimed at providing a brief review of the different modified infrared suppression devices with Hybrid-IRS and Cylindrical funnels with conical obstacles, developed by this author. These newly developed IRS devices are expected to reduce the detectability of ships in the sea in a war-like situation.

Materials and Methods: The authors use Ansys Fluent- Release 22 for numerical simulation of IRS Devices with Cylindrical, Conical and Hybrid funnels and cylindrical funnels with conical obstacles. This employs finite volume method. Continuity, Reynolds Averaged Navier Stokes Equations and energy equations have been used for studying the effect of different IRS device geometries on air entrainment ratio and outlet temperature. Grid sensitivity tests have been conducted to ensure optimum number of grids in the computation domain.

Results and Discussion: For Natural Convection cooling with Rayleigh No. between and n and Diameter ratio, Hybrid IRS has the greatest Nusselt Number and for Rayleigh No >, the cylindrical IRS device has the greatest Nusselt Number. Nusselt no. increases with diameter ratio up to 1.15.

With conical obstacle in cylindrical IRS devices, it is about 28.9% higher than that without obstacle. The air entrainment increases drastically, decreasing outlet temperature substantially more. The outlet temperature decreases by about 7.7% with an optimum blockage volume ratio of 0.0266.

Conclusion/Recommendation: Cylindrical Funnels with conical obstacles are recommended for future IRS devices.

Keywords: Infrared Radiation Suppression, cylindrical-IRS, Conical-IRS, Hybrid-IRS

Thermal Modeling Analysis of Passive Solar Photovoltaic Thermal System

Runu Das*, Sudhansu S. Sahoo

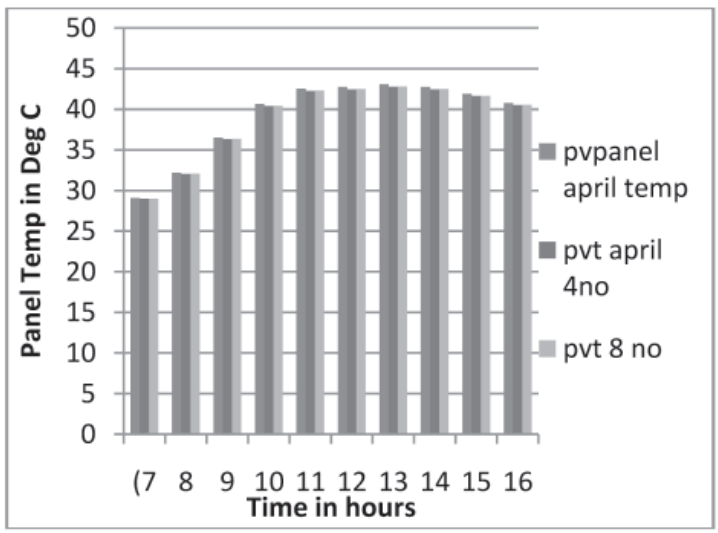
School of Mechanical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: runudasme@outr.ac.in

Introduction: In the Present era of energy moving toward renewable, solar energy is a primary focus for researchers and scientists because it is free, feasible,sustainable, less impact on climate change. Solar energy can be harvested using photovoltaic (PV) collectors or solar collectors.Photovoltaic (PV) cells lose power efficiency as a result of warming up in the sun. In this, detailed Thermal energy modeling is carried out on a photovoltaic thermal (PV/T) system considering the passive cooling method. PV/T systems are hybrid systems combining both methods to produce electrical energy & thermal energy to maximize solar energy collection and overall performance.

Materials and Methods:The flow of water below the PVT through copper tube to collect the heat from the solar panel and cool the solar panel, which will help to decrease the panel temperature. The thermal energy modeling analysis is done analytically by using Matlab to calculate energy and various efficiencies of the system.

Results and Discussion: The thermal and electrical performance of a PVT system is obtained based on energy modeling. The energy harnessed from the PV and PVT are obtained having 4 tubes and 8 tubes using water of the system, analyzing PV, PVT with 4 tubes, and PVT with 8 tubes in Bhubaneswar zone. The energy efficiency was found to be between 0.12 and 0.18 for both PV and PVT systems. The Panel temperature also has been reduced by varying no of tubes. However, considering thermal effectiveness, the system proves more effective .The year-round weather data corresponding to Bhubaneswar, a city in east-coastal zone of India are employed for data reduction. During January, February, December, and November, the water temperature increased by 4-7°C. The overall efficiency of PVT system has been improved.



Conclusion/Recommendation: The thermal efficiency and overall efficiency is improving.PV/T systems effectively collect solar energy, increasing electrical power output and simultaneously collecting solar heat that can be used for industrial and household purposes.

Keywords: Photovoltaic thermal, passive method, Overall efficiency, Energy modeling, Weather data

Environmental Impact Assessment of Ethanol Production from Rice Straw Using Life Cycle Analysis with its Bibliometric Insights

Suraj Kumar Samal and Sudhansu Sekhar Sahoo*

School of Mechanical Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: sudhansu@outr.ac.in

Introduction: The study investigates the life cycle assessment (LCA) of bioethanol production from lignocellulosic biomass, with a focus on rice cultivation and bioethanol refining. The primary objective is to quantify the environmental impacts of bioethanol and compare its sustainability with conventional fossil fuels. Using the ReCiPe methodology in the SimaPro software, this study assesses the environmental burdens associated with rice cultivation, ethanol processing, and associated emissions. The findings contribute to evaluating the feasibility of bioethanol as an alternative fuel in the Indian scenario.

Materials and Methods: The study follows the ISO 14040 and 14044 LCA framework, encompassing goal and scope definition, inventory analysis, impact assessment, and interpretation. The system boundary follows a "cradle-to-gate" approach, covering raw material extraction, paddy cultivation, and bioethanol processing up to the refinery gate. Data sources include field surveys, literature reviews, and Ecoinvent 3 databases. Midpoint impact indicators under the ReCiPe methodology evaluate global warming, acidification, eutrophication, toxicity, and resource depletion. The functional unit is defined as the production of 1 liter of bioethanol.

Results and Discussion: The environmental impacts of paddy cultivation are analyzed, revealing significant greenhouse gas emissions due to diesel usage in farm machinery and fertilizers. The global warming potential (GWP) for paddy production is estimated at 0.973 kg CO2-eq per kg of paddy. Bioethanol production shows a total GWP of 2.58 kg CO2-eq per liter, with paddy cultivation accounting for 44% of the emissions. Other major contributors include electricity consumption, primarily from coal-based power plants. Sensitivity analysis highlights that modifying energy sources can substantially reduce emissions. Allocation approaches, such as energy-based allocation, significantly influence impact values. The study also identifies key contributors to impact categories such as ozone depletion, terrestrial acidification, and water consumption.

Conclusion/Recommendation: The LCA results indicate that while bioethanol production from rice straw offers a renewable fuel alternative, it is not without significant environmental trade-offs. The high dependency on fossil-based electricity in the production chain contributes to its environmental impact. Future work should focus on improving energy efficiency in biorefineries, adopting renewable electricity sources, and optimizing agricultural inputs. Additionally, economic feasibility and payback period assessments are required for policy recommendations. Overall, the study provides valuable insights into the sustainability of bioethanol and its potential role in reducing fossil fuel dependency.

Keywords: Rice straw; Bioethanol; Sustainability; Life Cycle Analysis; Alternate fuels

Application of Braided Structure Composite in Technical Textiles

Dinesh Pradhan*

Department of Textile Engineering, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: dineshpradhan2706@gmail.com

Introduction: Braided structure composites have gained widespread attention in the technical textile industry due to their superior mechanical performance, flexibility, durability, and adaptability to complex shapes. These composites, formed by interlacing or intertwining of continuous multiple strands or fibers in a specific pattern, exhibit excellent load-bearing capacity, impact resistance, and energy absorption properties. Their application in technical textiles spans across aerospace, automotive, biomedical, protective gear, and industrial reinforcements. The versatility of braided structures allows the development of high-performance fabrics that offer superior strength-to-weight ratios, fatigue resistance, and damage tolerance. Research in this domain has focused on optimizing different fibre, braiding techniques, braiding angle and resin systems to meet the stringent demands of modern applications.This paper explores the current applications of braided structure composites in technical textiles, the research advancements in this field, and the potential future directions.

Applications: Significant progress has been made in leveraging braided structure composites for technical textile applications. In aerospace, these composites are utilized in lightweight structural components such as aircraft panels, turbine blades, and space exploration materials, providing enhanced impact resistance and reduced weight. The automotive industry employs braided composites in crashworthy structures, seat reinforcements, and under-the-hood components, ensuring improved safety and fuel efficiency.Braided structure composites have gained significant attention in the automotive industry due to their high strength-to-weight ratio, impact resistance, and durability. Their unique fiber architecture enhances structural integrity while allowing flexibility, making them ideal for automotive textiles used in interior reinforcements, safety components, and lightweight structural parts. As automakers aim for increased fuel efficiency, sustainability, and enhanced passenger safety, braided composites provide an innovative solution for next-generation vehicles.

Biomedical applications have seen extensive use of braided structures in prosthetics, orthopaedic implants, and vascular grafts due to their high flexibility and biocompatibility. Protective textiles, including ballistic armour, firefighter suits, and industrial gloves, benefit from braided composites due to their superior energy dissipation and puncture resistance. Additionally, braided composites play a crucial role in geotextiles, construction reinforcements, and marine applications, where high durability and environmental resistance are essential.

Conclusion/Recommendation: Braided structure composites have proven to be highly effective in technical textiles, offering superior strength, flexibility, and impact resistance across various industries. Their applications in aerospace, automotive, biomedical, and protective textiles enhance performance, durability, and safety. Continued advancements in material science and manufacturing techniques will further optimize their integration into high-performance technical textiles. Future research should focus on improving design precision and expanding their functional capabilities for next-generation applications.

Key words: Braided composite; Technical textiles; Aerospace applications; Automotive industry;

Bio medical applications; Protective textiles

Optimization of Process Parameters in Ultrasound-Assisted Dyeing using Box-Behnken Design

Himadri Tanaya Mahanta* and Bibhu Prasad Dash

Department of Textile Engineering, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: htanaya1992@gmail.com

Introduction: Natural dyes are environment-friendly and have become important alternatives to synthetic dyes in many dyeing products. Therefore, better extraction and dyeing techniques need to be developed for the dyeing process of natural dyes. The first objective of this study is colouration of cotton fabric with Indian madder dye using ultrasonic technology. The second objective is to optimize the process parameters such as dyeing time, dyeing temperature and ultrasonic time using Box-Behnken Design.

Materials and Methods: The cotton fabric was dyed using Indian madder dye under a liquor ratio of 1:50 and in ultrasonic-assisted conditions. A three-factor-three–level Box–Behnken design was employed to explore the dyeing conditions. The colour strength, tensile strength and colour fastness to washing of dyed fabric were measured and characterized by FESEM.

Results and Discussion:A quadratic model employed to optimize the colour strength value of cotton fabric dyed with Indian madder dye. The results showed that interaction between dyeing time (A), dyeing temperature (B) and ultrasonic time (C) had significant effects on the colour strength values. It was found that ultrasonic waves can effectively improve the shade depth as compared to the conventional dyeing process. The K/S value can reach 1.77 with dyeing time of 30 minutes and ultrasonic time of 40 minutes at temperature of 70p C. Field Emission Scanning electron microscope images showed that the application of ultrasound did not cause obvious fibre damage.

Conclusion/Recommendation: As a result, Box-Behnken Design could be quite efficient for the optimization of dyeing of cotton fabric with Indian madder dye and provide efficient parameters for scaled-up industrial processing of fabric as allows quick screen of a large experimental domain in order to predict the optimal conditions of response. This represents the reproducibility of the shade depth upon the selection of controlled variables. It is highly important that feasibility of the process and low production cost may further broaden this application to the industrial scale.

Key words: Indian Madder (*Rubia Cordifolia*), Ultrasound-assisted Dyeing, Box-Behnken Design, Sustainability

Experimental studies on Graphene treated Jutefibres and their biopolymer composites for technical textile application

Rudrapratap Sahoo[1*], Ashwini K Dash[1,] and Prasanta K Panda[2]

[1]Department of Textile Engineering, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

[2]Bombay Textile Research Association, Mumbai-400086, India

[*]Corresponding author E-mail: rudrapratapsahoo2@gmail.com

Introduction: A composite material combines two or more materials with different physical and chemical properties. These have specific properties including being stronger, lighter in weight and more durable. The researchers are focusing on bio-based composites and eco-friendly materials due to their lower environmental impact such as less carbon emission and fossil fuel consumption, biodegradability, lower cost, lower density, and ease of fabrication. This research aims to contribute to sustainable development of composite materials by investigating the potential of green composites by enhancing their performance by incorporating graphene.

Materials and Methods: Jute fibre and fabric have been procured from ICAR-Kolkata, India. Polylactic acid (PLA) granules from Deltora Biopolymers Pvt. Ltd., Gujarat. Graphene Oxide (GO) & reduced Graphene Oxide (rGO) from Techinstro, Nagpur. Alkali and silane were procured locally. Alkali treatment on jute fabric using sodium hydroxide solution typically of 5% & 10% concentration (w/l). Prepared a silane solution of 2% (w/w) silane agent (3-aminopropyltriethoxysilane) with 95% methanol and 5% distilled water. Dispersed GO &rGO with distilled water using different concentration % (w/w) solutions were observed using an optical microscope.

Result and Discussion: Alkali treatment on jute fabric using NaOH removes these impurities, exposing the cellulose content of the fibers. It was observed the water absorbency was higher at a 10% concentration than at 5%, improving surface roughness and promoting better mechanical adhesion with the matrix. After applying 2% (w/w) silane treatment to both the untreated and alkali-treated jute fabrics, we found that the water absorbency percentage was low in the untreated fabric and extremely low in the treated fabric. The dispersion level of GO and rGO with distilled water with different concentration % such as GO (0.5%, 1%, 1.5%, and 2%) and rGO (0.25%, 0.5%, 1%, 1.5%, and 2%) was observed with an optical microscope and the images were collected. Then the untreated jute fabric was immersed with GO and rGO solution for 1 & 0.5 hours. The water absorbency % was observed and was found that the absorbency was higher in GO and lower in rGO.

Conclusion/Recommendation: Graphene-treated natural fibers and biopolymer composites hold immense potential for revolutionizing the field of technical textiles. Jute fabrics were treatedwith alkali with different concentration%. Absorbency of alkali treated jute fabrics wereinvestigated by the water drop test method and the absorbency % was observed. It was found the jute fabrics treated with 10% concentration of alkali showed higher absorbency level. Jute fabrics treated with 2% silane concentration showed very low water absorbency %. When the fabric were treated with different concentrations of GO and rGO,it was observed that the absorbency %was high in GO and low in rGO.

Keywords: Alkali, Composite,Graphene, Jute fibre, Polylactic acid,Silane.

Investigating the Impact of Moisture Absorption on Natural Fiber-Reinforced Composites

Sanat Kumar Sahoo, Bibhu Prasad Dash*

Textile Engineering Department, Odisha University of Technology and Research, Bhubaneswar- 751029, Odisha, India

*Corresponding author E-mail:bpdash@outr.ac.in

Introduction: In recent years, natural plant fibers such as jute, sisal, coir, banana, hemp, kenaf, and flax have garnered significant attention from researchers and academicians as a viable alternative to synthetic fiber-reinforced polymer composites. This study investigates the impact of chemical treatments and span length on the tensile strength and flexural strength of natural fiber composites and hybrid composites, highlighting the importance of optimizing these factors to achieve enhanced mechanical properties.

Materials and Methods: Natural fibers like Jute, Sisal and Coir fibers wereused to manufacture composites. For composite preparation compression molding machine was used. For characterization, Instron UTM was used for composites. Other instruments that were used for the procedure include a mechanical stirrer for mixing of epoxy resin and hardener, and a cutter machine was used to cut the composites in testing specimen size. Tensile strength was tested according to ASTM D 3039 with specimen size (250×25×4) mm. and for flexural strength, the ASTM D 790 was followed for characterization with specimen size (127×12.7×4) mm. Also for wet stage testing, it was carried out after 5 days of water soaking of specimen.

Result and Discussion: Flexural Test Analysis: For Sisal composites,in the dry state, the mean maximum load was **117.774 N**. In the wet state, these values decreased to **103.52 N**. Jute composite, in the dry state, generated the mean maximum load of **136.14 N**. In the wet state, these values decreased to **117.73 N**. Further, the coir fibre composite generated the mean maximum load is **160.46 N** in dry state and in the wet state, these values decreased to **140.49 N**. This suggests that Coir composites, like Sisal and Jute, also lose strength when exposed to water.

Tensile Test Analysis: For sisal fibre reinforced composites,in the dry state, the mean maximum load was **2260.62 N** and in the wet state, the mean maximum load decreased to **2088.45 N**. Jute composite generated, maximum load of **2975.32 N in** dry state and **2525.47 N** in wet state. Coir fibre composite, in the dry state, generated the mean maximum load is **2358.46 N** and **1421.02 N** in wet state.

Conclusion/Recommendation: It was concluded that, the effect of alkali treatment on natural fibre gives approx. 15 % better strength compared to untreated. Both tensile and flexural strength in dry condition is better as compared to wet composite. There is a 23 % difference between dry and wet tensile and flexural test, which shows that the product can resist water for a long period. In between these three natural fibres, jute gives 39%more tensile strength and coir gives 28 % more flexural strength.

Keywords: Natural fiber, chemical treatment, composites, water absorption, mechanical test

Reinforcement Learning based Path Selection in Multi-hop Device to Device Communication

Rashmita Routray*, Tapas Kumar Patra

School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding author E-mail: rroutray@outr.ac.in

Introduction: The current cellular communication tends to be incapable of meeting the rising subscriber demands. This increase in demand is due to the popularity of a variety of larger bandwidth-demanding applications. Here we investigated the computation time required to establish a multi-hop path between two devices using reinforcement learning algorithm. The goal is to relieve the base station from traffic burdens and increase network efficiency. Path selection plays a crucial role in Device-to-Device (D2D) communication which reduces time delays in data transmission. Here, we attempted to establish a multi-hop routing path by using Q learning and Dijkstra algorithm and compared both the results.

Materials and Methods:

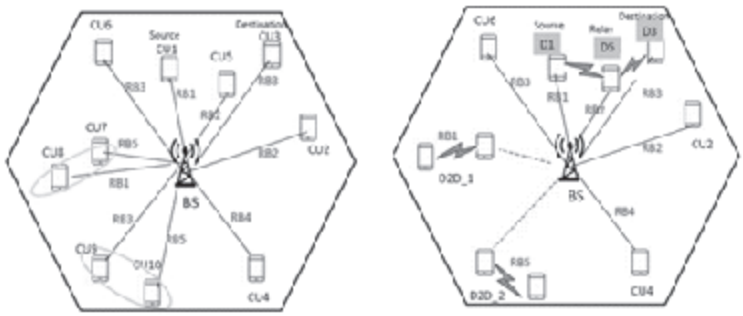


Fig 1:(a) A cell Scenario with BS and Cellular Users (b)multi-hop path between source and destination

In this paper, we considered a hexagonal cell. We randomly distributed the cellular users (CU), where 'k' represents the total number of cellular users (CU1, CU2,...CUk), available in the cell. The base station is placed at the center of the cell (0,0). When a cellular user wants to establish a communication link with another cellular user, it has to send a request message to the base station. The Base Station is the only authority that accepts the request message (RM) from the transmitting CU or source CU. However, when a source CU is far away from the destination CU, it must establish a multi-hop relay path between them to communicate data from source to destination. It must be noted that the CU in the relay path should be free at that moment, with no data to transmit. Finally, by using multi-hop relaying, it increases the coverage area and system throughput while reducing delay,

Results and Discussion: We randomly distributed 25 number of cellular users within a limited radius of 10m. We carried out the simulation 100 times successively using MATLAB, and plotted the achieved shortest path. The optimal path using the Dijkstra algorithm and Q learning algorithm is calculated. It is observed that the computation time taken to find the multi-hop shortest path using Q learning is lesser than Dijkstra.

Conclusion/Recommendation: The simulation result shows that Q learning gives a better result than Dijkstra in terms of computation time irrespective of number of communication requests

Key words: D2D, multi-hop, Q learning, Dijkstra

Enhancing Frequency regulation of standalone microgrid using MRFO algorithm

[1]Pravat Mohanty*, [2]Saroj Kumar Padhan, [1]Ajit Kumar Barisal

[1]School of Electronic Sciences, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

Department of Electrical Engineering

[2]Parala Maharaja Engg. College, Berhampur, Odisha, India-761003

*Corresponding author E-mail: pravat.pmec@gmail.com

Introduction: Recently, Manta Ray Foraging Optimization (MRFO) algorithm optimized Proportional-Integral (PI) controller is studied for frequency regulation of a standalone micro grid (MG). The MG system consists of a Diesel Engine Generator (DEG), Fuel Cell (FC), Micro Turbine (MT) through PI controller and photovoltaic (PV) systems with maximum power point trackers (MPPT) through another PI controller.

Materials and Methods: The gains of the PI controllers are optimized by MRFO algorithm using an Integral of Time multiplied Absolute of Error (ITAE) as objective function. The simulation is carried out with different case studies. When compared to the results of other optimization approaches for the same MG, such as Swalp Search Algorithm, Particle Swarm Optimization, and Teaching Learning Based Optimization, the MRFO-based PI controller outperforms them in all scenarios. According to the simulation findings, the MRFO technique gives better dynamic responses in terms of overshoot, undershoot value, settling time, and Integral Time Absolute Error.

Results and Discussion: The proposed MRFO algorithm is employed to tune the controller gain considering ITAE criteria as the objective function. The control parameters of MRFO consists of 20 manta rays and 100 iterations. The optimization process was repeated 20 times to obtain the best fitness. The performance of the MG with the proposed approach was investigated considering the following case studies.

Conclusion/Recommendation: This paper presents the application of Manta Ray Foraging Optimization (MRFO) based PI controller for frequency regulation of a standalone micro grid (MG). The performance of the MG with the proposed approach was investigated considering 5 different case studies. The simulation results obtained from MRFO based PI controller are compared with the results obtained from SSA, PSO and TLBO based PI controller. From the comparison, it is observed that the proposed approach gives better response in reducing frequency deviation, settling time, peak overshoot and undershoot as compared to the other approaches under various condition.

Key words: Frequency regulation, microgrid, manta ray foraging optimizer, renewable

energy.

Application of MCDM and Geo-Spatial Techniques in Urban Spatial Pattern Assessment: A Case Study of Bhubaneswar, India

Shreeparna Sahoo*

School of Infrastructure and Planning, Odisha University of Technology and Research, Bhubaneswar-751029, Odisha, India

*Corresponding Author E-mail: shreeparna.work@gmail.com

Introduction: The growing demand for sustainable energy solutions necessitates a shift from conventional energy sources to renewable alternatives. Public institutions, such as universities, hospitals, and government buildings, consume substantial amounts of energy, making them ideal candidates for self-sustaining power solutions. Among various renewable sources, solar energy emerges as a viable option due to its abundance and reliability. Odisha, with its immense solar potential—ranging from 25.78 GWp (as estimated by the National Institute of Solar Energy) to 169 GWp (as projected by the International Forum for Environment, Sustainability, and Technology)—offers a promising landscape for solar energy integration. This research focuses on developing a way for self-sustaining institutions powered by solar energy, incorporating efficient energy generation, advanced battery storage, and hybrid systems to optimize resilience and cost-effectiveness.

Materials & Methods: This study employs a mixed-methods approach, incorporating analyses to assess the feasibility of self-sustaining public institutions powered by solar energy. A technical analysis was conducted to evaluate the efficiency of solar PV systems and advanced battery storage solutions by government reports. Hybrid solar models were also examined to determine their ability to feed surplus energy into the grid, reducing dependency on conventional power sources. A cost-benefit analysis was performed to compare the financial and environmental impacts of solar energy adoption versus traditional grid-based electricity. Case studies of existing solar-powered institutions were analyzed to identify best practices and scalability potential.

Results & Discussion: The findings indicate that integrating solar PV systems with advanced battery storage can significantly reduce an institution's reliance on conventional power grids, leading to lower electricity costs and improved energy security. Odisha's vast solar potential makes it an ideal candidate for large-scale solar adoption in public institutions. Hybrid solar systems, which allow excess energy to be supplied to the grid, were found to enhance resilience and generate additional financial benefits. The cost-benefit analysis revealed that while the initial investment in solar infrastructure is substantial, the long-term savings in operational costs and the reduction in carbon footprint outweigh the expenses. Institutions adopting solar energy can achieve a sustainable and economically viable energy model, setting a precedent for widespread adoption across other regions

Conclusion/ Recommendation: The transition to self-sustaining public institutions powered by solar energy presents a scalable and effective solution for reducing dependence on conventional electricity grids. Institutions should conduct feasibility studies to determine the optimal system design for their energy needs. Additionally, further research should explore advancements in battery storage technology and policy frameworks that support large-scale solar integration. Implementing these recommendations can pave the way for a more resilient, cost-effective, and environmentally sustainable energy future for public institutions.

Keywords: Renewable Energy; Solar Photovoltaic (PV) Systems; Energy Storage Solutions; Hybrid solar systems; Energy Security.