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Abstract Index

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Water Quality IoT-Based Soil Condition Monitoring System for Supporting Precision and Sustainable Agriculture in West Java

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Smallholder horticultural farmers in West Java continue to face challenges related to soil moisture instability, inefficient irrigation practices, and the lack of real-time field monitoring. To address these issues, this study develops an Internet of Things (IoT)-based soil condition monitoring and automatic irrigation system designed to support precision agriculture at the farm level. The system integrates an ESP32 microcontroller with soil moisture, temperature–humidity, and ultrasonic water-level sensors. It also features a web-based dashboard and a Telegram Bot interface for real-time monitoring and remote control. The prototype was evaluated in a representative smallholder farming setup under different network conditions using mobile hotspot and Wi-Fi router connectivity. Quantitative evaluation results indicate that the system operates with high responsiveness, achieving web server loading times of 0.34–0.67 seconds, sensor update intervals of approximately 1.90 seconds, and pump activation delays as low as 0.58 seconds. The sensor performance was stable, with soil moisture fluctuations below 5% and an ultrasonic water-level measurement accuracy of ±0.2 cm. Based on the observed irrigation cycles during system operation, the proposed system indicates a potential improvement in water use efficiency under observed operating conditions compared to conventional manual irrigation practices. These findings demonstrate the feasibility of the proposed system in providing accurate soil condition monitoring, reliable automated irrigation control, and accessible remote interaction through a Telegram Bot interface. The system is presented as a low-cost and practical reference model for supporting precision and sustainable agriculture in smallholder farming environments in West Java.

Keywords: Internet of Things; soil moisture; ESP32; smart irrigation; precision agriculture.

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Numerical Performance Analysis of Novel-Generation Materials for Mach–Zehnder Interferometer Applications

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Advances in optical technology have driven the need for new-generation materials that are more efficient in Mach–Zehnder interferometer (MZI) structures, particularly for high-precision optical sensors and communication applications. This study aims to evaluate the optical performance of ten material configurations, namely As_2S_3, a-GST, BTO (TE), BTO (TM), c-Si, LNOI (TE), LNOI (TM), PMMA, Si_3N_4, and SU-8, in an MZI configuration using a numerical simulation approach based on the Beam Propagation Method (BPM), the Crank–Nicolson scheme, and the Padé approximation method. Simulations were conducted using MATLAB software to analyze the transverse Ey field, refractive index profiles, and optical transmission efficiency. The results indicate that materials such as BTO (TE/TM), LNOI (TE/TM), and As_2S_3 exhibit superior performance with Ey loss values ≤ 0.01, indicating excellent optical field confinement and high transmission efficiency. Meanwhile, polymer materials, such as PMMA and SU-8, exhibit poor performance with significant loss values, making

them unsuitable for active waveguide functions. The novelty of this study lies in the systematic comparison of ten novel-generation material configurations under a uniform MZI simulation framework, enabling the direct evaluation of material-dependent optical confinement, Ey field loss, and transmission efficiency. These findings provide practical guidance for selecting suitable materials for next-generation MZI-based optical sensors, modulators, and integrated photonic devices.

Keywords: Mach–Zehnder interferometer, beam propagation method, new-generation materials, numerical performance analysis, refractive index.

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Epilepsy Classification Using Support Vector Machine with Frequency Domain Feature Extraction

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Epilepsy is a brain-related condition characterized by abnormal electrical activity in the brain. This condition can be identified by observing EEG signals, which record the brain's electrical activity. Automatically detecting seizures using EEG signals helps doctors diagnose the condition more quickly and accurately. In this study, a method is proposed that uses a Support Vector Machine (SVM) to classify EEG signals. The features used for classification are extracted from the frequency domain using a technique called Fast Fourier Transform (FFT). The dataset used is called the UCI Epileptic Seizure Recognition Dataset, which includes 11,500 EEG samples divided into five classes. These samples are then categorized into two main types: seizures and non-seizures. The research process includes data preprocessing with MinMaxScaler normalization, feature extraction using FFT, and data classification using SVM with varying numbers of features. Model performance is measured using several metrics, including accuracy, precision, recall, F1 score, and ROC-AUC. The results showed that the use of 21 features with the SVM model provided the best performance, with an accuracy of 97.7%, a precision of 93.2%, a recall of 95.4%, an F1 score of 94.3%, and an AUC value of 0.9930. These results are better than previous studies using similar methods, indicating that the combination of FFT and SVM is effective for detecting epilepsy using EEG signals. These findings help build a more reliable system for medical diagnosis and highlight the importance of using balanced evaluation measures in healthcare.

Keywords: epilepsy, SVM, FFT, EEG, accuracy.

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Simulation-Based Design of LTE Indoor Networks in High-Density Building Scenarios

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The implementation of 5G mobile communication technology in Indonesia faces significant challenges due to limited infrastructure and coverage in several regions. Consequently 4G technology is still the favorite among the public. However, not all areas are covered by a good quality 4G long term evolution (LTE) network, especially inside buildings, because the signal from the eNodeB weakens due to the building construction. This study aims to determine the optimal antenna configuration to improve network quality inside the building, in this case in the XYZ building by implementing an indoor building solution (IBS) on the 4G LTE network using radiowave propagation simulator software. The IBS design uses two approaches, namely coverage dimensioning and capacity dimensioning. The simulation comparing the location of antenna placement in the center or edge building and the results show that placing the antenna in the center of the building is more optimal than placing it at the edge of the building. The average of received signal strength indicator (RSSI) values obtained from the ground floor to the 2nd floor are -46.67 dBm, -50.09 dBm, and -49.41 dBm, respectively. Meanwhile the average of signal to interference plus noise ratio (SINR) values obtained from each ground floor to the 2nd floor are 18.77 dB, 23.20 dB, and 27.77 dB, respectively. Both parameter values are included

with an Excellent rating based on the RKX operator's key performance indicator (KPI) standards. Hopefully that the results of this research can be used as a reference, model, and implemented in other indoor locations so that 4G network coverage in Indonesia can be further expanded, especially indoors.

Keywords: Capacity Dimensioning, Coverage Dimensioning, Indoor Building Solution, 4G LTE Network.

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Development of a Solar Autonomous Boat Navigation Guidance System for Future Swarm Unmanned-Surface-Vehicle Implementation

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Changes in the quality of the lake environment due to human activities demand efficient and sustainable monitoring solutions. This research designed a navigation guidance system for the solar autonomous boat that operates independently using solar energy and designed as a modular navigation unit to support future swarm-based cooperation between multiple vessels. The system relies on GPS ATGM336H and GY-271 digital compass sensor as positioning and direction determinants, controlled by a TTGO ESP32 LoRa microcontroller. Navigation data is processed in real-time and sent over the LoRa network to a central or intership gateway. This research focuses on the development and validation of the autonomous navigation core, providing the necessary guidance capabilities for integration into a swarm unmanned surface vehicle (USV) framework. The test results showed that the boat could follow the destination's direction with an accuracy of 92%, where most of the trajectory was within the pre-programmed directional tolerance. The average direction error was recorded at 5.4 degrees, within acceptable tolerance limits. The system can adaptively maintain a stable heading and respond to aquatic environmental conditions. By establishing this stable autonomous navigation baseline, the system provides a scalable platform for future swarm implementations aimed at improving large-scale environmental monitoring. This system is considered successful as an intelligent and sustainable autonomous navigation solution.

Keywords: solar-autonomous-boat, LoRa communication, swarm USV, environmental monitoring.

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LSTM-Based Daily Power Forecasting for a 1 MWp PV System in Tropical Indonesia: Toward Operational Optimization

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Variations in solar irradiance and module temperature significantly affect the performance and operational efficiency of large-scale photovoltaic (PV) power systems, especially in tropical regions. This study investigates the application of a Long Short-Term Memory (LSTM) network for accurate real-time power prediction in a 1 MWp PV power plant at Institut Teknologi Sumatera (ITERA), Indonesia. Unlike traditional approaches and conventional artificial neural networks (ANN), LSTM networks can effectively capture long-term temporal dependencies and highly nonlinear patterns in PV output data. A five-minute resolution dataset, including actual power output, solar irradiance, and module temperature, was collected throughout March 2025 for model training, with validation performed using independent data from April. The developed LSTM model achieved a mean absolute error (MAE) of 42.8 kW (approximately 4–6% of maximum plant capacity) and a coefficient of determination (R^2) of 0.84 during active hours (05:00–19:00) on the validation dataset. These findings indicate that the model performs well not only on the training data, but also maintains strong generalization to unfamiliar data. The proposed approach enables reliable real-time power prediction, supporting applications such as energy forecasting, inverter control, dispatch planning, and anomaly detection in PV systems. This work provides a practical and scalable solution for improving the adaptability and integration of solar power plants in dynamic tropical environments, contributing to the advancement of AI-driven sustainable energy systems.

Keywords: Photovoltaic Power Forecasting, LSTM Neural Network, Tropical Climate, Utility-Scale

PV, Real-Time Prediction, Smart Grid Integration, Data-Driven Modelling.

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Explainable IoT Intrusion Detection Using Random Forest, SMOTE, and SHAP

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Class imbalance in Internet of Things (IoT) Intrusion Detection System (IDS) datasets is a major challenge that degrades detection performance on minority attacks and complicates model interpretability. This study investigates an IoT IDS based on Random Forest (RF) combined with the Synthetic Minority Over-sampling Technique (SMOTE) and explainable Artificial Intelligence (AI) using SHapley Additive exPlanations (SHAP) on the public IoT Network Intrusion Dataset (IoTID20). The pipeline comprises data preprocessing, a stratified train-test split (7,000 training, 3,000 test samples), training an RF baseline, applying SMOTE to balance the Denial of Service (DoS), Scan, Normal, and Man-in-the-Middle Address Resolution Protocol (MITM ARP) spoofing classes, and training an RF-SMOTE model. Both models are compared using per-class and macro-averaged accuracy, precision, recall, and F1-score, followed by SHAP-based global feature importance analysis. Results show the RF baseline achieves high performance (accuracy of about 0.99, macro F1 of approximately 0.984), while RF-SMOTE maintains the same accuracy with a macro F1 of around 0.983. SMOTE improves training-set class distribution but yields only minor differences in aggregate performance: RF-SMOTE slightly enhances sensitivity for some minority classes, while F1-score for MITM ARP spoofing decreases marginally versus baseline. SHAP analysis indicates that flow-related traffic features, including connection duration, packet counts, byte volume, and packet direction ratios, dominate both models, with RF-SMOTE showing greater relative contribution from features representing rare attack patterns, making minority-class explanations more prominent. Overall, the RF-SMOTE-SHAP combination preserves strong detection performance while improving class balance and interpretability, rather than outperforming baseline RF in aggregate predictive accuracy.

Keywords: Explainable AI, Intrusion Detection System, Internet of Things, Random Forest, SMOTE, SHAP.

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Bio-Based Surface Engineering of AISI 316L for Durable Electromedical Devices

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This study investigates a bio-based pack carburizing treatment for AISI 316L austenitic stainless steel using an environmentally friendly carburizing mixture composed of 70% Alaban wood charcoal and 30% eggshell powder. The treatment was conducted to improve the surface properties of AISI 316L for potential use in non-implant metallic components of electromedical devices. Solid-state pack carburizing was performed at 600 °C, 700 °C, and 800 °C for 3 h. The treated specimens were evaluated in terms of surface carbon content, microstructural changes, diffusion layer thickness, surface hardness, and hardness distribution. The results showed that increasing carburizing temperature enhanced carbon absorption and surface modification. The highest surface carbon content of 0.80% was obtained at 800 °C. At the same temperature, the surface hardness increased to 346 HV, and the maximum diffusion layer thickness reached 16.7 μm. Microstructural observations revealed the gradual formation of a darker and more continuous carbon-enriched modified layer as the carburizing temperature increased. These improvements indicate that the treated surface became more resistant to localized deformation, repeated contact, and light friction, which are important factors for maintaining the durability and functional reliability of metallic parts in electromedical devices. These findings indicate that the Alaban wood charcoal–eggshell powder mixture can act as an effective bio-based carburizing medium for improving the surface durability of AISI

316L stainless steel. Therefore, the proposed treatment not only enhances the surface performance of AISI 316L but also offers a sustainable and low-cost surface engineering approach for non-implant electromedical components exposed to repeated handling, cleaning, and maintenance activities.

Keywords: AISI 316L stainless steel, bio-based carburizing, surface hardness, diffusion layer, sustainable surface engineering.

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