Jurnal Elektronika dan Telekomunikasi

Volume 25, Number 2, December 2025

e-ISSN: 2527-9955; p-ISSN: 1411-8289

Abstract Index

Helmy[a], Suko Tyas Pernanda[a] , Septiantar Tebe Nursaputro[a], Mona Inayah Pratiwi[b], Brian Rahmaditya[a], Clara Silvia Anggreini[a] ([a]Electrical Engineering, School of Electrical Engineering, Politeknik Negeri Semarang, Semarang, Indonesia, [b]Business Administration, Politeknik Negeri Semarang, Semarang, Indonesia)

Implementation of Internet of Things-Based Autofeeder to Maintain Koi Pond Water Quality

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 71 - 79.

Koi fish farming requires careful monitoring of water temperature and pH to prevent adverse impacts on the fish. This study presents a prototype IoT-based autofeeder that integrates real-time water quality monitoring and automatic feeding, controllable via both an Android application and local device buttons. The system allows users to configure feeding schedules, feed throw levels, and durations, as well as set pH thresholds. When the pH exceeds the safe range, the system automatically stops feeding and sends notifications, enabling the user to inspect and maintain pond water quality. The findings demonstrate that the dispensing level significantly influences the feed-throwing distance; higher dispensing levels result in longer distances. Small-sized feed (S) consistently produced the highest output, followed by medium-sized (M) and large-sized (L). Increasing the feeding duration enhanced the weight of the released feed. Additionally, the average delay in sensor data transmission to the database was recorded at 5.48 seconds. The data loss rate during the testing period was 1.72%, which is considered acceptable and does not adversely affect system operations. The data transmission system demonstrated good and stable performance with relatively low data loss.

Keywords: koi fish, autofeeder, temperature sensor, pH sensor.

Farrah Vauzia[a], Enceng Sulaeman[a], Yana Taryana[b] ([a]Electrical Engineering Department, Politeknik Negeri Bandung, Bandung, Indonesia, [b]Research Center for Telecommunications, National Research and Innovation Agency, Bandung, Indonesia)

2.4 GHz Energy Harvester for Ultra-Low Power IoT Sensor Applications

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 80 - 85.

IoT is a technology that integrates various devices and can be controlled remotely via the internet. Currently, IoT is rapidly developing in sectors such as health, agriculture, housing, and more. Sensors play an essential role in IoT devices to collect information from the surrounding environment. The sensors rely on batteries as a power source, which affects their performance. Recent technologies have developed ultra-low power sensors to extend the battery life. However, using batteries for IoT devices over a long period is not cost-effective and efficient in terms of installation. To address this issue, an Energy Harvester system has been developed. This system collects energy from the surrounding environment and converts it into electrical energy. The focus of this research is to design and implement an energy harvester powered by Radio Frequency (RF), specifically in the 2.4 GHz frequency band for ultra-low power IoT sensor applications. The RF energy harvester (RFEH) was designed and simulated using ADS 2011.11 software. The RFEH was fabricated on FR4 epoxy PCB and the measurement was conducted in two conditions: directly connected to the signal generator and in a far-field area. The harvester achieved a maximum output current of 32.6 μA under a received power of -3 dBm, satisfying the requirements for ultra-low power IoT sensors.

Keywords: Energy harvester, IoT, 2.4 GHz, RF-DC Converter, Rectenna

Doni Bowo Nugroho, Nada Nadzira Ayasha Kamal, Rosita Wati, Nova Resfita (Biomedical Engineering Study Program, Institut Teknologi Sumatera, Lampung, Indonesia)

Fabrication of Quartz Crystal Microbalance Coated with GO/PVC Nanofiber for Benzene Detectionas Tuberculosis Biomarker

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 86 - 92.

Tuberculosis (TB) is a highly contagious illness and a major contributor to global mortality, with over 1.5 million deaths reported annually. TB is caused by *Mycobacterium tuberculosis* (Mtb), which is often difficult to diagnose in the early stages of infection. Existing diagnostic methods are limited by long processing times, high costs, and suboptimal sensitivity. Therefore, this study aimed to develop a Quartz Crystal Microbalance (QCM)-based biosensor employing polyvinyl chloride (PVC) nanofibers coated with graphene oxide (GO) for rapid detection of volatile TB biomarkers, particularly benzene. The sensing platform utilized a 10 MHz AT-cut silver electrode QCM coated with electrospun PVC nanofibers, followed by GO deposition via immersion. Scanning Electron Microscopy (SEM) showed uniform nanofibers with diameters increasing from 183 ± 54 nm to 348 ± 50 nm after GO coating, while FTIR confirmed the presence of GO functional groups. Sensor evaluation revealed a clear and concentration-dependent frequency shift, with a sensitivity of 1.88 Hz·L/mg, a strong linear correlation (R^2 = 0.99) across 1.18–23.68 mg/L, and a fast response time of 71 seconds. The limits of detection and quantification were determined to be 0.88 mg/L and 2.66 mg/L, respectively. Adsorption followed the Langmuir isotherm model, indicating monolayer uptake. These results demonstrate that the GO/PVC nanofiber-coated QCM offers a promising, low-cost, and sensitive approach for TB biomarker detection in breath analysis.

Keywords: benzene, graphene oxide, polyvinyl chloride, quartz crystal microbalance, tuberculosis.

Agus Wantoro[a], Wahyu Caesarendra[b], Admi Syarif[c], Hari Soetanto[d] ([a]Department of Technology and Informatics, Universitas Aisyah Pringsewu, Pringsewu, Indonesia, [b]Department of Mechanical and Mechatronics Engineering, Malaysia Curtin University, Sarawak, Malaysia, [c]Department of Computer Sciences, Universitas Lampung, Lampung, Indonesia, [d]Department of Technology Information, Universitas Budi Luhur, Jakarta, Indonesia)

Feature Selection and Class Imbalance Machine Learning for Early Detection of Thyroid Cancer Recurrence: A Performance-Based Analysis

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 93 - 101.

Early detection of thyroid cancer recurrence is a crucial factor in patient survival and treatment effectiveness. Misdetection results in disease severity, high cost, recovery time, and decreased service quality. In addition, the main challenges in developing a Machine Learning (ML)-based detection decision support system are class imbalance in medical data and high feature dimensions that can affect model accuracy and efficiency. This study proposes a feature selection-based approach and class imbalance handling to improve the performance of early detection of Thyroid cancer. Several feature selection techniques, such as Information Gain (IG), Gain Ratio (GR), Gini Decrease (GD), and Chi-Square (CS), can select features based on weighted ranking. In addition, to overcome the imbalanced class distribution, we use the Synthetic Minority Over-Sampling Technique (SMOTE). ML classification models such as k-NN, Tree, SVM, Naive Bayes, AdaBoost, Neural Network (NN), and Logistic Regression (LR) are tested and evaluated based on a confusion matrix, including accuracy, precision, recall, time, and log loss. Experimental results show that the combination of imbalanced class handling strategies significantly improves the prediction performance of ML algorithms. In addition, we found that the combination of CS+NN feature selection techniques consistently showed optimal performance. This study emphasizes the importance of data pre-processing and proper algorithm selection in the development of a machine learning-based thyroid cancer detection system.

Keywords: Class imbalance, Feature selection, Machine Learning, Thyroid cancer.

Muthia Rahmah, Indra Maulana (Informatics and Computer Engineering Education, Institut Prima Bangsa Cideng, Cirebon, Indonesia)

Comparative Performance of Regression and Ensemble Learning Algorithms in Precision Irrigation Forecasting of Sweet Potato

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 102 - 118.

Precision irrigation is essential for sustainable agriculture under increasing water scarcity. This study compared regression and ensemble learning algorithms for forecasting irrigation requirements in sweet potato, a crop characterized by high variability in water demand. An Internet of Things (IoT)-based prototype was deployed to collect real-time data on soil moisture, temperature, humidity, light intensity, and atmospheric pressure over 42 hours and 50 minutes (August 4-5, 2025), encompassing two complete diurnal cycles at 10-minute intervals and yielding 243 temporal observations. Following preprocessing and feature engineering with lag-based temporal features, the final dataset comprised 240 samples (192 training, 48 testing) using chronological time-based splitting to prevent data leakage. Five algorithms, Support Vector Regression (SVR), AdaBoost, Extreme Gradient Boosting (XGBoost), Random Forest Regressor (RFR), and CatBoost, were evaluated under default and hyperparameter-tuned configurations using Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and Coefficient of Determination (R^2) as evaluation metrics. Tuned Random Forest achieved superior performance ($R^2 = 0.9802$, RMSE = 9.58, MAE = 6.08), followed by default Random Forest ($R^2 = 0.9786$) and default CatBoost ($R^2 = 0.9687$). XGBoost demonstrated strong performance ($R^2 = 0.9670$ tuned) but exhibited overfitting tendencies with near-perfect training scores. SVR improved substantially after tuning ($R^2 = 0.328$ to 0.797), although it remained inferior to ensemble methods. Overall, ensemble methods, particularly XGBoost and Random Forest, demonstrated superior efficacy for sweet potato irrigation forecasting. These findings underscore the potential of IoT-integrated machine learning to enhance water-use efficiency and support sustainable smart farming practices.

Keywords: ensemble learning, IoT, machine learning, precision irrigation, regression, sweet potato

Robeth Viktoria Manurung[a], Jonathan Edwards Telaumbanua[b], Richard Anthony Lim[b], Winda Astuti[b], Dedi[a], Agustina Sus Andreani[c] ([a]Research Center for Electronics, National Research and Innovation Agency, Bandung, Indonesia, [b]Automotive and Robotics Program, Computer Engineering Department, BINUS ASO School of Engineering, Bina Nusantara University, Jakarta, Indonesia, [c]Research Center for Chemistry, National Research and Innovation Agency, Banten, Indonesia)

Smartphone-Based Colorimetric Platform with RGB-CIELAB Multivariate Regression and 3D-Printed Illumination for Portable Colorimetric Detection

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 119 - 125.

Smartphone-based colorimetry has become an effective alternative to bulky, costly spectrophotometers, especially for portable and field-based analysis. This study aims to develop Colorizer, a modular smartphone-based colorimetric platform designed to deliver accurate and affordable measurements for environmental, chemical, and biomedical uses. The system integrates a custom Android app with a 3D-printed sampling station that features controlled LED lighting, RGB-to-CIELAB conversion, calibration blanking, and multivariate regression modeling to ensure consistent results across devices. Illumination is controlled by an ESP32 microcontroller and activated via Bluetooth within a light-tight chamber to minimize ambient interference. Additional validation includes measuring multiple concentrations, benchmarking against standard spectrophotometers, and calibrating across different smartphones. Results indicate that Colorizer maintains high linearity across red, yellow, and blue dyes (R^2 up to 0.9952), shows improved stability with the sampling station, and aligns well with spectrophotometric calibration curves. These findings demonstrate that the platform offers reproducible, portable performance while functioning fully offline with local calibration storage. Colorizer provides a practical, low-cost alternative to benchtop spectrophotometers for routine colorimetric analysis. The platform presents a compact, scalable framework for portable analyte detection and sets the stage for future expansion into multi-indicator sensing applications.

Keywords: Controlled Illumination, Digital Image Colorimetry, Low-Cost Diagnostics, Multivariate Regression, Point-of-Care Testing, Portable Analytical Devices, Smartphone-based Colorimetry.

Eril Mozef, Ridho Shofwan Rasyid, Enceng Sulaeman, Tiyo Rizky Mulyana, Fahrizal Al Farik, Thaskia Qolbi Junjunan (Department of Electrical Engineering, Politeknik Negeri Bandung, Bandung, Indonesia)

Phase-Sensitive Radar Using ADALM-Pluto SDR and Cantenna for Sub-Millimeter Displacement Measurement

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 126 - 140.

The capability of phase-sensitive radar to detect sub-millimeter displacement has been widely demonstrated, enabling a range of applications such as structural vibration monitoring, human vital-sign detection, gesture sensing, and precision motion tracking. In these domains, particularly in non-contact human respiratory monitoring, conventional phase-sensitive radar systems offer key advantages, including high phase stability, robust performance under non-ideal lighting or environmental conditions, and the ability to operate without physical contact. These strengths make them effective for capturing small periodic chest movements required for accurate respiratory assessment. However, conventional hardware implementations often suffer from limited flexibility, higher development cost, and increased design complexity. These constraints motivate the shift toward software-defined radio (SDR) solutions, which provide reconfigurability, simplified prototyping, and significantly lower cost while retaining the essential phase-sensitive capabilities. This motivation forms the basis of the present research. This study realizes a phase-sensitive radar using an ADALM-Pluto SDR operating at 2.45 GHz with a cantenna antenna configuration. Compared with previous SDR-based works that focus primarily on Doppler vital-sign extraction or require more elaborate RF front-ends, the proposed system emphasizes displacement-resolution enhancement through careful phase processing while maintaining minimal hardware complexity. The combination of a compact SDR platform, simple antenna structure, and optimized signal processing pipeline yields a practical and accessible radar prototype. Experimental results demonstrate that the proposed system achieves a displacement resolution of 0.5 mm, meeting the requirements for developing a reliable respiratory-monitoring application and confirming the suitability of SDR-based phase-sensitive radar for low-cost biomedical sensing.

Keywords: phase-sensitive radar, software-defined radio, sub-millimeter-displacement measurement, cantenna directional antenna, non-contact human respiratory monitoring.

Bayu Wira Yudha, Hasballah Zakaria (School of Electrical Engineering and Informatics, Institut Teknologi Bandung, Bandung, Indonesia)

Comparative Analysis and Mitigation of Extremely Low Frequency (ELF) Magnetic Field Exposure from Smartphone Internal

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 141 - 147.

While public concern regarding smartphone electromagnetic field (EMF) exposure is largely focused on radio frequency (RF) emissions, this study investigates the overlooked extremely low frequency (ELF) magnetic fields originating from internal hardware circuits, such as the Power Management Integrated Circuit (PMIC). This research employs a quantitative experimental methodology to characterize and compare the near-field emissions of two smartphone models with distinct internal architectures: the Xiaomi Redmi Note 8 Pro (12nm mid-range chipset) and the Samsung Galaxy S23 (4nm premium chipset). Magnetic field intensity measurements were conducted using a Hall-effect Gaussmeter, both in free space and with a 3D-printed cubic head phantom fabricated from PETG and filled with a conductive saline-based tissue-simulating liquid (TSL). The primary findings reveal unique ELF emission "fingerprints," where the premium-engineered device exhibits a peak exposure of 0.269 mT—nearly three times lower than its mid-range counterpart at 0.799 mT. Theoretical analysis utilizing the Biot-Savart Law attributes this reduction to the minimized current loop areas inherent in advanced 4nm process nodes compared to older 12nm architectures. Quantitative analysis of mitigation strategies demonstrates that spatial separation (a 15 cm distance) is the most dominant factor, achieving up to 90.7% attenuation, which surpasses the material shielding provided by the phantom (82.0%). Although peak contact exposure can exceed the ICNIRP reference level, the rapid near-field decay ensures compliance at minimal practical distances. This study concludes that ELF exposure is a function of engineering quality rather than network technology, and mitigation is most effectively achieved through physical distance.

Keywords: electromagnetic fields (EMF), extremely low frequency (ELF), exposure mitigation, 3D printed phantom, smartphone design, electromagnetic compatibility (EMC).

Mochamad Yunus[a], Yamato[a], Bloko Budi Rijadi[a], Waryani[a], Muhammad Farhan Maulana[b], Teguh Firmansyah[c], Achmad Munir[d] ([a]Department of Electrical Engineering, Faculty of Engineering, University of Pakuan, Bogor, Indonesia, [b]Telecommunication Engineering, School of Electrical Engineering, Telkom University, Jakarta, Indonesia, [c]Department of Electrical Engineering, Faculty of Engineering, Sultan Ageng Tirtayasa University, Banten, Indonesia, [d]Radio Telecommunication and Microwave Laboratory, School of Electrical Engineering and Informatics, Institut Teknologi Bandung, Bandung, Indonesia)

Dual-Function Aperture-Coupled Spiral Resonator Antenna with Integrated Impedance Matching Network for Enhanced Radiation Performance

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 148 - 161.

This paper proposes the design and implementation of a dual-function aperture-coupled spiral resonator (SR) antenna integrated with a compact impedance matching network (IMN) to achieve enhanced radiation performance and miniaturization. The antenna uses a two-layer FR4 substrate, where the SR is printed on the top layer as the radiating element and excited through a slotted aperture on the ground plane. To maximize power transfer, the IMN, consisting of an inter-digital capacitor (IDC) and a meandered inductor (MI), is embedded into the feed line on the bottom substrate. A comparative study between the conventional SR antenna and the proposed dual-function SR with IMN was conducted. Electromagnetic simulations and experimental measurements demonstrate that the integrated IMN improves the reflection coefficient (S_{11}) by 43.64%, increases radiation efficiency from ~72% to ~87%, and enhances gain from ~3.2 dBi to ~4.8 dBi, while maintaining a compact footprint. The aperture-coupled feeding also contributes to bandwidth enhancement and isolation between the feed and radiating element. This dual-function design effectively resolves the trade-off between miniaturization and radiation performance, demonstrating its applicability for IoT, 5G, and wearable wireless devices.

Keywords: Aperture-coupled feeding, dual-function antenna, impedance matching network, radiation enhancement, and spiral resonator.

Tole Sutikno[a,b], Tri Wahono[a,b], Ahmad Raditya Cahya Baswara[a] ([a]Faculty of Industrial Technology, Ahmad Dahlan University, Yogyakarta, Indonesia, [b]Embedded System and Power Electronics Research Group, Yogyakarta, Indonesia)

PID Controller-Based Closed-Loop Fast Charging of Lithium-Ion Batteries Using the CCCV Method

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 162 - 169.

This paper presents a closed-loop fast charging system for lithium-ion batteries based on the Constant-Current Constant-Voltage (CCCV) method enhanced with a Proportional Integral Derivative (PID) controller. The proposed system dynamically regulates the charging parameters by using real-time feedback from voltage and current sensors, with the aim of improving the efficiency of the charging and ensuring battery safety. Experimental results demonstrate that the PID-controlled method maintains a higher current during the initial bulk charging phase, significantly reduces total charging time, and avoids harmful voltage overshoot. Compared to conventional CCCV charging, the system achieves more stable voltage regulation and gradual current tapering, effectively minimizing thermal stress and preventing overcharging. A comparative analysis shows that the PID approach outperforms traditional methods in terms of energy efficiency, thermal management, and operational safety. The system architecture is suitable for integration into Battery Management Systems (BMS) of electric vehicles, portable electronics, and renewable energy storage. This research not only validates the practicality of using PID in fast charging applications but also lays the foundation for future enhancements using intelligent control strategies and adaptive learning algorithms. The findings suggest that PID-controlled charging systems offer a promising solution to the challenges of rapid, reliable, and safe energy replenishment in modern battery-powered technologies.

Keywords: fast charging, lithium-ion battery, PID controller, CCCV method, closed-loop control, battery management system.

Rusfa[a], Rozeff Pramana[a], Bavitra[a], Ferly Oktavia[b], M. Hasbi Sidqi Alajuri[a], Andreas M Simannulang[a] ([a]Department of Electrical Engineering and Informatics, Faculty of Maritime Engineering and Technology, Universitas Maritim Raja Ali Haji, Tanjungpinang, Indonesia, [b]Department of Civil Engineering And Planning, Faculty of Maritime

Engineering and Technology, Universitas Maritim Raja Ali Haji, Tanjungpinang, Indonesia)

Design, Fabrication, and Experimental Evaluation of a 435 MHz Helical Antenna for 433 MHz IoT Modules

Jurnal Elektronika dan Telekomunikasi, December 2025, e-ISSN: 2527-9955, p-ISSN: 1411-8289, Vol. 25, No. 2 pp. 170 - 180.

The rapid growth of wireless communication demands within Internet of Things (IoT) applications requires antennas that exhibit high efficiency, compact dimensions, and reliable performance in the UHF band. This study aims to design, simulate, fabricate, and evaluate the performance of a helical antenna operating at 435 MHz, with its results compared against a slot antenna. The design process was conducted using CST Studio Suite with parameter optimization to achieve an optimal configuration. The prototype was fabricated using copper wire as the radiating element and an aluminum ground plane. Experimental testing was carried out with a UHF Antenna Demonstrator, followed by validation through a 433 MHz RF module integrated with Arduino. The simulation results indicated that the optimized helical antenna achieved a Voltage Standing Wave Ratio (VSWR) of 1.8 and a gain of 11.5 dBi. In contrast, the measurement results demonstrated improved performance, with a VSWR of 1.05, a return loss of −32.4 dB, and a bandwidth of 41 MHz. Comparative analysis revealed that the helical antenna outperformed the slot antenna in terms of efficiency, directional radiation pattern, and transmission distance, reaching up to 25 m compared to 15 m for the slot antenna. These findings confirm that the helical antenna is a more suitable and effective solution for UHF IoT communication systems, providing reliable performance for modern wireless applications.

Keywords: Helical Antenna, Slot Antenna, UHF, VSWR, Reflection Loss, IoT

Jurnal Elektronika dan Telekomunikasi

Volume 25, Number 2, December 2025

e-ISSN: 2527-9955; p-ISSN: 1411-8289

Author Index