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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA

NCC PROFESSORIAL CHAIR ENDOWMENT

22nd – 23rd April 2024

CONFERENCE OVERVIEW

In this era of rapid technological evolution, the digital frontier represents uncharted territories of possibilities. Thus, the Nigerian Communications Commission (NCC) has endowed professorial chairs in some tertiary institutions across Nigeria. This is NCC's mechanism in entrenching innovations in our tertiary institutions, as well as having graduates that are industry-ready.

Consequently, as one of the recent beneficiaries, the Professorial Chair Endowment at the Federal University of Technology (FUT) Minna, is organizing the ***1st International Computing and Communications Conference (I3C)*** aimed at enhancing the provision of qualitative and efficient telecommunications services throughout the country. The conference will also avail the Professorial Chair Endowment at FUT Minna, a medium of communicating research results, activities, and advancement in computing and communication within its focus areas. Additionally, the conference will explore and illuminate the cutting-edge advancements in computing and communication technologies that are reshaping our world. From artificial intelligence and quantum computing to 5G networks and Internet of Things (IoT), these innovations stand as pillars shaping our future.

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A Pattern Reconfigurable Metamaterial-Based Antenna for Sub-6G Millimeter- Wave Application

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ABSTRACT
The surge in applications, services, and use cases is propelling the transition from 5G to 6G. 6G is envisioned to leverage the sub-THz (90-300 GHz) and THz (0.1-10 THz) bands. However, operating at such high frequencies presents challenges like high path loss and atmospheric absorption. Overcoming these challenges necessitates a highly directional and reconfigurable antenna. This paper introduces a novel pattern reconfigurable metamaterial-based antenna designed for sub-mmWave applications. The antenna utilizes a graphene metasurface with a square-spherical split ring (SSSR) resonator, placed above a rectangular microstrip patch antenna to enhance gain and spectral efficiency while absorbing unwanted signals. A Rogers 5800 substrate with ε=2.0 and 0.1mm thickness supports the structure. Operating in the 90-120 GHz range, aligned with WRC 2023 standards for advanced 6G use cases, the antenna's main beam is pattern reconfigured by two PIN diodes (d1, d2) on the patch antenna. d1 operates from 90-98 GHz with a peak radiation pattern of -70.7 dB at 97.5 GHz, while d2 spans 98-120 GHz with a peak pattern of -69.6 dB at 105.4 GHz. When fully loaded, the antenna achieves a -64.5 dB peak, surpassing comparable designs. Compact, wideband, and efficient, this antenna is well-suited for 6G applications like holographic presence and smart transport requiring high radiation efficiency.

Keywords: *antenna, 6G, metamaterial, reconfigurable, mmWave*

Systematic Review of One–Bit Compressive Sensing Algorithm for Wideband Spectrum Sensing

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ABSTRACT
Spectrum sensing (SS) stands as a crucial aspect of wireless communication, aiding in grasping the radio landscape. However, conventional SS methods face challenges due to their reliance on expensive high-rate analog-to-digital converters (ADCs), rendering them impractical for real-time communication needs. These challenges include sparsity level estimation, measurement count determination, noise and receiver uncertainties, sensitivity issues at low signal-to-noise-ratio (SNR) levels, and interference from channel coding. One-bit compression (CS) emerges as a promising alternative, offering straightforward, efficient, and rapid sampling and quantization for wideband spectrum sensing. It finds application in cognitive radio (CR) systems by leveraging spectrum sparsity resulting from underutilization. This paper presents an overview of compressive spectrum sensing (CSS) algorithms in wideband CR, discussing the current state-of-the-art, advantages, and limitations of CSS in wideband spectrum sensing (WBSS) communication.

Keywords: *Cognitive Radio, Spectrum Sensing, Primary Users, Secondary Users, Compressive Sensing,Sparsity.*

Smart Traffic Management System for Smart Cities with Emergency Prioritization

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ABSTRACT
As cities grow, managing traffic efficiently becomes crucial, especially in smart cities. Conventional traffic lights often cause unnecessary delays and don't cater well to vehicle priorities. This paper introduces a Smart Traffic Management System (STMS) designed for smart cities, with a focus on emergency vehicle prioritization. The system combines a microcontroller, Radio Frequency Identification (RFID), and infrared (IR) sensors, adapting dynamically to vehicle types and lane congestion. Emergency Vehicles (EVs) like Ambulances and Fire trucks receive priority via RFID, while sensors monitor lane occupancy. Using sensor networks and smart algorithms, the STMS adjusts traffic signals in real-time and coordinates with emergency services for swift responses during critical events. Simulation and real-world tests assess the system's effectiveness and scalability, highlighting its potential to improve urban mobility, alleviate congestion, and enhance emergency response in smart city environments.

Keywords: *Congestion, emergency, priority, RFID, sensors, traffic*

Systematic Review on Spear Phishing Detection

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Abstract

Phishing remains a significant social engineering tool exploited by hackers, especially with the increasing adoption of internet technology leading to a surge in attacks. This systematic literature review explores techniques aimed at detecting and preventing spear phishing attacks. Analyzing 106 papers using the PRISMA framework revealed a high accuracy range of 88% to 99.4% achieved by researchers. However, it was noted that datasets for spear phishing detection are limited, and there's an underutilization of hybrid machine learning approaches. Therefore, future research should focus on exploring and combining various machine learning algorithms to enhance detection and prevention capabilities.

Keywords: *Phishing, Spear Phishing, Machine learning.*

Design And Development of An Iot – Based Health Vital Signs Monitoring System

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ABSTRACT
This study introduces an IoT-based health vital signs monitoring system designed to track a patient's basic physiological parameters in real-time. The system incorporates four sensors: a body temperature sensor, an electrocardiogram (ECG) sensor, an accelerometer sensor, and an eye blink sensor, all of which gather data from the patient. These sensor data are then displayed on a liquid crystal display (LCD) for easy access. The system also includes memory modules for storing designated phone numbers and a GSM module that connects to cellular networks to transmit vital sign data via SMS. The microcontroller, programmed in C++, manages and integrates all sensor functionalities, facilitating the transmission of health data to healthcare providers via IoT for further analysis and processing.

Keywords: *ESP32 microcontroller, GSM module, Internet of things, LCD, Sensors, WiFi module*

Towards Green Future Cellular Network in Nigeria: Artificial Intelligence Approach

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ABSTRACT
The information sector prioritizes green communications to cut energy costs and fossil fuel usage. The surge in terminals and network equipment with 5G and upcoming 6G drives up energy needs, emphasizing the need for greener solutions. However, 6G's advanced specifications like intelligence and security pose challenges to energy efficiency. Dynamic energy harvesting in 6G adds complexity to network management. AI is crucial for automation and reducing human intervention. This study explores AI's role in enhancing energy efficiency, network management, and energy harvesting control. It discusses primary factors driving green communications and reviews AI-based approaches. It focuses on AI's integration with Deep Learning (DL), Machine Learning (ML), Heuristic algorithms, Reinforcement Learning (RL), and Deep Reinforcement Learning (DRL) beyond 5G. It highlights Heuristic algorithms and ML for flexibility and efficiency in green cellular network communication (CNC). RL and DRL optimize resource allocation and power control but face challenges in training due to metric complexities.

Keywords: *Green communication, AI, ML, Terahertz, 6G, CNC, MIMO, Energy Efficiency.*

Simultaneous Distributed Generation Allocation and Network Reconfiguration: A Review of Computational Intelligence

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ABSTRACT
The escalating load growth on distribution networks hampers their optimal performance, prompting the use of Network Reconfiguration (NR) and Distributed Generation (DG) allocation to enhance efficiency. This review paper delves into how Computational Intelligent Techniques (CITs) can address the optimization challenge of simultaneously implementing NR and DG. Surveying fifty-two articles, including two review papers, over a five-year period on Google Scholar, various algorithms and techniques were examined for NR and DG deployment. Four metrics were evaluated: Case Scenarios, Fitness/Objectives, Test network, and Implementation platform, with a focus on Single objective, Weighted multiple objectives, and multi-objective optimization variants under Fitness/Objectives. The strengths and weaknesses of each technique in handling multi-objective optimization and ensuring efficient convergence were analyzed. The findings reveal a predominance of NR-only reviews (80%), followed by reviews addressing multiple objectives (56%), where only a small fraction considered conflicting objectives like maximizing load growth while minimizing power loss or voltage deviations. DG-only reviews constituted 54%, while simultaneous NR and DG planning reviews were the least (46%), suggesting a need for more research on simultaneous NR and DG planning given the increasing DG integration into distribution networks.

Keywords: *Distributed Generation, Distribution network, Network Reconfiguration, Power loss reduction.*

Improving Power Factor of a Distribution System Using Optimally Sited and Sized Capacitor Bank

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ABSTRACT
This study addresses the issue of poor power factor in distribution systems due to predominantly inductive electrical loads, which result in higher reactive power. The objective was to enhance the power factor, decrease power loss, and optimize the voltage profile in distribution systems by strategically placing and sizing capacitor banks. The study utilized a modified IEEE 14-bus system as a case study and applied the Particle Swarm Optimization (PSO) Algorithm to achieve these goals. By adjusting the inertia weight in the PSO algorithm, its performance was improved in finding solutions while reducing computational costs. The approach was evaluated using simulation in PSAT, which modeled the system and assessed the algorithm's effectiveness in identifying solutions. Simulation results demonstrated a 3.7% reduction in system loss, improvement of the voltage profile to 1.0 per unit, and maximized net savings amounting to $57,674.4.

Keywords: *power factor, capacitor bank, Multi-Objective Particle Swarm Optimisation (MOPSO), power loss.*

Design Of Novel SSR Based Octagonal Shape Radiator for Terahertz Application

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ABSTRACT
Antennas with enhanced gain and efficiency across a broad frequency spectrum are highly advantageous in a wide range of applications. However, achieving these qualities at higher frequencies while maintaining a compact size adds complexity to the design process. This study introduces a novel square split ring (SSR) octagonal radiator tailored for metamaterial structures. The design incorporates a Rogers substrate with specific dielectric properties, including a dielectric constant of 2.2, 0.8mm thickness, and a low loss tangent of 0.00009. The SSR dimensions are 2.0 by 2.0mm², with the total unit cell size measuring 2.4 by 2.4mm². Electromagnetic characteristics, such as S11 and S12 parameters, are analyzed using the commercially available CST MICROWAVE STUDIO software, employing the Finite-Difference Time-Domain (FDTD) method for simulation. The antenna's performance is assessed based on reflection coefficient, permittivity, and permeability, showcasing a reflection coefficient ranging from -10dB to -35dB across frequencies from 190GHz to 300GHz. The resonator effectively creates stop-bands at 210GHz and 255GHz (x-direction) and 219GHz and 290GHz (y-direction). Additionally, the designed radiator exhibits near-zero permeability and permittivity, rendering it suitable for metamaterial antenna design in Terahertz applications.

Keywords: *Antenna, Terahertz, Metamaterials, Square Split Ring, CST, 6G.*

A Multiband T-Shaped Antenna Array for 6G Mobile Communication

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ABSTRACT
The paradigm shift in the use cases of wireless communication necessitates the need to move toward high data rates, large bandwidths, and reconfiguration. This paper presents a novel double T-shaped antenna array that operates between 4GHz to 16 GHz for 6G mobile communication. The antenna consists of a rectangular microstrip with a fractal T-shaped slot, cut at the rear of the microstrip to provide an air gap for an improved radiation pattern. The antenna is separated at 9 degrees to create a 3 × 3 array which is fed through a 0.8 × 2.77 mm^2 microstrip line. The antenna was designed and simulated using the CST suite based on Finite Integration Technique. The antenna exhibits a peak gain of 7.99 dBi at 15.35 GHz, with a maximum reflection coefficient of -31.01 dBi at 8.43 GHz. It also operates in four bands, 6.62-7.54 GHz, 8.27-8.78 GHz, 10.98-11.78 GHz, and 13.65-15.4 GHz respectively, realizing a 92% radiation efficiency between 8.27-8.78 GHz frequency band. The antenna array was fabricated on Rogers 5880 substrate with 2.2-, and 0.766-mm thickness, displaying an S11 ≤ -10 dB over the entire operating frequency. This validates the simulated results. The antenna is compact (30.9 × 26.63 × 0.1 mm3) and suitable for 6G mobile broadband applications.

Keywords: *6G, antenna, array, microstrip patch, broadband*

A Review on IoT-Based Carbon Footprint Tracking System for Demand-side Energy Management

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ABSTRACT

The rising global concern over energy consumption and its environmental repercussions has fueled a growing demand for energy management solutions. With CO2 levels escalating and threatening to drive up average global temperatures and trigger extreme weather events such as droughts, heatwaves, and floods, the need for sustainable practices is urgent. These conditions not only endanger food security but also impact the livelihoods of millions of people. Tracking carbon footprints is crucial in pinpointing high-emission areas and implementing effective reduction strategies. Leveraging cloud-based IoT devices with real-time data visualization can enhance energy efficiency, reduce costs, and streamline energy consumption by enabling remote control, predictive maintenance, and optimized usage. This review delves into the benefits of employing an IoT-based carbon footprint tracking system for demand-side energy management, highlighting its potential to align with UN Sustainable Development Goals 12 and 13 within stipulated timelines and stressing the necessity for ongoing innovation. Carbon footprint tracking emerges as a pivotal metric in demand-side energy management, especially in urban areas where electricity consumption is significant, surpassing traditional cost-based metrics in effectiveness. Its integration has the potential to drive behavioral changes and transform electricity usage patterns across all customer segments.

Keywords: *Carbon Footprint, Energy Management, IoT*

Image Restoration: A LSHADE-GAN Approach for Yoruba Documents

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ABSTRACT

The paper introduces an innovative approach to reconstructing historical handwritten texts, specifically focusing on Yoruba documents. This method combines a generative adversarial network (GAN) with the LSHADE algorithm to create the LSHADE-GAN model. Trained on a curated dataset of five degraded Yoruba documents, this model surpasses traditional image-processing techniques and deep learning-based methods in performance. Evaluation of the LSHADE-GAN model using two samples reveals F-measures of 61.83% and 78.02%, showcasing its superiority over DE-GAN (58.24% and 75.23%) and PSO-GAN (51.67% and 66.46%) approaches. Additionally, the model demonstrates enhanced PSNR and visual quality, underscoring its effectiveness in preserving cultural heritage through accurate reconstruction of historical texts.

Keywords: *Historical document restoration, GANs, LSHADE, image processing, deep learning, Yoruba culture,cultural heritage preservation.*

Long Range Wide Area Network Based Internet of Things System for Postharvest Management of Selected Tuber Crops

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ABSTRACT

This research proposes a compact, solar-powered IoT-based cold storage monitoring and control system utilizingLong Range Wide Area Network (LoRaWAN) communication for postharvest management of tuber crops. The system incorporates a cost-effective cooling unit, designed as an alternative to expensive CoolBot systems. Temperature, gas, and humidity sensors are integrated with the Heltec ESP32 LoRa board, allowing for real-time data transmission for spoilage risk assessment using pre-defined Food and Agricultural Organization of the UnitedNations (FAO) thresholds. A user-friendly interface on the Azure Web Service (AWS) Internet of Things (IoT) platform is expected to visualize sensor data and identify potential spoilage threats. The research anticipates a reduction in post-harvest spoilage losses compared to traditional approaches, resulting in improved agricultural product quality and reduced food waste. This study showcases LoRaWAN's potential for remote monitoring andcontrol in sustainable cold storage applications.

Keywords: *LoRaWAN, IoT, Cold Storage, Real-time Monitoring, Spoilage Risk-assessment*

Enhanced Convolutional Neural Network Model Using Bidirectional Encoder Representations from Transformers and Long Short-Term Memory for Hate Speech Detection

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ABSTRACT
In the digital age, hate speech has emerged as a significant concern, amplified by the widespread use of social media for communication and social interaction. This trend has created new challenges in cybercrime, cyberbullying, privacy breaches, and threats to information security, impacting the governance and internal security of nations. Detecting and addressing hate speech on online platforms has become crucial due to the pervasive influence of social media and the internet in spreading hate and inciting hate crimes. This thesis proposes a model for more accurate hate speech detection on online platforms using Bidirectional Encoder Representations from Transformers (BERT) to enhance feature selection in Convolutional Neural Networks (CNN), along with a hybrid of CNN and Long-Short-Term Memory (LSTM). The proposed BERT-CNN-LSTM model achieved an accuracy of 96.1%, a notable improvement from the benchmark paper's 95.63%. This model offers a novel and precise tool that, when integrated into organizational and governmental security policies, can protect user rights and privacy, mitigating both physical and psychological harm resulting from online hate propagation.

Keywords: *Hate Speech, Ensemble, Machine Learning, Detection. Social Media*

An In-depth Review of Fuzzy Logic Technique for Engineering Applications

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ABSTRACT

Fuzzy logic diverges from Boolean logic by incorporating uncertain information, making it a valuable artificial intelligence tool for modeling and augmenting process control and operator expertise. Its adoption offers a competitive edge to industrial firms seeking technical and economic optimization. Notably, fuzzy logic complements rather than replaces conventional control systems. This study undertook a review of prevalent fuzzy logic systems and their applications, examining current research in industry, agriculture, and process optimization. The review encompassed twenty-five papers across four key areas: industrial applications, agronomy, crop husbandry, and process control system optimization. The findings highlight fuzzy logic's efficacy as a feedback system within control systems, recommending its use in automating and controlling systems.

Keywords: *Neural network, optimization, automation, Microcontroller, fuzzy logic*

Enhanced Fractional Frequency Reuse in 5G Network Resource Allocation: A Survey

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ABSTRACT

The deployment of 5G technology in Nigeria heralds' advancements in mobile communication, promising moderate rates of 50+ Mbps universally and ensuring high reliability. However, challenges such as interference issues persist, necessitating innovative solutions. This study explores Enhanced Fractional Frequency Reuse (EFFR) in 5G networks utilizing Machine Learning (ML) algorithms to address interference within femtocell networks. HetNets, with densely deployed femtocells, offer enhanced capacity, handoff, throughput, and spectrum utilization. Yet, the intricacies of radio resource allocation pose significant challenges, exacerbated by interference, penetration losses, and reduced capacity and throughput. Consequently, mitigating interference within femtocell networks is imperative for optimal network performance. The proposed EFFR approach, leveraging ML algorithms, aims to optimize frequency reuse, enhancing network efficiency and reliability. By surveying existing methodologies and exploring ML-driven solutions, this research contributes to the evolving landscape of 5G network optimization and interference mitigation strategies.

Keywords: *Fractional Frequency Reuse (FFR), femtocell, Heterogeneous Networks (HetNets), interference mitigation, 5G networks, Machine Learning (ML).*

DSP in Communication Engineering - A Review

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ABSTRACT
This paper provides a comprehensive review of Digital Signal Processing (DSP) in communication engineering, elucidating its fundamental principles, practical applications, and recent advancements. Beginning with an overview of DSP's distinguishing features and historical evolution, the paper delineates its pivotal role in processing real-world signals, including speech, image, and seismic data. Furthermore, the introduction of Software Defined Radio (SDR) is examined, underscoring its transformative impact on communication systems by enabling dynamic spectrum access and multi-standard operation through DSP algorithms. Additionally, the emergence of Quantum Signal Processing is explored, highlighting its significance in secure communication through Quantum Key Distribution (QKD) and Quantum Error Correction. Despite the benefits offered by DSP, challenges such as computational complexity and signal distortions are addressed, emphasizing the need for advanced techniques and algorithms to mitigate these issues. Ultimately, this paper elucidates DSP's enduring relevance and innovation in shaping the future of communication engineering.

Keywords: *Digital Signal Processing, Communication Engineering, Software Defined Radio, Quantum Signal Processing, Dynamic Spectrum Access, Signal Modulation.*

A Comparative Study of Classical Metaheuristic Optimization Algorithms for Tuning IMC and PID controllers in Solar Tracking Control System

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ABSTRACT

This research explores the optimization of Proportional Integral Derivative (PID) and Internal Model Control (IMC) controllers for sun tracking systems using various optimization algorithms. The study begins with an extensive literature review, covering optimization algorithms for control systems and solar energy optimization strategies, along with the performance of PID and IMC sun tracking controls. Identified gaps in the literature highlight the need for further research in this area. The methodology section details the mathematical modelling of the sun tracking system and the selection and implementation of optimization algorithms, including Genetic Algorithm (GA), Particle Swarm Optimization (PSO), and Simulated Annealing (SA). Simulation experiments were conducted to optimize PID and IMC controllers, and results were analysed and discussed. The study concludes by highlighting the efficacy of GA and PSO in optimizing both PID and IMC controllers, while acknowledging the challenges faced with SA. Recommendations for future research are provided to address the identified gaps and further enhance the efficiency and performance of sun tracking systems.

Keywords: *Internal Model Control (IMC), Optimization algorithms, PID controllers, Simulated Annealing (SA), Sun tracking systems.*

A User Oriented, Flexible Real-Time Motion Triggered Surveillance System for Highly Restricted Areas

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ABSTRACT
In today's contemporary society, the need for security has escalated, especially in areas marked by stringent restrictions and critical operations. The essential requirement for robust security measures stems from the potential risks associated with unauthorized access, intrusions, and illicit activities within these highly restricted zones. As insecurity remains a pressing concern in various environments, it necessitates a critical evaluation of existing security measures. The problems associated with the existing surveillance systems include inadequate coverage, delayed detection, and a high rate of false alarms, contributing to a less effective overall security apparatus. To handle the problems, a system equipped with a camera module, and seamless communication apparatus is proposed. The system also employs Telegram for real-time alerting and monitoring with visual evidence to the user, enhancing the system's effectiveness in providing timely information about security incidents. The results obtained from the system shows that the Telegram bot responses exhibited swift interaction with users' commands. Furthermore, the system's response time results consistently achieved a total response time within the acceptable threshold of 3 seconds, with an operational accuracy of 96.93%. Finally, the video compression results demonstrated the system's efficiency in compressing video clips to meet the set criterion of less than 2 seconds with a total accuracy of 94.55%. The system offered a robust, intelligent surveillance solution that is cost-effective and fast alerting operation, tailored to meet the specified security needs of the present society.

Keywords: *Surveillance System, Intruder, Motion Detection, System, Security.*

Intercell Interference Mitigation in Outdoor VLC System: A Review of Optical Non-Orthogonal Multiple Access as Promising Techniques

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ABSTRACT
Visible Light Communication (VLC) is a promising technology offering advantages such as higher bandwidth, faster transmission speeds, spectral efficiency, and enhanced security compared to Radio Frequency (RF) bands. This research focuses on addressing challenges faced by VLC systems, particularly in outdoor environments with multiple light sources and limited LED modulation bandwidth. By implementing optical non-orthogonal multiple access (O-NOMA) and Superposition Coding (SC) for power allocation, the study aims to enable simultaneous multi-user transmission in Li-Fi systems while mitigating interference. Successive Interference Cancellation (SIC) is utilized for accurate data decoding at the photodetector. Through a comprehensive review of O-NOMA VLC systems within a MIMO framework, the paper discusses power allocation algorithms, interference mitigation strategies, and evaluation parameters like Signal-to-Interference and Noise Ratio (SICIR) and Bit Error Rate (BER) critical for system performance assessment.

Keywords: *Interference, Light Fidelity, O-Noma, Superposition Coding, Successive Interference Cancellation*