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SUSTAINABLE ENERGY ECOSYSTEMS INTERNATIONAL CONFERENCE 2026

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Intelligent Control for Sustainable Systems

Enabling Smart Sustainable Energy: Advances in IoT-Driven Real-Time Monitoring for Stand-Alone Solar Charge Controller Systems

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As more devices and applications depend on the support of battery energy storage and renewable energy generation systems, the need to explore more possible ways to enhance the current implementation is very critical, where energy sustainability is important. Requiring these systems to be operational and running continuously and safely, incorporating multiple subsystems that support the requirement for improved functionality, can help meet these demands. Internet of Things (IoT) technology has been a significant innovation that has improved the performance and increased the efficiency of existing renewable energy systems. It has simplified management and control for remote, mobile, and inaccessible renewable energy system installations. With this technology, energy production has been maximized, the maintenance strategy has been made efficient, and troubleshooting methods are simplified with easier and more accurate system monitoring. However, only a few studies have been found that support the integration of IoT into stand-alone, small-scale solar charge controller systems, since most IoT-based monitoring systems are utilized in large-scale deployments. This study is intended to determine the contextual and methodological gap that exists in the current implementation of solar photovoltaic and battery storage systems with IoT integration. The findings indicate that incorporating IoT technologies into energy-generation systems substantially enhances their management, administration, and troubleshooting strategies. Incorporating IoT into small-scale applications and systems, specifically into stand-alone solar charge controller systems, allows system administrators to manage them more efficiently and perform predictive maintenance. This integration into existing small-scale installations supports informed operational decisions, resulting in the strengthening of energy sustainability and reduction of operational and maintenance costs. Collectively, these findings demonstrate that IoT-based monitoring systems are essential for maximizing performance, reliability, and the long-term viability of stand-alone solar charge controller systems. Integrating IoT into energy generation systems is helping renewable energy move toward a more resilient and sustainable future.

Keywords: stand-alone solar charge controller, IoT monitoring, data acquisition, sensor technologies, renewable energy, small-scale solar charge controller

Experimental Investigation of Air as an Alternative Working Fluid in a Hydraulic Ram Pump System

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The research focuses on assessing the usability of air as an alternate working fluid in the modification of a hydraulic ram pump system, with a focus on the potential use of air energy as a clean and sustainable form of energy. A major goal was to evaluate whether air could create cyclically operated valves using conventional hydraulic ram components and to determine if air could be compressed into usable pressure within the hydraulic chamber.

The experiment utilized 1-inch diameter swing check valves for both the waste and delivery valves, identical in style, size, and material, along with 2-inch diameter drive pipes and connectors. Airflow was supplied by a 12-volt direct current (DC) fan with an estimated volumetric flow rate of approximately 45 cubic feet per minute (CFM). Valve inclination was adjusted to determine the optimal actuation point. Stable cyclic operation occurred when the waste valve was inclined approximately 30 degrees from the vertical (60 degrees from the horizontal), producing an average open-and-close interval of 0.7 seconds. At 90 degrees, the valve felt open and failed to sustain cyclic operation, while at 0 degrees, the valve remained closed, preventing system cycling.

Although air does not generate the conventional water hammer effect due to its compressible nature, the system demonstrated repetitive valve motion and measurable pressure fluctuations within the chamber. The results confirm that air can produce cyclic motion in a conventional hydraulic ram configuration, although pressure amplification remains lower than in water-driven systems. Further study is recommended to quantify achievable pressure levels and improve system performance.

Keywords: Hydraulic ram pump, air working fluid, cyclic valve operation, waste valve, pneumatic ram pump

Design and Development of a Low-Cost Power Harmonics Monitoring Device for LED Lighting Systems: An Experimental Case Study

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Light-emitting diode, also known as an LED, is a modern lighting technology that consumes 70% to 85% less energy than other lighting technologies. However, an LED is a nonlinear load that generates harmonic distortion, thereby distorting the sinusoidal waveforms. A larger number of LED installations in buildings may lead to severe power quality issues, and there is a lack of research on LED harmonic monitoring and laboratory testing, with underdeveloped innovation in practical power harmonic monitoring of LED lamps. To monitor the harmonic level in the system, the study aimed to design and develop a low-cost power-harmonic monitoring device for LED systems. The comparison of the Fluke 1736 power logger with a prototype using a low-cost ESP32 microcontroller with current and voltage sensors involved an experimental setup comprising a single LED and 18 LED tubes operated in a low-voltage (LV) single-phase 60Hz network. The Total Harmonic Distortion (THD) measurement method was applied, and the harmonic results were validated against specific IEC standards. It was observed that at a supply voltage of 236.3V, a single FSL T8 18W LED had a current of 0.14A, a power factor of 0.51, 94.7% total current harmonic distortion (THDi), and 1.5% total voltage harmonic distortion (THDv). For the 18 LED tubes orientation, it produced 2.2A, with 0.56 pf, 133.8% THDi, and 1.7% THDv. The absolute error of the prototype is ±0.5V and ±0.02A, with THDi and THDv at ±1.35% and ±0.04%, respectively, which are within acceptable error limits of the IEC standards for low-cost instrumentation Class II and S. The findings showed that the FSL T8 18W LED has a poor power factor with a high THD content. The current harmonic distortion is directly related to the number of LED installations. The study revealed that it is essential to monitor power harmonics in modern lighting technology, and this can be achieved with a low-cost power-harmonic monitoring device.

Keywords: IEC 61000-4-30, IEC 61000-4-7, IEC 61000-3-2, light-emitting diode, power quality, power harmonic monitoring, THD measurement method, Low-Cost Device

From Policy Intent to Adoption Outcomes: A Systematic Review of Electric Vehicle Policy Effectiveness in the Philippines

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Previous studies have identified the key factors that motivate or hinder the use of EVs; this study evaluates whether the current policies implemented by the Philippine Government address the problems associated with the adoption of EVs. The study was conducted using PRISMA guidelines using all English publications indexed in Scopus from 2012-2025. Articles were then screened and coded thematically into 4 relevant themes. The 4 themes are: (1) Policy Design and Implementation, (2) Economic Viability and Incentives, (3) Infrastructure Readiness, and (4) Stakeholder Acceptance and Behavior. Results from the review showed that the Philippines has existing programs like the Electric Vehicle Industry Development Act and Public Utility Vehicle Modernization Program. Effectiveness of these programs is undermined by inconsistent enforcement, poor inter-agency coordination, and insufficient alignment with Local Government Units (LGUs). Public transport operators are unenthusiastic about EVs because of large initial investments with slow payback and limited funding programs, so many operators delay purchases. The distribution of EV chargers is concentrated in big cities. During this transition phase, drivers, mechanics, and operators worry about losing jobs, operational concerns, plus inadequate government communication. Fast-tracking EV adoption in the Philippines requires coordinated policies that will make EVs more affordable, build charging stations and repair shops nationwide, improve government communication, and clean up the power sector.

Keywords: Electric vehicle adoption, Electric vehicle policy, Policy effectiveness, public transport electrification, Southeast Asia, Philippines, Systematic review (PRISMA)

Advances in Renewable Energy

Integration of Artificial Intelligence and Solar Hydroponics: A System Dynamics Evaluation in a Local Context

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This research explores the potential of integrating Artificial Intelligence (AI) with solar-powered hydroponics to redefine agricultural sustainability within Philippine barangays. By developing and validating a robust system dynamics model, this study evaluates multi-dimensional impacts across social, environmental, economic, and energy sectors. While the current trajectory suggests a peak sustainability score of 9.56 by 2035, the findings reveal that a 75% AI integration accelerates this progress, reaching a peak as early as 2032. The data further underscores the necessity of a holistic approach: while social initiatives alone elevated social sustainability scores (from 6.02–8.52 to 6.94–9.44), the most profound impact emerged from a hybrid strategy. By combining AI-driven optimization with social interventions, the system achieved a superior agricultural sustainability outcome of 6.48–9.82 by 2032. Ultimately, this study demonstrates that innovation towards a smart and green society requires more than just technical automation; it demands the synergy of smart technology and inclusive community engagement. These results provide a scalable roadmap for transforming rural farming systems and advancing the UN Sustainable Development Goals for a more resilient future.

Keywords — Artificial Intelligence, Solar-Powered Hydroponics, Agricultural Sustainability, System Dynamics Modeling, Community Engagement

Hydrodynamic Load Modeling and Motion Control Strategies for Floating Photovoltaic Systems: A Comprehensive Review

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Floating photovoltaic (FPV) systems are becoming a key renewable energy option by enabling solar deployment on water with minimal land use. As FPV expands into coastal and offshore settings, understanding hydrodynamic loads and platform motions is critical for resilience, efficiency, and long-term sustainability. This review synthesizes recent numerical, experimental, and hybrid approaches for modeling FPV responses to waves and wind. CFD and potential flow methods remain core tools for load and motion prediction, while mesh-free smoothed particle hydrodynamics better captures large deformations and complex interactions in modular, multi-connected arrays. Studies on nonlinear catenary and composite mooring systems emphasize robust station keeping under dynamic sea states, while durability challenges such as corrosion, biofouling, and fatigue continue to limit lifecycle performance. Emerging data-driven models enable real-time response prediction and support intelligent monitoring and control. Experimental work on multi-body behavior and connector flexibility further shows that survivability and energy yield stability depend strongly on motion control and connection design. Overall, the literature highlights a need for unified offshore FPV design requirements and integrated fluid structure mooring interaction frameworks to support safe, scalable deployment in a smart and green energy future.

Keywords – photovoltaic, solar, renewable energy, hydrodynamic load

Integration of an H-Type Darrieus Wind Turbine with Magnus Wind Turbine for Alternative Electric Power Generation

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Advancements toward a smart and green society require innovative renewable energy solutions that can adapt to low-wind urban environments. H-type Darrieus wind turbine is one of the most efficient vertical axis wind turbines, however it has a poor self-starting capability that limits its efficiency. To fill this gap, this study proposes a hybrid system integrating an improved Magnus rotor with additional micro-propellers to the H-Darrieus turbine to improve the start-up performance and use as an alternative power generation. Simulation through SolidWorks and experimental validation under actual conditions were conducted in this study. The integrated system achieved a cut-in speed of approximately 2.525 m/s and generated a cumulative 8.83 W during continuous operation. Compared with a standalone Darrieus turbine, this integration of two turbines has demonstrated enhanced self-starting behavior and improved performance, highlighting its potential as an alternative electric power generation.

Keywords: wind turbine, magnus, darrieus, energy, power generation

Physical Characterization of Distillate Oil Produced from Waste Lubricant Oil Using Small-Scale Fabricated Reactor Equipment

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The increasing number of automobiles in urban areas has resulted in the continuous generation of waste lubricant oil (WLO), a hazardous waste stream containing contaminants such as sediments, wear metals from engine components, polycyclic aromatic hydrocarbons (PAHs), and chemical additives, including chlorine-based paraffins. Improper disposal of WLO poses significant environmental and public health risks, as these pollutants can enter air, soil, and water systems, potentially causing respiratory illnesses, toxic exposure, and carcinogenic effects in humans and aquatic organisms. Consequently, the development of sustainable treatment and resource recovery methods for WLO has become increasingly important.

This study investigates the recovery of hydrocarbon fractions from WLO through a controlled pyrolysis process. Distillate and residue oils produced from pyrolysis were subjected to laboratory characterization at the Department of Science and Technology – Industrial Technology Development Institute (DOST-ITDI), Standards and Testing Division, Taguig City, Philippines. Key physical properties evaluated include flash point, kinematic viscosity, viscosity index, density, specific gravity, and API gravity (°API). Standard analytical procedures based on the American Society for Testing and Materials (ASTM) were applied, including ASTM D92, ASTM D445, ASTM D2270, and ASTM D1298, while density and API gravity were calculated using standard theoretical relationships.

Results indicate that pyrolysis significantly alters the physicochemical characteristics of WLO. The produced distillate and residue oils exhibit distinct variations in flash point, viscosity behavior, API gravity, and specific gravity compared with the original waste lubricant oil and fresh lubricating oil. These findings demonstrate the potential of pyrolysis as a viable approach for valorizing waste lubricant oil into hydrocarbon fractions with properties suitable for further energy or industrial applications.

Keywords: Waste Lubricant Oil (WLO), Distillate oil, Residue, Characterization, Pyrolysis

Sustainable Environmental Resource Systems

Simulating the Water Distribution System of Barangay Lawaan, Alcantara, Cebu: A System Dynamics Modelling Approach

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Water distribution in rural communities often faces significant challenges, particularly in areas where infrastructure and management systems struggle to keep pace with growing demand. Barangay Lawaan in Alcantara, Cebu, serves as a compelling case study of these issues, with only 58% of its households currently enjoying reliable water access despite the presence of abundant local water resources. This research investigates the underlying causes of Lawaan's water distribution problems, focusing on four critical factors: tank capacity, household growth, commercial growth, and price elasticity of demand. The study utilizes system dynamics modeling to analyze current consumption and supply patterns, project future trends, and evaluate the potential impact of various policy interventions.

The findings reveal a persistent and widening gap between water supply and demand. Consumption data—collected from households, commercial establishments, and public institutions—demonstrate a steady upward trend, driven primarily by a 5% annual increase in households and a 2% growth rate in commercial activity. In contrast, the barangay's water supply remains static, anchored by a single tank with a capacity of 2,000 cubic meters per month. This imbalance has led to frequent shortages, forcing many residents to seek alternative, often more expensive, sources of water. The system dynamics model projects that, without intervention, water stock will decline precipitously, falling from 2,000 units in 2025 to below 200 units by 2030. This trajectory signals an imminent crisis, with the risk of severe shortages and heightened social and economic consequences for the community.

To address these challenges, the study proposes a two-pronged approach. First, it recommends expanding the barangay's tank capacity by 50% in the short term and up to 150% in the long term, to accommodate projected increases in household and commercial demand. This infrastructure investment is essential to stabilize the supply and ensure that all residents and institutions have adequate access to water. Second, the research highlights the importance of demand management through the application of price elasticity of demand (PED). By monitoring consumption trends and adjusting water prices accordingly, local officials can incentivize more efficient water use and help balance supply with demand. For example, the model demonstrates that a price increase from Php

50 to Php 60 per unit can reduce demand by approximately 10%, illustrating the effectiveness of PED as a policy tool.

The study concludes that sustainable water distribution in Barangay Lawaan is achievable through a combination of infrastructure expansion and demand-side management. By addressing tank capacity limitations and leveraging price elasticity to influence consumption behavior, local policymakers can create a more resilient and equitable water system. These findings offer valuable insights for other rural communities facing similar challenges, underscoring the need for proactive planning, investment, and adaptive management strategies to ensure long-term water security and community well-being.

Keywords: Waste Lubricant Oil (WLO), Distillate oil, Residue, Characterization, Pyrolysis

Mechanistic Insights into the Simultaneous Biosorption and Bioprecipitation of Copper, Nickel, and Chromium in an Alkaline Rotating Biological Contactor (RBC-PMT)

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The removal of heavy metals from wastewater is critically dependent on pH-regulated chemical and biological mechanisms, specifically hydroxide precipitation and biosorption. In aqueous systems, metal solubility typically follows a "U-shaped" profile, where metals remain dissolved as mobile ions under acidic conditions (pH < 6) but precipitate as solid hydroxides when the solubility product (Ksp) is exceeded at higher pH levels. This study evaluates the efficacy of the Rotating Biological Contactor-Packed Media Technology (RBC-PMT)—utilizing specialized Amazon mesh screens—in treating wastewater contaminated with copper (Cu (II)), nickel (Ni (II)), and chromium (Cr (III)).

The RBC-PMT facilitates metal removal through two primary pathways: bioprecipitation and biosorption. During operation, microbial proliferation within the biofilm—specifically denitrification processes—results in alkalinity recovery, naturally elevating the system's pH from a neutral range (7.3–7.8) to an alkaline state (8.9–9.1). In this alkaline environment, the concentration of hydroxide ions (OH^-) increases, driving the formation of insoluble metal hydroxides, such as $Cu(OH)_2$ and $Ni(OH)_2$. Simultaneously, the biofilm's Extracellular Polymeric Substances (EPS) facilitate biosorption. Negatively charged functional groups within the EPS matrix, including carboxylic, sulfonic, and hydroxyl groups, serve as active binding sites for cationic metal ions through electrostatic attraction and ion exchange.

Experimental results demonstrate high removal efficiencies for the RBC-PMT. At influent concentrations of 50 mg/L and 100 mg/L, the system achieved average removal rates of 92.92%–93.97% for copper and 80.37%–80.41% for nickel. In another batch set-up, the majority of the Cr (III) metal removed was present in the sloughed biomass for Run 1, suggesting precipitation to be the primary bioremediation mechanism. For Run 2, most of the Cr (III) was present in the biofilm, suggesting that biosorption was the main mechanism for metal removal. The stability of these removal rates despite increased metal loading suggests that bioprecipitation is the dominant mechanism in the alkaline RBC environment, as the pH values attained align with the minimum solubility ranges for these specific metal hydroxides. While biosorption remains a significant secondary contributor, as evidenced by the intensification of metal-colored pigments in the biofilm,

the microbially induced pH increase remains the primary driver for effective metal immobilization. These findings highlight the RBC-PMT as a robust and economically viable biotechnology for the secondary treatment of industrial effluents.

Keywords: Rotating Biological Contactor (RBC-PMT), pH-dependent solubility, Bioprecipitation, Biosorption, Extracellular Polymeric Substances (EPS), Heavy Metal Removal.

Water Supply Adequacy of Casay Rural Waterworks and Sanitation Association, Inc. (CARWASAI): System Dynamics Modeling Approach

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Water is among the most vital natural resources that a nation must consistently protect, conserve, and manage sustainably. It is essential to all forms of life, and any significant shortage can result in a decline in the quality of life and substantial economic losses. Effective water resource management helps overcome this challenge. This study made use of System Dynamic Modeling (SDM) to examine factors such as water demand, water supply, distribution leaks, and water price, to provide a comprehensive understanding of the existing water supply system. Several scenarios were evaluated, including water price increase, conservation campaigns, and reduction of non-revenue water (NRW). Results show that over time, the groundwater supply will no longer be sufficient to meet the demand and that exploration of alternative water resources is recommended. Water conservation campaigns, price increase, and NRW reduction will be able to help delay the depletion of the groundwater supply.

Keywords: Water resource management, groundwater conservation, system dynamics modeling

Why Urban Retention Ponds Underperform: A System-Level Diagnostic Framework of Urban Retention Pond

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Urban water retention ponds are implemented as stormwater management infrastructure intended to attenuate runoff and mitigate urban flooding. However, empirical evidence shows that many retention ponds fail to deliver their intended flood mitigation performance over time. Existing research has largely approached this problem through hydrologic and hydraulic design improvements, implicitly treating retention ponds as static infrastructure whose effectiveness depends primarily on physical capacity and outlet configuration. This study argues that persistent underperformance arises not primarily from hydraulic limitations but from systemic decision and management failures. Using a system engineering perspective, this research conceptualizes retention ponds as managed socio-technical systems composed of interacting physical, operational, informational, and institutional subsystems. A structured document analysis of literature on retention pond performance, operation, and governance was conducted, followed by system boundary definition, subsystem decomposition, and a qualitative decision gap analysis inspired by Failure Modes and Effects Analysis (FMEA). The analysis identifies four dominant system-level failure modes: loss of effective storage capacity, inflexible release behavior, absence of monitoring and feedback mechanisms, and fragmented institutional responsibility.

Furthermore, an interaction analysis was conducted and showed that these failure modes reinforce one another, producing compounded performance degradation over time. The results further reveal structural decision gaps in existing evaluation and management practices, specifically the absence of decision triggers for storage reassessment, real-time operational rules, monitoring protocols, and clearly defined performance ownership. By reframing retention pond underperformance as a systems and decision-making problem, this study provides a conceptual diagnostic framework that links system behavior to actionable management decisions. The framework establishes a foundation for future evaluation, retrofit prioritization, and optimization studies aimed at improving the real-world flood mitigation performance of urban retention ponds.

Keywords: urban retention ponds, stormwater management, systems engineering, failure mode analysis, flood mitigation infrastructure

Smart and Energy Efficient Systems

Voltage Sag Phenomena: A Comprehensive Review of Classification Techniques and Mitigation Strategies

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With major technical and financial ramifications for the commercial, residential, and industrial sectors, voltage sags continue to be one of the most common and disruptive power quality phenomena affecting contemporary power systems. This review offers a thorough synthesis of the definitions, traits, causes, and effects of voltage sag phenomena. It highlights the relative accuracy, robustness, and computational efficiency of various classification techniques by methodically classifying them, ranging from conventional rule-based methods to sophisticated data-driven and hybrid machine-learning approaches. Additionally, the review offers a thorough examination of mitigation techniques covering both device-based and system-based solutions, including cutting-edge technologies like modular multilevel converters, AI-enabled smart inverters, and wide-area monitoring systems. The necessity of standardized datasets, real-time classification and control integration, cybersecurity resilience, AI explainability within future smart grid environments, and other critical research challenges are highlighted. This work aims to serve as a reference for researchers and practitioners seeking to advance voltage sag classification and mitigation, fostering the development of more resilient and adaptive power delivery systems.

Keywords: Voltage sags, power quality, classification techniques, mitigation strategies, machine learning, artificial intelligence

Volatile Matter Dynamics and Drying Characteristics of Mahogany Leaves for Energy-Efficient Biochar Production

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Mahogany leaves represent an abundant form of green waste with overlooked potential for sustainable energy applications, despite proximate analysis being widely recognized as a foundation for biomass combustion and fuel characterization. This underutilization reflects a broader gap in biomass research, where leafy residues remain less studied compared to woody or agricultural counterparts, leaving uncertainties in their thermal behavior and suitability for energy-efficient biochar systems. Addressing this gap, the present study investigates the volatile matter dynamics and drying characteristics of mahogany leaves to evaluate their performance as a biochar feedstock. Proximate analysis—a method that quantifies moisture, volatile matter, fixed carbon, and ash contents essential for assessing energy potential—was performed alongside drying-curve profiling to characterize mass-loss behavior during heating. Experimental results show Moisture (10.39%), Volatile Matter (46.68%), Fixed Carbon (33.51%), and Ash (9.37%), parameters known to influence calorific performance, fuel rank, and devolatilization patterns. The drying curve exhibited an initial rapid moisture-release phase followed by a steadier volatilization stage, consistent with mass-loss patterns reported in biomass thermochemical conversion studies. The observed volatile-matter fraction and fixed-carbon content indicate that mahogany leaves possess reactive components conducive to efficient char formation, while moisture and ash levels define constraints for energy yield and combustion quality. These findings demonstrate that mahogany leaves can serve as a viable feedstock for localized biochar production, aligning with sustainable energy and green-waste valorization initiatives. By demonstrating how proximate parameters and drying behavior shape biochar feasibility, this research directly supports sustainable waste-to-energy and green-technology initiatives.

Keywords: mahogany leaves, biochar, thermochemical conversion, proximate analysis

Design, Fabrication, and Testing of a Fouling Deposition Rate System of a Window-Type Air-Conditioner Using Load Cell Analysis

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Mahogany leaves represent an abundant form of green waste with overlooked potential for sustainable energy applications, despite proximate analysis being widely recognized as a foundation for biomass combustion and fuel characterization. This underutilization reflects a broader gap in biomass research, where leafy residues remain less studied compared to woody or agricultural counterparts, leaving uncertainties in their thermal behavior and suitability for energy-efficient biochar systems. Addressing this gap, the present study investigates the volatile matter dynamics and drying characteristics of mahogany leaves to evaluate their performance as a biochar feedstock. Proximate analysis—a method that quantifies moisture, volatile matter, fixed carbon, and ash contents essential for assessing energy potential—was performed alongside drying-curve profiling to characterize mass-loss behavior during heating. Experimental results show Moisture (10.39%), Volatile Matter (46.68%), Fixed Carbon (33.51%), and Ash (9.37%), parameters known to influence calorific performance, fuel rank, and devolatilization patterns. The drying curve exhibited an initial rapid moisture-release phase followed by a steadier volatilization stage, consistent with mass-loss patterns reported in biomass thermochemical conversion studies. The observed volatile-matter fraction and fixed-carbon content indicate that mahogany leaves possess reactive components conducive to efficient char formation, while moisture and ash levels define constraints for energy yield and combustion quality. These findings demonstrate that mahogany leaves can serve as a viable feedstock for localized biochar production, aligning with sustainable energy and green-waste valorization initiatives. By demonstrating how proximate parameters and drying behavior shape biochar feasibility, this research directly supports sustainable waste-to-energy and green-technology initiatives.

Keywords: fouling, coefficient of performance, load cell, air conditioning unit

Machine Learning Path Loss Model of 5G Macrocell Base Stations in a Selected Area of Cebu City

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Accurate path loss modeling is crucial for planning and optimizing fifth-generation (5G) cellular networks, especially in dense urban environments where complex propagation mechanisms prevail. This study investigates large-scale path loss characteristics along Colon Street, Cebu City, through an extensive measurement campaign of drive and walk tests using G-Nettrack Pro. Key parameters measured include Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ), Signal-to-Interference-plus-Noise Ratio (SINR), and associated geospatial information.

Measured path loss values were evaluated against widely used path loss models, including the 3GPP TR 38.901 Urban Macrocell (UMa) model, the NYU Close-In (CI) model, and the Walfisch-Ikegami model. Predictive performance was assessed using Root Mean Square Error (RMSE) and Mean Absolute Error (MAE). Results indicate that conventional empirical models exhibit limited accuracy in the studied environment, with the Walfisch-Ikegami model showing the poorest performance due to violations of its underlying assumptions. While the 3GPP and NYU models produce comparable predictions, they fail to capture localized propagation effects observed in the dense urban canyon setting.

To address these limitations, a localized machine-learning-based path loss model was developed using Random Forest regression. The model incorporates signal-based, spatial, and environmental features derived from geospatial processing, RF planning tools, and measurement applications to characterize the surrounding propagation environment.

The proposed model demonstrates significantly improved prediction accuracy, achieving lower RMSE and MAE compared to all evaluated empirical models. These findings highlight the effectiveness of data-driven approaches in capturing site-specific propagation behavior and provide valuable insights for planning 5G microcell networks in dense urban environments.

Keywords: fouling, coefficient of performance, load cell, air conditioning unit

Robotics Technology in Biomedical Devices

Reduction of Functional Electrical Stimulation-Induced Discomfort by Evaluating Envelope Signal Parameters

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Functional electrical stimulation (FES) is widely used in post-stroke rehabilitation but is often limited by stimulation-induced discomfort, specifically for pain-sensitive patients. However, strategies targeting this discomfort remain limited. This paper explores improving FES stimulation delivery by investigating the effects of different envelope signal parameters and stimulation thresholds on finger flexion and discomfort.

Investigation of Forearm Electrode Matrix Locations in Functional Electrical Stimulation for Finger Extension

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Functional Electrical Stimulation (FES) was used to analyze forearm electrode matrix locations for finger extension using 24- and 36-electrode configurations. Data from ten participants show substantial inter- and intra-subject variability, with numerous possible stimulation combinations, preventing generalized electrode placement and highlighting the need for an automated stimulation-location selection system.

Development of an FES-based Foot Drop Assist System

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Stroke is a leading cause of long-term disability and commonly results in hemiplegia, which can impair voluntary muscle control and lead to mobility deficits such as foot drop. Foot drop occurs when weakened neural pathways prevent proper ankle dorsiflexion, causing instability during walking and increasing fall risk. Functional Electrical Stimulation (FES) offers a non-invasive approach to assist movement by stimulating motor nerves to produce muscle contractions. This study investigates the feasibility of adapting an existing FES system originally designed for finger flexion to induce ankle dorsiflexion. Healthy participants were recruited to evaluate electrode placement around the common peroneal nerve and tibialis anterior while measuring ankle motion using a 3D pose estimation system with ArUco markers. Initial tests showed minimal dorsiflexion using the original parameters. System modifications including reduced carrier frequency, increased signal amplitude, improved power delivery, and optimized electrode size significantly improved movement responses. The results demonstrate that meaningful dorsiflexion can be achieved using the adapted system, highlighting its potential for future development of FES-based foot drop assistance devices.

Machine Learning-Based Analysis of fNIRS Signals for Drowsiness Detection in Motorcycle Helmets

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This study builds upon prior fNIRS system validation by applying machine learning–based analysis for drowsiness assessment in a helmet-mounted setup. Unsupervised methods are used to examine physiological patterns in fNIRS signals and compare them with EEG measurements, investigating whether fNIRS can complement or potentially replace EEG for drowsiness detection.

Software Systems for the Community

Development of a Lightweight Deep Learning Model for Gesture-To-Speech Conversion of Cantilangnon Sign Language

Dione S. Duero, Breig Dinese A. Cantila, Iza C. Flores

Sign language is the primary means of communication for the Deaf and Hard of Hearing (DHH) community. However, limited technological support for localized dialects restricts accessibility, particularly in rural areas of the Philippines. Most existing gesture-recognition and translation systems focus on American Sign Language and require high computational resources, making them unsuitable for low-cost, real-time deployment in resource-constrained settings. The absence of automated tools for regional sign systems such as Cantilangnon Sign Language further creates communication barriers in education, healthcare, and public service environments. This study developed a lightweight, embedded deep learning-based gesture-to-speech translation system tailored to Cantilangnon Sign Language. The system utilizes a Raspberry Pi 5, OpenCV for real-time hand tracking, and a customized Convolutional Neural Network (CNN) for gesture classification. A dataset of 55 localized signs was collected and annotated, linking hand gestures to corresponding Bisaya translations with pre-recorded audio outputs. The application enables real-time recognition, sentence formation, and multimodal feedback through text and speech. Evaluation with 50 participants demonstrated stable performance, consistent accuracy, and high user satisfaction in functionality, usability, and reliability. Findings highlight the potential of low-cost embedded systems to promote inclusive and culturally responsive communication solutions.

Hybrid Online Archiving System Using Pagerank Algorithm

Cenge P. Flores; Nelyne Lourdes Y. Plaza; Ariel A. Dormendo; Joel S. Gracia; Cheryl O. Tayo

The manual handling of research and development documents at North Eastern Mindanao State University Cantilan Campus has resulted in frequent data loss, inefficient retrieval, and poor system transparency. This study addresses these limitations by developing a hybrid online archiving system using the PageRank algorithm to enhance document indexing, visibility, and user access. The system aims to automate the archiving process while improving the precision and efficiency of information retrieval. The research adopted the Object-Oriented Analysis and Design Methodology (OOADM) to guide system development. Functional modules were designed, including a user interface, document repository, and a pagerank engine responsible for computing document relevance based on content and citation structure. User roles – student, faculty, and administrative staff – were assigned specific permissions to access, upload, and manage archival content. Results showed that the PageRank-based ranking mechanism improved search relevance and reduced manual sorting by 64%. Feedback tools embedded in the system enabled users to evaluate research outputs, contributing to dynamic content appraisal. The system also demonstrated scalability and support for real-time monitoring and secure storage of academic materials. The developed archiving solution significantly improved document access, reduced retrieval time, and supported digital preservation initiatives. Its integration of algorithmic ranking into archiving workflows presents a practical model for academic institutions seeking to modernise their records management.

E-HEALom: A Mobile Application Integrating AI and Forecasting to Improve Mental Health Accessibility and Support

Breig Dinese A. Cantila; Joel S. Gracia, MSCS; Nelyne Lourdes Y. Plaza, PCpE, PhD; Fae Mylene M. Etchon, PhD; Iza F. Maligsa; Mark Vincent Arnaldo

Mental health concerns among students in higher education institutions have become a significant issue, with limited access to professional psychological support due to stigma, insufficient mental health personnel, and logistical barriers. This study presents E-HEALom, a mobile application designed to address these challenges and improve access to mental health consultation services at a Philippine university. The system integrates three computational methods: Constraint Satisfaction for efficient appointment scheduling, Item-Based Collaborative Filtering for personalized mental health resource recommendations, and ARIMA forecasting to anticipate demand for consultations. Developed using an Agile methodology, the system was evaluated by students, faculty, staff, psychometricians, and IT professionals using ISO 25010 software quality standards. The overall user acceptability rating was 4.38 (strongly agree), with high ratings for usability, reliability, and security, reflecting the application's confidentiality, ease of use, and the usefulness of its consultation and resource features. The successful implementation of E-HEALom demonstrates that mobile applications can significantly enhance the accessibility and efficiency of mental health services in university settings. This research contributes to the growing body of work on technology-assisted mental health interventions, offering a model for integrating digital tools into mental health support systems in higher education. Future improvements may include the expansion of real-time chat consultations and broader integration with university systems to enhance the mental health support infrastructure.

One-Tap Emergency Application

Sharon A. Bucalon; Jehu Roeh C. Rubenial

One Tap Emergency Application (E-TAP) to address common delays in reporting emergencies such as accidents, fires, health complications, and natural disasters. Many incidents become more difficult to manage when responders receive late, unclear, or incomplete information, especially in areas with weak internet signals. The goal of this study is to design a simple Android-based mobile app that allows users to send the essential details of an emergency—who needs help, the location, the time, and the type of incident—with just one tap. By sending this information directly to the appropriate response agencies, the application aims to shorten response time, strengthen coordination, and support public safety in the Municipality of Cantilan. A developmental research design guided the creation of the system, following the Rapid Application Development (RAD) model. This model was selected because it supports fast prototyping and continuous feedback from users and emergency responders. The application was built using Java for Android, integrating GPS and Google Maps for real-time location, Firebase for cloud-based data handling, and an SMS fallback option to support areas with unstable connectivity. Surveys, interviews, and field observations were used to collect data and evaluate the system's performance and acceptance among community members and responders. Findings show that E-TAP effectively improves the flow of emergency information. Respondents noted faster communication, more accurate location tracking, and clearer reporting steps. Efficiency received the highest rating compared with other criteria. Overall, users and responders found the application dependable, easy to use, and helpful in real emergencies. The study recommends the adoption of E-TAP by the Local Government Unit of Cantilan to strengthen its emergency response operations and improve community safety.

Applied Smart Automation

Investigating Temperature & Humidity Regulation Factors in a non-Image-based Sensor Fusion Chicken Egg Incubation System

Dela Rama, Ralph Arven; Astillo, Philip Virgil

Temperature and relative humidity are significant factors in the development and hatching of healthy chicks. In the absence of a brooding mother hen, artificial incubation systems are designed to provide the necessary environmental conditions to promote development of the embryo inside chicken eggs which leads to hatching after 19 to 21 days. This study aims to investigate the different factors affecting the temperature and humidity regulation process of a chicken egg incubation system designed to collect non-image-based parameters to be used for embryonic development analysis. The inverse relationship between temperature and humidity changes is discussed, as well as the effects of the number of open ventilation ducts and amount of tray water in the system on both temperature and humidity change rates. Results of this study may be used as contributory insight for designing and optimizing incubation systems in order to maximize hatching efficiency of chicken eggs for scientific or possibly commercial purposes. Keywords: chicken egg, egg incubation, embryonic development, temperature regulation, humidity regulation

Automated Imaging System for Microplastics Sample Classification using Convolutional Neural Network

Piolo Pascual Besinga, Lysander Uy, Ivor Louisetyne Canque

The University of San Carlos developed a microplastic imaging system, C.Scope.AI, which has proven to address the challenges of microplastic microscopy. Despite its efficacy, the system presented gaps, as its software is fragmented, the XY platform is overspecified, and the system has a complicated retraining. To address these issues, Version 2 introduced a redesigned hardware and software architecture. Key improvements include a hardware design that is adaptable to more existing microscopes, a simplified software architecture for easier setup to end users with nontechnical skills, and a retraining pipeline that enables local model retraining to improve generalization. The redesigned system demonstrated significant physical and economic efficiency gains, resulting in a unit that is 42% smaller than Version 1, with a cost reduction from 14,500.00 PHP to 8,934.00 PHP. Furthermore, software performance from benchmarks on an Intel(R) Core(TM) i3- 1115G4 system revealed detection speedups of 9.8% and 11.71% for binary and multiclass models, respectively, alongside a reduction in memory utilization of ~1,459.4 MB (1.5 GB). Lastly, The local retraining pipeline demonstrated an improved generalization on unseen data by 3.6% (relative gain of AP), specifically improving the detection of small-scale microplastics with confidence levels exceeding 90%.

Low-Cost Automated Fluid Mixing Device for Agitation Experiments: Computational Fluid Dynamics–Based Analysis of Design Specifications

Josef Dante A. Dumalagan; Luis Gerardo S. Cañete Jr.

Delivery of quality chemical engineering education requires a sufficiently-equipped learning center as technical skills can only be honed through meaningful hands-on lab experience and experimentation. However, laboratory access is often limited by the high cost and maintenance demands of commercial apparatus, such as the Armfield CEK and CEK MKII. This work highlights laboratory hurdles encountered in agitation experiments and solutions that explore low-cost construction and microcomputer-based automated equipment for streamlined data acquisition, processing, and validation. Furthermore, design decisions such as motor sizing and sensor selection were based on computational fluid dynamics (CFD) using the SOLIDWORKS Flow Simulation package as a quantitative basis in the absence of reliable empirical data.

Study on Resilient Real-Time Edge Device Localization in Wi-Fi Mesh Networks

Leesandro Juanite; Genesis Polotan; Emmanuel Torres

Global Positioning Systems (GPS) lack reliability in indoor environments due to signal attenuation, necessitating alternative solutions for asset tracking and navigation. This study presents the development of a low-cost, secure Real-Time Locating System (RTLS) utilizing Wi-Fi Received Signal Strength Indicator (RSSI) fingerprinting on a Raspberry Pi 3 platform. The system integrates three distinct positioning methodologies: Log-Distance Trilateration using a Bounding Box algorithm, Weighted K-Nearest Neighbors (WKNN), and a machine learning-based Random Forest Regressor. These were implemented within a unified web-based dashboard that provides real-time visualization. The primary objective was to evaluate the comparative accuracy and stability of deterministic and probabilistic localization algorithms while addressing security vulnerabilities inherent in wireless tracking.

Computer Systems Integration 1

Development of a Raspberry Pi-FPGA Prototype Platform Using Secondary Memory Interface Protocol for Educational Robotics Applications

Thairell C. Imperial; Luis Gerardo S. Cañete Jr.

Robotic platforms nowadays are used in various applications such as prototyping and experimentation, encouraging research and development on varying fields of expertise in the industry and educational sectors. These robotic platforms are made up of a single board computer that have both software and hardware peripheral components that can perform numerous functionalities, but the acquisition of these prevalent platforms in the market have been limited due to cost and component flexibility. This study aims to create a low-cost prototype platform using Raspberry Pi for a Field Programmable Gate Array using the Secondary Memory Interface. The study involves developing a software module for the Raspberry Pi that allows user applications to interface using the Single Memory Interface protocol while the Field Programmable Gate Array provides the desired hardware functionality of the system base from the specifications applied from the software. This platform prototype will serve as a rudimentary platform tool for robotics education and can also be used to accelerate the implementation of ideas for innovation and research.

Automated HDL Code Generation for Reconfigurable Robotic Platforms: A Template-Based Correctness-By-Reuse Approach

Stephen H. Haim; Dr. Luis Gerardo S. Cañete

Field-Programmable Gate Arrays (FPGAs) offer deterministic real-time performance essential for educational robotics, yet their adoption is limited by the complexity of Hardware Description Languages (HDL). LLM-based HDL generators do not solve this: they exhibit single-pass failure rates exceeding 28%–50%, producing non-deterministic outputs that are unsuitable for reproducible classroom use.

This study introduces HDLGenTool, an automated template-based code generator grounded in a Correctness-By-Reuse methodology. A graphical wizard accepts PWM, quadrature encoder, and ADC peripheral specifications and assembles pre-validated register-transfer-level (RTL) modules into complete synthesizable projects targeting the Raspberry Pi Secondary Memory Interface (SMI) — with no manual Verilog authoring required.

A simulation-based validation across 14 configurations (3–32 peripherals) yielded zero assertion violations in 25,223 behavioral tests, confirming behavioral equivalence with the reference implementation. Synthesis on a Cyclone V FPGA peaked at 5.6% ALM utilization. Generation averaged 1.99 s across 46 configurations ($R^2 = 0.98$). These results demonstrate that template-based generation correctly addresses the technical dimension of the HDL adoption barrier for educational FPGA platforms. Physical hardware validation and formal pedagogical assessment remain as future work.

Lab in A Box: A Portable and Low-Cost Electronics Learning System for Filipinos

Aguilar, Sean Karl Tyrese G. ; Caños, Bea Belle Therese B. ; Elciario, Von Juztis A.

The shift toward self-paced and remote learning has exposed a critical gap in technical fields like electronics, where hands-on practice is essential. Traditional laboratory setups cost ₱150,000 to ₱300,000, and limited equipment forces students into brief, scheduled sessions that restrict skill development.

Lab in A Box (LAB) is a portable, low-cost electronics learning system designed to make hands-on education accessible. Developed based on a standard electronics curriculum, LAB consolidates essential instruments into modular tools: Oscilloscope, Function Generator, Logic Analyzer, Voltmeter, Ohmmeter, Digital and Analog Circuit Checkers, and Power Supply, all at approximately ₱7,000.

Paired with its complementary software interface and control application, LABSoft, LAB enables students to conduct experiments, visualize signals, and test circuits anytime, anywhere. Its distinct edge is automated assessment, providing immediate, objective feedback on circuit performance, allowing independent troubleshooting while reducing instructors' manual grading burden.

While not matching high-end industrial specifications, LAB is sufficient for undergraduate learning objectives. Currently at 90% core functionality as a Minimum Viable Product, the system requires final validation for deployment. LAB represents a meaningful contribution to electronics education, bridging the accessibility and cost divide for Filipino students and resource-limited institutions.

Lab in A Box: Performance Assessment and Reimplementation of LABSoft

Acain, Jhaycee Anthony, P.; Dr. Cañete, Luis Gerardo, S. Jr

Establishing accessible laboratory instruments remains a critical challenge in remote learning environment for Computer Engineering electronics courses. This study assesses the software performance of Lab in A Box (LAB), a portable, Raspberry Pi-based trainer kit designed to replicate traditional electronics laboratory instruments for signal analysis and circuit validation. While LAB is functional and deployable, the current LABSoft application relies on a monolithic architecture where the Raspberry Pi Zero manages both hardware abstraction and graphical rendering. Preliminary profiling reveals this setup reaches critical performance limits; CPU utilization spikes at 99.3% during dual-channel plotting, causing severe display latency and system freezing during algorithmic software triggering.

To resolve these bottlenecks, this research proposes a decoupled, browser-based architecture. By offloading intensive frontend visualization to a client's machine via WebSockets, the Raspberry Pi is reserved strictly for backend data acquisition. This study quantitatively assesses current performance constraints—focusing on execution time, transfer latency, and CPU/memory usage—to validate the proposed reimplementation. By reducing the Raspberry Pi's computational burden, the proposed framework can possibly achieve higher frame rates and stable triggering. Ultimately, this research future-proofs the LAB ecosystem, providing a scalable, cost-effective model for high-performance diagnostic tools that uphold rigorous engineering standards in remote learning environments.

Robotics in Environmental Research

Development of an ArUco Marker-based Localization System for an Underwater Glider Robot

Jun Niel Paquibot, Takayuki Takahashi, Ayumu

For Underwater Gliders (UG), early-stage control development requires verifying vehicle behavior under ideal conditions. Understanding the ideal behavior allows deviations caused by external disturbances (such as currents) to be attributed correctly. This enables the design of strategies to counteract them. Thus, accurate pose estimation is critical for this verification, yet existing localization methods are unsuitable for controlled underwater environments: inertial sensors drift, acoustic systems suffer multipath interference, and optical motion-capture setups are costly and complex. This study proposes a low-cost, real-time vision-based localization system that provides high-accuracy position estimates, enabling reliable early-stage experimental validation of underwater gliders.

A Parametric Approach to Modeling Multiple Buoyancy Controller Enabled Underwater Glider

Cañete, Luis; Matsumoto, Masaharu; Takahashi, Takayuki;

This paper discusses the development of a model for an underwater glider robot equipped with multiple buoyancy controllers aimed at environmental surveying of lakes. Primary target of the model is performing simulation of actual gliding that will lead to control system development. This proves to be a challenge as gliding requires calculation of hydrodynamic forces in the medium, in this case water, which typically involves Computational Fluid Dynamics (CFD). Although CFD is a well-established technique, it's a well-known fact that it is expensive both in terms of computational resources and valuable time. Instead, an approach that combines CFD with Euler-Lagrange equations is proposed and undertaken. Discussion regarding the proposed underwater glider, derivation of the model, the architecture of the simulation, and preliminary simulation results referenced with actual gliding results are presented.

Initial Investigation of Voith Schneider Propeller Thrust Performance with Pitch Angle Variation using NACA 0012

Precious Julia Ablir; Luis Gerardo S. Canete, Jr.

The use of Voith Schneider Propeller (VSP) at small scales and low speeds remains underexplored despite its omnidirectional maneuverability. This study presents the optimization of a 2-bladed VSP using NACA 0012 for integration in a Microplastic Sampling Robot on bodies of water. This paper evaluates the hydrodynamic performance of the NACA 0012 blade at varying pitch angles and speeds using computational fluid dynamics (CFD). Simulated results show that NACA 0012 has sensitive lift and drag coefficients with pitch angle variations. High lift-drag ratios are recorded at small angles (1°-9°) but with minimal lift and drag forces generated, indicating high efficiency but low thrust. Angles from 10°-19° reveal a balance between power efficiency and thrust. Higher angles (20°-39°) produce high lift forces, but with higher drag forces, requiring more thrust. Angles higher than 40° are low in efficiency with high drag, indicating poor hydrodynamic performance. These results serve as the basis for the design optimization of the VSP, contributing to the improvement of the mobility and energy efficiency of the microplastic sampling robot.

Thermal Energy Harvesting Using Thermoelectric Generator (TEG) Across Different Soil Types: An In-Depth Review and Future Directions

Shyrill D. Ogoc; Dr. Philip Virgil B. Astillo

Thermal energy harvesting via thermoelectric generators presents a promising pathway for powering low-voltage devices in remote and agricultural environments by exploiting naturally occurring soil–air temperature gradients. Solar radiation does not penetrate deeply; the soil remains cooler than the surrounding air, thus creating a reliable temperature gradient. This review synthesizes recent advances in soil based thermoelectric generator systems, evaluating how soil properties—including composition, moisture content, and heat capacity—critically influence energy output. Reported studies indicate that high atmospheric temperatures combined with cooler soil conditions enhance energy harvesting performance. Specifically, sandy soils heat up quickly but lose energy faster, whereas clay-rich soils retain heat more effectively. Although the technology is promising, current thermoelectric generators face limitations, including low conversion efficiencies (5–6%), with prototypes up to 15%, material supply risks, and sustainability concerns. Emerging innovations in nanostructured thermoelectric materials, hybrid energy systems, and thermal interface design offer pathways to improved performance. The paper concludes with targeted recommendations for future research to enable reliable, field-deployable soil-thermoelectric generator solutions for Internet of Things and precision agriculture.

Keywords: Thermoelectric generators; thermal energy harvesting; soil–air temperature gradient; soil thermal properties; nanostructured thermoelectric materials; precision agriculture

Software Systems Analysis and Design 1

Comparative Analysis of Existing and Proposed Pipeline Leak Detection System

Fae Mylene M. Etchon

This study presents a comparative analysis of the effectiveness of existing and proposed pipeline leak detection systems in selected households across three barangays in Cantilan, Surigao del Sur. The proposed system integrates sensor technology to detect pressure drops in pipelines and automatically triggers SMS alerts to users and the water district. It is supported by mobile and web-based monitoring platforms for real-time supervision. Evaluation was conducted using the ISO 25010 software quality framework, focusing on functionality, reliability, usability, efficiency, maintainability, and security. Quantitative data were analyzed through mean scores and paired-sample t-tests to determine significant performance differences between the two systems. Results revealed statistically significant improvements across all evaluated attributes in the proposed system. Reliability and efficiency showed the most notable gains, as automated detection and instant notifications minimized water loss and response time. Usability improved through intuitive interfaces, maintainability through simplified diagnostics, and security through enhanced data protection. The findings indicate that the proposed system demonstrates superior operational performance compared to the existing setup. It enhances user satisfaction, promotes sustainable water management at the household level, and provides a model for improving water distribution efficiency in similar communities.

Keywords: Comparative Analysis, Leak Detection System, Sensor Technology, Water Conservation.

Development of Courier Management Application for NEMSU Cantilan's Centralized Recommender System of Extension Program and Services

Franklin M. Ganancias; Fae Mylene M. Etchon; Jehu Roeh C. Rubenial; Sharon A. Bucalon; Lyndon A. Rosas

This study presents the development and evaluation of a Courier Management Application integrated into the Centralized Recommender System for Extension Programs and Services of NEMSU Cantilan, with the primary aim of improving the efficiency, transparency, and coordination of extension-product ordering and delivery processes. Guided by an iterative Systems Development Life Cycle (SDLC), the system underwent structured phases of requirements analysis, design, prototyping, integration, and evaluation to address persistent operational inefficiencies. Usability and performance were assessed using the System Usability Scale (SUS) with 30 respondents representing extension implementers, administrative personnel, and selected beneficiaries. The results yielded a mean SUS score of 78.2, reflecting a high level of usability and a generally positive user experience, particularly in terms of ease of use, functional integration, and user confidence, with minimal perceived system complexity. Qualitative feedback further underscored the system's contribution to improved delivery coordination, real-time tracking, and enhanced operational transparency. In relation to existing scholarly work, the study offers a distinct contribution by integrating courier management with a recommender system tailored to extension-product distribution, a configuration that remains underexplored within Philippine higher education institutions. Overall, the findings demonstrate the system's potential to enhance logistical efficiency, support informed decision-making, and strengthen service delivery, while also providing a scalable framework for other institutions seeking to modernize logistics within extension and community-oriented programs.

Keywords: Courier Management; Recommender System; System Usability Scale; Extension Services; System Development

Integration of Sentiment Analysis Algorithm on Customer Satisfaction of Frontline Offices in NEMSU – Cantilan

Iza F. Magliza

The frontline offices in public institutions, particularly in universities, play a critical role as the first point of contact for clients, influencing their overall experience and satisfaction. This study investigates the application of sentiment analysis algorithms to assess and enhance client satisfaction in the frontline offices of North Eastern Mindanao State University (NEMSU) - Cantilan Campus. Client feedback, including satisfaction ratings and open-ended comments, was collected through surveys administered to students, faculty, and staff. The feedback was analyzed using Google Colab and Natural Language Processing (NLP) techniques to categorize the sentiments into positive, negative, and neutral categories. The study employed sentiment classification algorithms, including tokenization, stopword removal, and sentiment scoring, to process the textual data and extract actionable insights. The results indicated that 57.68% of the feedback was positive, 32.58% neutral, and 9.47% negative, with several areas identified for improvement, such as long waiting times and unclear communication. The findings suggest that sentiment analysis offers valuable real-time insights into client satisfaction, allowing for targeted service improvements. The study highlights the potential of sentiment analysis to facilitate data-driven decision-making in public service delivery, enhancing client relations and service quality. In conclusion, the integration of sentiment analysis in frontline offices provides an efficient tool for identifying areas for improvement and fostering a more responsive and client-centered service environment. Recommendations include expanding the use of sentiment analysis in other offices and implementing continuous feedback loops to maintain service quality.

Keywords: Sentiment Analysis, Client Satisfaction, Frontline Offices, Service Improvement, Public Institutions

Paper 32

The Role of Facebook Group Engagement in Moderating the Relationship Between E-Waste Awareness, Environmental Concern, and Intentions to Dispose of E-Waste Properly for Sustainability

Jose P. Calipayan, Jr.

This study investigates the role of Facebook group engagement in moderating the relationship between e-waste awareness, environmental concern, and college students' intention to dispose of e-waste properly in Surigao del Sur, Philippines. Additionally, it explores whether Facebook group usage has a direct effect on e-waste disposal intention. A total of 303 respondents from North Eastern Mindanao State University participated, with data collected through structured surveys measuring awareness, environmental concern, Facebook group engagement, and disposal intention. Structural Equation Modeling (SEM) was used to test the hypothesized relationships. The findings show that Facebook group engagement moderates the relationship between awareness and intention to dispose of e-waste, as well as the relationship between environmental concern and intention. Specifically, students who actively engage in Facebook groups dedicated to environmental issues exhibit stronger positive relationships between awareness and intention. Moreover, Facebook group participation was found to have a direct positive effect on the intention to dispose of e-waste properly. This indicates that active participation in these groups promotes responsible e-waste disposal behaviors, regardless of students' level of awareness or concern. The study highlights the importance of leveraging Facebook groups as an effective tool for encouraging pro-environmental behaviors among college students. Recommendations include incorporating Facebook groups into educational campaigns and sustainability initiatives. Future research should explore the role of digital communities in promoting sustainable behaviors.

Robotic Technologies for Sustainability

Redevelopment and Evaluation of an IoT Urban Farming System Using ESP32 with Sensors, Cloud Database, and Mobile App Monitoring

Paolo Gabriel Manila, Dave Nelson Ogue, John Jason Zamora

This research aims to address the challenges of food insecurity and establishing sustainable food production in urban environments through an IoT-enabled urban farming system. This system integrates automated irrigation and monitoring to optimize plant growth conditions. It builds upon a previous design by addressing limitations like water leakage and inconsistent soil pH readings. It contains multiple soil moisture sensors for the automation of watering the plant and one humidity, temperature, and pH sensor for monitoring the plant growth factors. Data from these sensors is used to control irrigation to aid in optimal plant growth. Additionally, the integration of a weather forecast API automates the adjustment of irrigation based on predicted weather conditions. A comparative analysis is conducted to differentiate the developed urban farming system from a conventional manual cultivation method. The aim of this study is to contribute to the development of cost-effective and sustainable urban farming solutions for cities with limited space and access to fresh agricultural products.

Fogponics as an Emerging Soilless System for Urban Agriculture: A Comparative Review

Vicky Q. Grijaldo

This review of existing studies aims to evaluate the practicality and promise of fogponics as an innovative soilless cultivation method by comparing it with hydroponics and aeroponics. Fogponics uses tiny droplets of water (fog) to deliver nutrients, appears to use water efficiently, provides better oxygen to the roots, and allows greater nutrient absorption. Unlike hydroponics, which may struggle with poor air circulation, and aeroponics, which can face nozzle clogging and high maintenance costs, fogponics uses ultrasonic or piezoelectric misting to generate a consistent root coverage while reducing water consumption. Recent studies by Suganob et al. (2024) and Regmi et al. (2024) report faster germination and improved growth of leafy greens and microgreens under fogponics systems, which positively affect plant health due to optimal air and nutrient availability. Despite its advantages, fogponics has been studied mainly at a small scale or experimental setup. Key gaps remain in scalability, long-term efficiency, crop range, cost, energy use, and system integration. Although fogponics shows strong theoretical potential, especially for propagation and tissue culture, its effectiveness for full-scale crops and commercial use remains uncertain. Addressing these knowledge gaps is essential for establishing fogponics as a relevant solution in the evolving landscape of resource-conscious and urban farming systems.

Keywords: Fogponics, Soilless system, controlled environment agriculture, hydroponics, aeroponics

Non-Intrusive Coconut Maturity Characterization Using Ultrasonic Wave Analysis with Machine Learning-Based Maturity Level Identification

Ben Cesar I. Cadungog; Ivan Michael Jon Galicia; Rhett Joshua L. Surban; Dr. Philip Virgil B. Astillo; Engr. Alvin Joseph S. Macapagal

This research presents the development of a non-intrusive coconut maturity characterization system utilizing ultrasonic wave analysis and signal processing, combined with machine learning-based maturity level identification. The primary objectives include prototyping the system, gathering data for characterization, collecting ultrasonic data across various maturity stages, and investigating feature derivatives to build and evaluate the performance of machine learning models such as deep neural networks, support vector machines, and random forests in combination with advanced signal processing techniques. This study provides valuable insights for researchers interested in non-intrusive coconut maturity assessment methodologies and holds potential applications in enhancing agricultural practices and fruit maturity assessment techniques.

EcoFarm Connect: Integrating Digital Market Access and IoT-Enabled Smart Farming in ASEAN Agriculture

Sharina Sodario, Kaye Louise Manilong, Philip Virgil Astillo

EcoFarm Connect explores a technology-oriented approach for addressing interconnected agricultural challenges in the ASEAN region, including inflation, climate variability, and food insecurity. While ASEAN is a major contributor to the global food supply, many farmers experience low income and limited market power due to intermediary-driven market structures and unstable environmental conditions.

This study identifies two complementary components in response to these challenges: the Shop-to-Plant Marketplace and the Virtual Farm. The Shop-to-Plant Marketplace enables direct farmer-to-consumer transactions through a mobile application developed using SAP Build Apps, reducing reliance on intermediaries and improving market access. Regional agricultural and economic data supporting this study were analyzed using SAP Analytics Cloud.

The Virtual Farm introduces an Internet of Things (IoT)-based monitoring approach using environmental sensors and ESP32 microcontrollers to support real-time crop monitoring, automated irrigation, and climate-smart farming recommendations. Its feasibility is informed by an IoT-enabled system developed in a university computer engineering research context.

EcoFarm Connect presents a framework to support agricultural sustainability, farmer resilience, and food security in ASEAN, aligned with UN SDGs 2, 8, and 13. Further pilot testing and stakeholder collaboration are recommended to evaluate scalability and practical implementation.

Computer Systems Integration 2

BIDS: A Web-based Borrowing System Integrated with An Automated Electrical and Electronic Components Dispensing System

Gamohay, Airahg G.; Gayondato, Elen Luz N.; Ty, Vince Louie L.

To address manual borrowing inefficiencies and tracking issues at the University of San Carlos's Digital and Microprocessors Laboratory (DML), this study developed BIDS: an ESP32-controlled automated dispensing system integrated with a FERN stack web application. The system features RFID authentication and custom 3D-printed dispensers designed for DIP14 integrated circuits and 1/4-watt resistors.

The hardware underwent four iterative prototype cycles and was validated through comprehensive unit, integration, and user acceptance testing. Results demonstrated significant operational improvements, with the dispensers achieving accurate single-component release and the web system substantially reducing transaction times for request creation, receiving, and returning compared to manual workflows. User Acceptance Testing (UAT) revealed high scores in usability and reliability, confirming alignment with laboratory needs.

This study concludes that the integration of automated dispensing hardware with a centralized, role-based web application effectively enhances laboratory management by minimizing manual workload, reducing human error, and improving accountability and inventory accuracy. Designed with modularity and scalability, the system provides a foundation for future expansion, including additional dispensing modules, broader component support, and further automation of laboratory processes.

Design and Development of a Low-Cost Portable Functional Electrical Stimulation (FES) with Touch User Interface

Abellana, Benedict A.; Ruiz, Jehu Lyndon J.; Cañete, Luis Gerardo S. Jr.; D'Silva, Andre Kimberly Trish D.

Stroke is a leading cause of disability in the Philippines, yet access to rehabilitation remains limited. Functional Electrical Stimulation (FES) is one technique that sends electrical pulses to the nerves and muscles, causing involuntary movements that help improve blood flow. However, traditional FES systems rely heavily on therapist expertise for electrode placement through trial and error. Researchers at University of San Carlos (USC) created an advanced FES system capable of automatically identifying effective electrode placements for finger movements but required a laptop with specialized software and cost ₱35,433, making it impractical for everyday clinical use. This project addressed these limitations by designing a low-cost, portable FES system featuring a 7-inch touchscreen interface on a Raspberry Pi 4B, a custom signal generator built using Raspberry Pi Pico with an 8-bit R-2R DAC merged with the power circuit, and redesigned stimulation circuit. The entire system eliminates the requirement of a desktop computer, contributing to decrease of workspace which fits within a 24 x 14 cm 3D-printed enclosure and its overall cost was reduced by 53.3% to ₱16,548. Testing confirmed that the system successfully replicated the original system's output and elicited finger flexion, representing a step toward accessible stroke rehabilitation.

Enhanced Web Application for USC DCPE Homegrown Attendance Monitoring System

Cabatingan, Lovely Ethyl O.; Ochia, May G.; Pastor, Marc Daniel R., Cañete, Luis Gerardo Jr., Cañete, Antoniette

Effective student attendance is vital for academic integrity but remains challenged by manual inefficiencies and limited integration with Learning Management Systems. This study addressed previous homegrown attendance system limitations developed at the University of San Carlos Department of Computer Engineering, specifically their lack of remote accessibility, inability to synchronize with the Canvas LMS, restriction to classroom-only settings, and bulky hardware design. To overcome these issues, the proponents developed an enhanced, LTI-compliant attendance monitoring system. The solution featured a redesigned portable device housing a Raspberry Pi 4 Model B and a web application supporting remote access and Canvas LMS integration. The system employs dual-mode authentication utilizing RFID and facial recognition for security. Robust synchronization mechanisms were implemented for data redundancy between local and online servers through automated file transmission. System testing confirmed successful handling of both classroom and non-classroom school settings with the prototype's reduced design, reflecting an approximate 45% reduction in volume compared to previous iterations. Deployment demonstrated reliable data consistency through conflict resolution algorithms and efficient enrollment times averaging 36.51 seconds for pre-registered participants. The study concludes that the system successfully bridged physical attendance logging and digital records, offering a secure, portable, and integrated solution for educational institutions.

AiO-SPARK: Development of All-in-One Self-service Printing Access and Retrieval Kiosk

Isaac Jadon R. Alotaya; Adrian Jose L. Cortidor; Kirk Louie N. Postrero; Philip Virgil B. Astillo

The growing demand for accessible and autonomous solutions for everyday tasks has driven the widespread adoption of self-service technologies across various sectors. This proposal outlines the design and development of an all-in-one self-service printing system aimed at addressing the challenges faced by individuals who lack convenient access to printing services in different environments. The system includes a payment mechanism, which ensures autonomy throughout the printing process, from document selection to payment confirmation, and until the final printed output. Its compact design allows for deployment in space-constrained areas such as libraries, schools, and public offices. By automating the entire process, the system helps users by providing easy access to printing services, and business owners who may provide these services without requiring extensive infrastructure or staffing. Its modular design allows for potential upgrades, ensuring adaptability to future technological advancements.

Software Systems Analysis and Design 2

GIYA: A Web Application for Effective Information Dissemination

Jehu Roeh C. Rubenial, Sharon A. Bucalon

The GIYA web application is developed for effective information dissemination and government service enhancement in Carmen, Surigao del Sur, presents a comprehensive solution to bridge information gaps and foster community development. Leveraging digital technology, the study explores the need for modernizing information dissemination which highlights the existing gaps, and introduces GIYA as a transformative tool. With objectives centered on developing a mobile application, enhancing public awareness, and providing a comprehensive platform, the study addresses limitations while emphasizing the significance of fostering transparency, citizen participation, and improved government services. The proposed GIYA system aims to benefit citizens, the community, government agencies, visitors, and researchers, signifying its multifaceted impact on community development. The system analysis delves into the technical aspects, outlining the software and infrastructure necessary for the development process. Utilizing the Agile model, the study proposes a systematic approach involving requirements gathering, design, build, test, deploy, and feedback phases. Recommendations include implementation of SMS notification, Augmented Reality (AR), and Initiate collaborations.

Offline Capable Learning Management System for SHS-STEM Education

Knash Josef Villarosa, Raezan Cabang, Zachary Bardoquillo, Linda Saavedra, Antoniette Cañete

Underserved and rural schools often struggle to deliver quality Science, Technology, Engineering, and Mathematics (STEM) education due to unreliable internet connectivity, which renders standard cloud-based Learning Management Systems (LMS) ineffective. Furthermore, existing offline educational interventions frequently lack integrated assessment and continuous performance tracking capabilities, preventing holistic instruction.

To address this digital divide, a web-based, offline-capable LMS was designed and developed specifically for Senior High School STEM education. Utilizing an offline-first architecture, the system operates on a local area network with localized data storage and features automatic data synchronization to a cloud server once connectivity is restored. The platform was evaluated through simulated testing in a controlled laboratory environment, utilizing proxy students and teachers to perform core LMS tasks and assess system usability, reliability, and offline functionality.

Results indicate that the developed system achieved 100% feature parity with the core instructional and assessment functionalities of industry-standard cloud platforms. Usability evaluations showed exceptionally high student satisfaction (overall mean score ≥ 4.74 out of 5), confirming intuitive navigation and continuous offline accessibility. However, the evaluation revealed a disparity in user experience, as the teacher administrative interface received lower satisfaction ratings (mean 3.00). Additionally, critical technical bugs were identified within specific assessment modules, including failure rates in matching (17.4%) and multiple-choice quizzes (8.7%).

In conclusion, the offline-capable LMS provides a highly functional and viable solution for facilitating uninterrupted digital learning and continuous assessment in resource-constrained settings. While the platform excels in student-facing operations, comprehensive efficacy requires resolving backend technical instabilities and administrative interface limitations.

To improve the system, future development must prioritize technical debugging to ensure assessment integrity and overall system stability. It is also recommended to comprehensively redesign the administrative user interface and resolve visual design issues to improve instructional workflows. Finally, future efforts should pursue actual pilot implementation in target school environments and integrate the platform with hands-on hardware STEM toolkits.

Digital Greenhouses for Cebu: Progress, Gaps, and Educational Solutions

Linda E. Saavedra; Antoniette M. Cañete, Luis Gerardo S. Cañete Jr.

In Cebu Province, seventy percent of vegetable crops are destroyed by typhoons yearly, while needing fifteen percent more food for growing cities. This paper reviews studies made in the last six years about protected greenhouses and smart farming and examines how digital technologies can transform high-value crop resilience amid climate extremes and aging farmers. It also presents an educational toolkit prototype integrating sensors, web dashboards, and AI predictive analytics, designed to bridge training deficiencies and localized implementation of Philippine Sustainable Agriculture Transformation (PSAT) programs.

Intent-Aware Artificial Intelligence: Frameworks, Applications, and Emerging Research Directions — A Survey

Elline L. Fabian; Dr. Philip Virgil B. Astillo

Intent-aware artificial intelligence (AI) has emerged as a significant research direction aimed at enabling AI systems to understand underlying human goals rather than merely executing explicit commands. As intelligent systems are increasingly deployed in complex and dynamic environments, accurately interpreting human intent becomes essential for effective human–AI collaboration. This survey reviews the current landscape of intent-aware AI by synthesizing research on conceptual foundations, key computational frameworks, and real-world applications. The paper analyzes major approaches, including human-aware frameworks, multi-modal intent modeling, generative AI–based architectures, context-aware multi-intent systems, and neuro-symbolic reasoning approaches. Comparative analysis highlights differences in adaptability, scalability, contextual understanding, and explainability across frameworks. The survey also examines applications across domains such as networking, healthcare, education, customer interaction systems, and industrial automation. Finally, the paper identifies major research challenges, including implicit intent inference, computational efficiency, explainability, and domain-specific adaptation. Emerging research directions such as hybrid architectures, federated learning, and cognitive-based modeling are discussed as promising pathways for advancing intent-aware AI systems.

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