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e-ABSTRACT BOOK

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I. Artificial Intelligence for Sustainable Development

AI-Driven Multi-Objective Optimisation for Sustainable Substation Asset Replacement Planning Using an ISO 55000-Aligned NSGA-III Framework

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Abstract: Aging substation equipment combined with accelerating electric vehicle (EV) adoption and distributed solar photovoltaic (PV) integration impose compound thermal, operational, and financial pressures on power utilities. Conventional single-objective and age-based replacement planning frameworks are structurally inadequate for navigating the Cost–Performance–Risk (CPR) trilemma mandated by the ISO 55000 Strategic Asset Management Plan (SAMP) standard. This paper presents an AI-driven, ISO 55000-aligned multi-objective optimisation (MOO) framework for substation asset replacement planning (SARP). The Non-dominated Sorting Genetic Algorithm III (NSGA-III) simultaneously optimises three conflicting objectives: (f1) minimisation of Total Cost of Ownership (TCO); (f2) minimisation of SAIDI/SAIFI composite per IEEE Std. 1366; and (f3) minimisation of operational risk from heterogeneous asset lifecycle divergence. The framework is applied to a proof-of-concept simulated substation model comprising eight heterogeneous asset groups, with n = 200 generations, 91 Das–Dennis reference points, and seed = 42 for full reproducibility. The frameworkgenerates 22 Pareto-optimal replacement strategies (f1: 294.1–332.9 M THB; f2: 7.202–17.764; f3: 20.68–64.17 M THB). The balanced CPR strategy achieves 32.0% operational risk reduction compared to the cost-minimised extreme at a TCO premium of only 4.1%, with 36.2% SAIDI/SAIFI improvement. The NSGA-III-based digital intelligence platform delivers an ISO 55000-compliant decision support foundation for sustainable power infrastructure investment, with direct applicability to utility asset management in Southeast Asia's energy transition context.

Keywords: multi-objective optimisation; NSGA-III; substation asset replacement planning; ISO 55000; sustainable power infrastructure

Efficient and Explainable Lithium-Ion Battery RUL Prediction Using Tree-Based and Neural Network Models

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Abstract: This research presents Machine Learning (ML) and Deep Learning (DL) techniques for predicting the Remaining Useful Life (RUL) of lithium-ion batteries. RUL plays a crucial role in Battery Management Systems (BMS) in electric vehicles and energy storage systems, as accurate RUL forecasting enhances safety, reliability, and maintenance planning efficiency. However, most previous research focused on improving the accuracy of DL models, often abandoning computational cost, model complexity, and explainability – significant limitations for practical application on resource-constrained devices. To address this gap, this research compares eight model types. Accuracy, computational performance, and explainability are evaluated using metrics such as MAE, RMSE, R^2, MASE, MBE, training time, prediction time, and model parameter count. Furthermore, Explainable Artificial Intelligence (XAI) was applied to analyze the importance of features affecting RUL prediction. The experimental results showed that XGBoost provided the best performance, with a MAE of 12.838, an RMSE of 27.883, and a high R^2 of 0.992. At the same time, it achieved a low prediction time of only 0.002 seconds and used significantly fewer parameters than deep learning models. In addition, Feature Importance analysis revealed that features related to cycle count and battery capacity degradation play a crucial role in RUL prediction. This study confirms that tree-based models, particularly XGBoost, can strike a balance between accuracy, computational performance, and explainability, making them suitable for future applications in BMS and edge computing devices.

Keywords: Explainable; Machine learning; Deep learning; Remaining useful life

Autoencoder-Guided Reinforcement Learning on Payload Images for Network Intrusion Detection

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Abstract: Network Intrusion Detection Systems face major challenges in detecting zero-day attacks due to the scarcity and class imbalance of labeled training data. This paper proposes an unsupervised autoencoder-guided reinforcement learning framework for intrusion detection that eliminates the need for labeled attack data. Packet payloads are represented as grayscale images and processed directly by a Deep Q-Network agent. A convolutional autoencoder is trained exclusively on benign traffic to learn normal behavior patterns. The resulting reconstruction error is used to generate label-free reward signals, enabling reinforcement learning without ground truth labels. This design avoids the limitations of supervised reward mechanisms and mitigates the impact of class imbalance. The proposed framework is evaluated on the CIC-IDS2017 dataset. Experimental results show that the model achieves a recall of 99.80%. This is comparable to supervised baselines (99.94%) despite using only benign data during training. In addition, the framework remains robust under severe class imbalance in the data. The framework maintains high recall, whereas supervised models exhibit significant performance degradation. Recall is adopted as the primary evaluation metric because missing attacks is more critical than raising false alarms in security applications. These results demonstrate that effective and robust intrusion detection can be achieved without labeled attack data, making the proposed approach suitable for real-world deployment where such data are scarce and imbalanced.

Keywords: network intrusion detection; deep reinforcement learning; autoencoder; unsupervised learning

Projection-Based Point Cloud Completion for Water Surface Reconstruction via Spatially Guided U-Net

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Abstract: Water surface reconstruction from 3D point clouds is a critical data product for hydraulic simulation, flood risk assessment, and reservoir capacity estimation in environmental engineering. However, point clouds acquired from Unmanned Surface Vehicles (USVs) equipped with LiDAR or bathymetric sonar frequently contain large holes caused by shallow water, narrow channels, acoustic shadowing, and turbidity. Classical interpolation methods, including linear and barycentric schemes, often produce flat or stair-stepped surfaces, while conventional deep-learning approaches based on CNNs may suffer from limited receptive fields, checkerboard artifacts introduced by transposed convolutions, and unrealistic hallucination in large void regions. To address these limitations, this paper proposes a projection-based point cloud completion framework for water surface reconstruction using a spatially guided U-Net (SPG-UNet). First, the irregular 3D point cloud is projected onto a depth map, transforming it into a structured 2D representation suitable for deep learning. Missing regions are then pre-filled using Inverse Distance Weighting (IDW) to estimate a smooth and globally consistent slope signal, which serves as spatial guidance. This IDW-derived slope map is concatenated with the raw depth map and jointly fed into a modified U-Net, whose decoder adopts bilinear upsampling to reduce checkerboard artifacts and enhance local surface details. Finally, the predicted depth map is converted back into 3D point clouds to recover complete water surface geometry for visualization and downstream analysis. The proposed framework was evaluated using synthetic missing regions generated from real point cloud data collected at 67 reservoir sites across Thailand using MAE, Chamfer Distance (CD), and Earth Mover's Distance (EMD), and was benchmarked against barycentric interpolation, IDW, and PointNet-based completion baselines under synthetic missing regions of varying sizes. SPG-UNet achieved the best performance across all three metrics, with an MAE of 0.218, CD of 0.845, and EMD of 3.138. Compared with the strongest baseline, barycentric interpolation, the proposed method reduced MAE by 26.6%, CD by 13.3%, and EMD by 1.8%, demonstrating more accurate and geometrically consistent reconstruction, particularly for large-scale holes (≥50% missing area) commonly observed in water-surface bathymetric data.

Keywords: Water surface reconstruction; point cloud completion; U-Net; inverse distance weighting; deep learning

Surrogate-Assisted Genetic Algorithm Optimization of Single Stator Double Rotor Axial Flux Permanent Magnet Synchronous Machines under No-Load Condition

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Abstract: Single stator double rotor axial flux permanent magnet synchronous machines offer high torque density and efficient magnetic utilization, but their no-load electromagnetic performance is highly sensitive to geometric parameters, particularly cogging torque and back-electromotive force distortion. To avoid the high computational cost associated with repeated finite element analysis, this paper proposes a surrogate-assisted optimization framework for the simultaneous minimization of cogging torque and total harmonic distortion in voltage for the axial flux permanent magnet synchronous machines. A Kriging surrogate model is coupled with a genetic algorithm to accelerate the optimization process by approximating the electromagnetic response over the design space. The permanent magnet span angle and stator slot opening width are selected as the key design variables. Based on finite element analysis validation, the proposed method achieves an 80% reduction in total harmonic distortion in voltage, a 33% reduction in peak cogging torque, and a 55.45% reduction in peak-to-peak cogging torque compared with the initial design. To further evaluate the effectiveness of the proposed optimization framework, particle swarm optimization is implemented under identical optimization settings, yielding comparable performance improvements and confirming the reliability of the optimum solution obtained. The results demonstrate that the proposed surrogate-assisted genetic algorithm framework effectively enhances the no-load electromagnetic performance of axial flux permanent magnet synchronous machines while significantly reducing the computational burden associated with direct finite element analysis based optimization.

Keywords: axial flux motor; back EMF; cogging torque; genetic algorithm; permanent magnet synchronous motor

Benchmarking Ordinal Loss Functions for Coconut Maturity Grading: Analysis of Mid-Ripe Class Recall

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Abstract: Quality assessment in the coconut industry is a critical yet challenging task, traditionally reliant on subjective and labor-intensive manual inspection. Vision-based coconut maturity grading achieves high accuracy for polar classes (Unripe, Ripe) but systematically under-detects the commercially premium Mid-ripe class, which commands the highest market price. We benchmark seven deep learning backbones against five loss functions, namely Softmax, Consistent rank logits (CORAL), Conditional Ordinal Regression for Neural networks (CORN), Ordinal encoding (OE), and Distance-penalized Cross-Entropy (DPCE) on 1,660 images of Nam Hom Sam Phran aromatic coconut validated via destructive flesh-thickness measurement across five stratified folds. While global Quadratic Weighted Kappa (QWK) gains from ordinal losses are negligible across all backbones, disaggregating by class reveals a critical distinction: the Mid-ripe deficit reflects class imbalance rather than the choice between nominal and ordinal supervision. On the best-performing backbone (ConvNeXt-Tiny), inverse-frequency weighted cross-entropy attains the highest Mid-ripe recall (0.781), above DPCE (0.736) and Softmax (0.720), with DPCE in turn above the strictest ordinal formulation, CORN (0.677). These Mid-ripe gains are obtained by trading polar-class recall and leave global QWK unchanged, indicating that intermediate-stage recall is governed by imbalance handling, with DPCE acting as a gentler, error-gated form of reweighting rather than a distinct ordinal mechanism. Gradient-weighted Class Activation Mapping (Grad-CAM) and Local Interpretable Model-agnostic Explanations (LIME) analyses illustrate spatially inconsistent Mid-ripe activations and reveal that the stalk region encodes maturity information in opposite directions across classes, consistent with the biological difficulty of the 3-4 mm flesh-thickness transition and DPCE's targeted correction. ShuffleNetV2 matches models ten times its size, establishing it as the preferred backbone for edge deployment.

Keywords: coconut maturity grading; ordinal loss; distance-penalized cross-entropy; deep learning benchmark; explainable artificial intelligence

A Multi-Level Evaluation Framework for Explainable AI: The Triangle Graph Approach

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Abstract: While machine learning performance is commonly evaluated using standard metrics such as accuracy and F1-score, transitioning to Explainable AI (XAI) introduces a steep learning curve due to the fragmented landscape of explanation methods and evaluation strategies. To address this challenge, we propose a unified multi-level evaluation framework aligned with the standard machine learning pipeline. The framework decomposes model behavior into three levels: Input, Internal, and Output, each associated with appropriate explanation and evaluation mechanisms. Quantitative results from these levels are integrated into a novel Triangle Graph visualization that enables intuitive assessment of holistic model reliability. We further introduce the Holistic Reliability Score (HRS), a scalar metric derived from the normalized triangle area, together with a weighted formulation for domain-specific priorities. The framework is evaluated across text (IMDb, ISOT), tabular (UCI Adult), and image (CIFAR-10) datasets using BERT, Bi-LSTM, XGBoost, MLP, and ResNet-20 architectures. Results show that single metrics such as F1, Input-Level NAOPC, or Internal-Level NAOPC lead to different model-selection conclusions, whereas the proposed HRS integrates these signals into a unified reliability assessment. The Triangle Graph further reveals trade-offs between predictive performance and multi-level explanation faithfulness that remain hidden under standard evaluation.

Keywords: Explainable AI, Faithfulness Evaluation, NAOPC, Triangle Graph, Holistic Reliability Score

Precision Nursing Approach to Clinical Surveillance: Leveraging Big Data Analytics for Mortality Risk Stratification Among Hospitalized Oncology Patients

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Abstract: The management of critical conditions in oncology demands timely identification of physiological decline, yet conventional early warning scores often lack the specificity required for cancer patients with complex clinical profiles. This study aimed to develop a precision nursing framework utilizing big data analytics to predict clinical deterioration and mortality risk among hospitalized oncology patients. A retrospective developmental study was conducted using electronic health records from 34,597 cancer admissions at a tertiary university hospital in Southern Thailand between 2008 and 2016. Guided by the Nursing Science Precision Health Model, demographic profiles, clinical diagnoses, procedural interventions, and financial metrics were analyzed. Three predictive algorithms Logistic Regression, Random Forest, and Gradient Boosting were evaluated to identify the most effective surveillance tool. The cohort comprised an equal gender distribution with a mean age of 51.9 years (SD = 21.47). The overall inpatient mortality rate was 5.9%, with breast, colorectal, and lymphoid malignancies being the most prevalent. The Gradient Boosting algorithm achieved the highest predictive accuracy (AUC = 0.7989, Precision = 0.6226). The analysis identified cumulative treatment cost (importance = 0.4997), patient age (0.2509), and length of hospital stay (0.1502) as the primary indicators of mortality risk. Big data analytics can significantly enhance precision nursing by providing robust early warning systems. Integrating these predictive models into routine clinical workflows empowers nurses to proactively identify high-risk patients, optimize resource allocation, and initiate timely interventions, ultimately improving the quality of oncological care.

Keywords: precision nursing; clinical surveillance; oncology care; big data analytics; predictive modeling; early warning system; electronic health records; machine learning; nursing informatics; patient safety

Impact of Language-Aware Calibration on AWQ Post-Training Quantization for Thai Large Language Model Evaluation

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Abstract: Large language models (LLMs) demand substantial GPU memory, limiting their practical deployment in resource-constrained environments. Post-training quantization offers an effective strategy for reducing this burden without requiring full model retraining. One prominent method, Activation-Aware Weight Quantization (AWQ), compresses model weights to four-bit integer (INT4) precision by identifying and protecting the most salient weight channels through a calibration corpus. Although AWQ maintains strong performance on English benchmarks, calibration is conventionally performed on English text, raising concerns about whether this convention adequately preserves performance on morphologically distinct, low-resource languages such as Thai. This study examines the impact of language-aware calibration on AWQ-based INT4 quantization in Thai large language model evaluation. Three open-weight, instruction-tuned models are investigated: Qwen2.5-7B-Instruct, Llama-3.1-8B-Instruct, and WangchanLION-v3. Model performance is assessed using the ThaiLLM Leaderboard protocol across three benchmark categories: Natural Language Understanding (NLU), Examination (Exam), and Natural Language Generation (NLG). For Qwen2.5-7B-Instruct, five AWQ calibration configurations are evaluated, encompassing Thai and English Wikipedia corpora at two sample-count settings, along with an official English C4-calibrated AWQ checkpoint. The results reveal that English-calibrated AWQ introduces measurable performance degradation on Thai benchmarks. Specifically, for Qwen2.5-7B-Instruct, NLU accuracy declines by 2.01 percentage points, while NLG performance drops by roughly 4.0% relative to the full-precision baseline. By contrast, Thai Wikipedia calibration using 512-token sequences and 256 samples recovers NLU performance to within 0.05 percentage points of the full-precision model. A seed-stability analysis further confirms that NLU standard deviations remain at or below 0.0005 across all full-precision models evaluated, establishing the reliability of single-run benchmark scores. These findings highlight the critical importance of language-matched calibration for deploying quantized LLMs in Thai-language applications. The proposed calibration strategy substantially reduces inference memory requirements while preserving benchmark performance, offering a reproducible, low-cost solution with broader implications for other low-resource language settings.

Keywords: Post-training quantization; AWQ; Large language models; Calibration data; Low-resource languages

II. Renewable Energy and Green Technology

Design of Wave Energy Generator Prototype for Teaching Physics and Renewable Energy Using MATLAB Simulation and STEM

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Abstract: This study aims to develop a prototype of a wave energy generator and to promote learning through STEM education by engaging students in the design and creation of real-world scientific models. The project uses the principle of electromagnetic induction, as defined by Faraday's law, which states that the change in the magnetic flux through the coil produces an electromotive force (EMF). The experimental results indicate that the induced voltage is between 60–80 mVpp at a frequency of 1.5–3.0 kHz, with the waveform consistent with the theoretical predictions of Faraday's and Lenz's laws. These findings confirm the success of converting mechanical wave energy into electrical energy at a small scale suitable for classroom demonstration. From an educational perspective This STEM-based activity combines knowledge in science, technology, engineering, and mathematics. Students learn the scientific basics of electromagnetic induction, use technological instruments such as digital multimeters and oscilloscopes, design engineering prototypes, and analyze mathematical relationships between frequency, voltage, and amplitude. This project enhances the conceptual understanding of the energy transition. It also promotes environmental awareness and sustainable energy literacy. Thus, this study shows that the wave energy generator prototype can serve as an effective educational tool for learning physics, linking theoretical knowledge with practical applications in renewable energy, and supporting the development of scientific talent in the 21st century.

Keywords: wave energy generators; electromagnetic induction; renewable energy; STEM education; matlab simulation

Simulation of Energy Harvesting Circuits on Measured Lightning Data in Sarawak

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Abstract: With the growing demand for sustainable energy solutions, RF energy harvesting has gained attention as a method of capturing ambient electromagnetic energy and converting it into usable DC power. However, conventional RF-to-DC converters face challenges such as low efficiency, sensitivity to frequency variations, and limited voltage output, which restrict their practical applications. This paper presents the design and simulation of a 4-stage Villard voltage multiplier circuit for harvesting RF signals across input voltages of 1.29 V and 3.8 V at frequencies of 100 kHz, 300 kHz, and 500 kHz. Simulations were conducted in LTspice using 1N5819 Schottky diodes and uniform 100 nF stage capacitors. A buck converter stage (LTC3639) was subsequently integrated to regulate the multiplier output for practical charging applications. Results demonstrate that the 3.8 V input consistently yields higher DC output across all tested frequencies, while frequency increase beyond 100 kHz progressively reduces output voltage due to capacitor charge-time limitations and diode switching constraints. The findings provide quantitative insight into the frequency-dependent performance of discrete-component Villard multipliers and their practical limitations in low-power energy harvesting scenarios.

Keywords:RF energy harvesting, Villard voltage multiplier, LTspice simulation, DC-DC buck converter, low-frequency RF-to-DC conversion, power conversion efficiency.

A Study on the Effects of Translucent Roofing Sheets on Indoor Lighting Conditions During Thailand's Rainy Season

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Abstract: Lighting is an essential factor for human vision, daily life, and work efficiency. Natural light, in particular, is an important energy source that helps reduce electricity consumption within buildings. Therefore, designing buildings to effectively utilize natural daylight has become a significant approach for energy conservation and for creating suitable indoor environmental conditions. At present, translucent roofing materials such as polycarbonate sheets and fiberglass sheets are widely used as roofing components in buildings to increase the amount of natural light entering indoor spaces and reduce dependence on artificial lighting. However, the light transmission and light diffusion performance of each material differ, especially under varying weather conditions during the rainy season, when cloud cover increases, outdoor light intensity decreases, and humidity levels rise. These factors can significantly affect indoor lighting conditions. Thailand has a tropical climate with a long rainy season. As a result, the use of translucent roofing sheets in buildings may be influenced by such climatic conditions, causing indoor illuminance levels to fall below standard requirements or user needs. This may affect work efficiency, visual comfort, and overall energy consumption within buildings. Therefore, this research aims to study the effects of translucent roofing sheets on indoor lighting conditions during Thailand's rainy season by comparing the light transmission properties of different translucent roofing materials. The findings are expected to provide useful information for selecting appropriate roofing materials in building design to improve lighting efficiency and energy conservation.

Keywords : Natural light, polycarbonate, fiberglass, Translucent Roofing

Performance Characteristics of R1234yf Ejector Refrigeration System under Low-Temperature Sources

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Abstract: Ejector refrigeration systems offer a promising pathway for utilizing low-grade waste heat as a primary driving energy source. However, their performance under low-temperature heat-source conditions remains limited by ejector pressure-lift capability and operating stability. This study investigates the performance and operational characteristics of an R1234yf ejector refrigeration system driven by low-temperature conditions below 75 °C. A real-gas constant-pressure mixing ejector model coupled with iterative solver and CoolProp thermophysical properties was developed and validated against published experimental data. The results indicated that generator temperature strongly influenced both ejector performance and operating stability. The optimum operating condition was obtained at the generator temperature of 66 °C and evaporating temperature of 12 °C, where the system achieved an entrainment ratio of 0.53, coefficient of performance of 0.44, a cooling capacity of 1.82 kW. Operating below this optimal generator temperatures induced a premature shift into the subcritical regime, resulting in unstable operation and compromised pressure-lift capability. Therefore, careful selection of the operating temperature range is critical to sustaining stable ejector performance under low-temperature conditions. The findings identify a stable operating region for the investigated ejector geometry and provide practical guidance for ejector design and operating-condition selection in low-temperature waste-heat-driven refrigeration applications.

Keywords: Critical back pressure; Ejector refrigeration system; Entrainment ratio; Low-grade waste heat; R1234yf.

InC MPPT with nonlinear control for a PV boost converter feeding an AC grid-connected converter

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Abstract: Extracting the maximum power from photovoltaic (PV) panels is crucial. This paper presents an approach to implement the maximum power point tracker (MPPT) using the well-known incremental conduction (InC) method, with a boost converter feeding a three-phase AC grid via an inverter. A PV panel is connected to a PV capacitor. The capacitor voltage is controlled via a nonlinear cascade control system, with the inner loop regulating the inductor current and the outer loop regulating the PV capacitor voltage to extract maximum power under the given conditions. The output voltage of the boost converter, connected to the inverter, is controlled by the inverter using a well-known cascade PI controller. Simulation results show that, with nonlinear control, the tracking response is faster than that of the PI controller with a lower PV capacitance, while the inductor current can be limited.

Keywords: Photovoltaic cells; InC MPPT; Boost converter; Three-phase inverter

Development of Green-Extracted Lipid Carrier Systems for *Houttuynia cordata* and *Curcuma longa* Using Coconut Milk Emulsions: Chemical Profiles and Anti-Inflammatory Efficacy

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Abstract: A green extraction system was developed using raw coconut milk as the natural solvent matrix to isolate bioactive compounds from fresh Plu Kaow (*Houttuynia cordata*) leaves or turmeric (*Curcuma longa*) rhizomes at coconut meat-to-biomass ratios of 1:0.2 to 1:0.5 (w/w). Botanical polarity heavily dictated extraction dynamics; the hydrophilic Plu Kaow system maximized physical oil yield (20.75 ± 0.35%) but showed low DPPH inhibition, whereas the lipophilic turmeric system capped its oil yield (15.25%–15.50%) due to surfactant-like interfacial localization but optimized antioxidant activity (77.64 ± 0.26%). The 1:0.4 ratio was selected as the optimized baseline for both plants. GC-MS analysis confirmed successful phytochemical sequestration; the Plu Kaow extract was enriched with lipophilic lactones (δ-decalactone 3.005%, δ-octalactone 1.927%), while the turmeric extract was dominated by sesquiterpenes (αR-turmerone 20.164%, turmeronol A 0.681%). Both formulations demonstrated exceptional biocompatibility (IC_{50} > 100 μg/mL}), proving nearly twofold safer than synthetic Diclofenac. In cellular anti-inflammatory assays, both extracts displayed gradual, moderate-to-low acute nitric oxide inhibition (IC_{50} > 100 μg/mL), governed by sustained interfacial release kinetics across the oil-water boundary. Overall, this green extraction strategy provides a safe, stable framework ideal for sustained-release topical anti-inflammatory formulations.

Keywords: Green extraction; Coconut milk emulsion; *Curcuma longa*; *Houttuynia cordata*; Lipid carrier.

Experimental and Computational Analysis of an IoT Based Solar-LPG Hybrid Fish Dryer System

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Abstract: Solar–liquefied petroleum gas (LPG) hybrid parabolic greenhouse dryers are widely used in the seafood industry in southern Thailand; however, non-uniform air circulation creates localized hot spots near the hot-air duct and inconsistent product quality. In this study, we optimized the drying conditions of a commercial solar-LPG hybrid fish dryer (8.0 m wide, 20.8 m long, 3.35 m high) by combining computational fluid dynamics (CFD) modelling with experimental validation and an Internet-of-Things (IoT) automatic control system. Six fan configurations were simulated under no-load and full-load conditions using the Lattice Boltzmann Method implemented in XFLOW, and the predicted temperature and velocity fields were validated with FLIR thermal imaging and in-situ measurements of temperature, air velocity, and relative humidity. Baseline performance was recorded over three drying cycles (pre-improvement rainy and summer seasons and post-improvement rainy season). The simulations showed that adding rear exhaust and floor circulation fans increased the mean air velocity (from 0.21 to 1.31 m/s) but lowered the mean chamber temperature (from 43.16 to 32.88 °C). Configurations 3 and 4 offered the best compromise between the 45°C and 55 °C target and adequate air movement in the tunnel. After installing 16” exhaust fans, new temperature/humidity sensors, and an IoT-enabled controller, the specific energy consumption decreased by 25.62 %, and the fish throughput per LPG cylinder increased by 22.02%, although the instantaneous drying efficiency decreased by 29.69%. CIELAB analysis confirmed the progressive browning of the product from the fresh to the brined to the dried state. The integrated CFD-IoT approach provides a practical route for more uniform, energy-efficient, and consistent industrial fish drying.

Keywords: fish drying; lattice boltzmann method; IoT control; solar-LPG dryer; drying efficiency

CFD-Based Assessment of Urban Wind Energy Resources under Building Obstacle Effects

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Abstract: The transition toward sustainable energy in urban environments has accelerated global interest in Urban Wind Energy (UWE) systems. However, evaluating wind resources in built environments is exceptionally complex due to extreme surface roughness and aerodynamic obstacles. This study investigates the impact of explicit building obstacle modeling on the accuracy of microscale urban wind resource assessments using Computational Fluid Dynamics (CFD). The research was conducted at the King Mongkut's University of Technology Thonburi (KMUTT), Bangkhunthien Campus, Thailand, utilizing a 120 m meteorological mast for baseline data validation. A 3-D wind field simulation employing the standard k-\epsilon turbulence model was executed under neutral atmospheric stability to model the flow. Simulations were evaluated under two distinct scenarios: one utilizing standard Land Use and Land Cover (LULC) roughness parameters, and another explicitly resolving high-resolution 3-D building geometries. Microscale wind resource maps indicated significant wake effects and velocity deficits at lower elevations (40 m and 65 m) caused by the campus infrastructure. Validating the models against the measured mast data revealed that explicitly resolving building obstacles significantly improves prediction accuracy. The vertical wind speed profile of the building-resolved CFD model aligned more closely with empirical data, increasing the coefficient of determination (R^2) from 0.559 (LULC only) to 0.686. These findings underscore that traditional macro-level topography modeling is insufficient for urban domains. Incorporating exact 3-D building footprints is essential to accurately predict wind shear, avoid overestimating wind speeds at lower hub heights, and ensure the economic viability of urban wind turbine installations.

Keywords: computational fluid dynamics; wind field; urban wind; obstacle effect; wind energy.

GIS-SAM Integrated Rooftop Solar PV Assessment for Net-Zero Urban Planning: A Case Study of Phatthalung, Thailand

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Abstract: This study develops a GIS-SAM three-phase framework for rooftop solar photovoltaic (PV) potential assessment and net-zero feasibility evaluation in Khuha Sawan subdistrict, Mueang Phatthalung District, Southern Thailand. Phase 1 disaggregated provincial electricity demand data from the Provincial Electricity Authority (PEA) Regional Office 3 using population-weighted household ratios from the Department of Provincial Administration (DOPA), yielding an annual electricity demand of 80,831 MWh for the study area. Phase 2 employed QGIS with AI-detected building footprints from the Google-Microsoft-OSM combined dataset to identify 3,266 buildings covering a total rooftop area of 1,261,584 m², yielding an installable PV capacity of 113.6 MWp after applying a 60% usability factor. Phase 3 simulated annual energy generation using NREL's System Advisor Model (SAM) with NASA POWER meteorological data, yielding an annual AC output of 133.1 GWh (164.7% of annual demand), which confirms net-zero feasibility. The levelised cost of energy (LCOE) of 1.39 THB/kWh is 67% below the PEA retail tariff of 4.20 THB/kWh. The framework is directly applicable to other Thai municipalities and comparable data-scarce urban settings.

Keywords: rooftop solar PV; GIS; net-zero; urban energy planning; Thailand

Techno-Economic Assessment of Floating Solar PV in the EEC of Thailand: A Case Study of the SCG in Rayong

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Abstract: This study presents a comprehensive techno-economic feasibility analysis of a 10.51 MWp floating photovoltaic (FPV) system installed on an industrial reservoir at an SCG Group facility in Rayong, Thailand (12.72°N, 101.13°E). Using PVsyst V7.4.7 with Meteonorm 8.1 meteorological data, three financial scenarios were evaluated: Scenario 1 (feed-in tariff of 2.168 THB/kWh with 20% income tax), Scenario 2 (feed-in tariff of 3.80 THB/kWh with 20% income tax), and Scenario 3 (feed-in tariff of 3.80 THB/kWh with tax exemption). The system comprised 18,117 Longi Solar LR5-72HGD-580M bifacial modules, 30 Huawei SUN2000-330KTL-H2 inverters, and an FPV-specific floating structure with mooring and anchoring systems. The simulation results demonstrated an annual energy output of 15,890 MWh/year, specific yield of 1,512 kWh/kWp/year, and performance ratio of 84.6%. The dominant energy losses were thermal (6.5%), module mismatch (2.1%), and soiling losses (3.0%). Financial analysis over a 25-year project lifetime revealed LCOEs of 1.71 THB/kWh across all scenarios, with payback periods of 16.4, 8.8, and 7.4 years, respectively. Under the most favorable scenario (FiT 3.80 THB/kWh, zero tax), the system achieved an IRR of 44.0%, ROI of 128.6%, and NPV of 370.15 million THB, confirming its strong investment viability. The FPV system also displaced 187,146 tCO_2 over its lifetime, demonstrating significant environmental co-benefits of industrial decarbonization in Thailand.

Keywords: Floating Photovoltaic (FPV); PVsyst; Performance Analysis; Techno-Economic Analysis; LCOE; Industrial Decarbonization; Thailand

Dynamic Modeling of Residential Solar-Wind-BESS with V2G Microgrid under Voltage Sag and LVRT Conditions: A Case Study of Phuket Island, Thailand

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Abstract: In recent years, focussing more on power quality and operational reliability of grid-connected microgrid systems due to increased penetration of renewable energy resources and electric vehicles, which has introduced severe voltage stability challenges. Phuket Island, Thailand, has high renewable energy potential with an electricity demand that is constantly increasing; therefore, it represents a suitable location for the deployment of a smart microgrid. In this study, a renewable energy-based microgrid incorporating Vehicle-to-Grid (V2G) technology is developed to increase the flexibility and resiliency of the system, especially under voltage disturbance conditions. The microgrid proposed in this study consists of a solar PV Rooftop 10 kW, an HAWT 5 kW, and a BESS 18 kWh coupled with a V2G 10 kW. The study is performed for a complete system using the MATLAB/Simulink simulation platform, and three case studies under voltage sag and low-voltage ride-through (LVRT) tests are created: 1) Base case scenario (no auxiliary support), 2) Microgrid and BESS support, and 3) Coordinated output control of BESS together with the vehicle-to-grid operation method. The performance analysis emphasized load supplant capacity, unserved energy, and power interchange with the utility network. Simulation results validate that the proposed microgrid maintains voltage and frequency stability in disturbance periods, while LVRT requirements of IEEE Std 1547-2018 are satisfied. The voltage dropped to a minimum of 0.82 p.u. at the time of fault incident and recovered back to its nominal operating limit within 8.05 s, while the load supply ratio increased from 56.13% in base case to 91.76% under coordinated BESS–V2G strategy The results validate successful suppression of renewable power fluctuations, voltage ride-through capability enhancement, renewable energy utilization increase in islanded microgrid systems integrated with BESS and V2G.

Keywords: Microgrid; Vehicle-to-Grid (V2G); Renewable Energy Integration; Voltage Sag, Low-Voltage Ride-Through (LVRT)

Next-Generation Resilient Virtual Power Plants through Machine Learning-Driven Digital Twin Wind Power Forecasting

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Abstract: The high penetration of variable wind generation challenges the reliable operation of next-generation virtual power plants (VPPs), in which accurate short-term power forecasting is a prerequisite for dispatch, reserve scheduling, and grid resilience. This study developed a machine-learning-driven digital twin for 24-hour-ahead wind power forecasting at an operating very small power producer (VSPP) wind farm with four turbines located in the Pak Phanang district of Nakhon Si Thammarat province on the coast of the Gulf of Thailand in southern Thailand. A three-domain nested Weather Research and Forecasting (WRF) model with an optimized ensemble of physics parameterizations was coupled with the WRF data assimilation system (WRFDA), which assimilates synoptic, aviation, ship, and buoy surface observations to generate a physics-based meteorological forecast. The forecasted parameters were then fused with on-site SCADA measurements through a digital twin built from six machine-learning regressors: CatBoost, Random Forest, support vector regression (SVR), k-nearest neighbors, XGBoost, and LightGBM to correct the predicted wind power. The models were tested for the inter-monsoon (April) seasons using the mean absolute error (MAE) and root mean square error (RMSE). The WRFDA baseline yielded an April power MAE of 398.3 kW and an RMSE of 618.5 kW. The digital twin reduced the April MAE to 262.3 kW with SVR, an improvement of approximately 34%. The best-performing model tracked the observed power far more closely than the raw WRF baseline, confirming that a hybrid WRF–WRFDA–machine-learning digital twin can deliver markedly more accurate forecasts to underpin resilient VPP operations.

Keywords: digital twin; wind power forecasting; machine learning; virtual power plant; WRFDA

7E Analysis (Energy, Exergy, Economic, Environmental, Energoeconomic, Exergoeconomic, and Enviroeconomic) of Wind Energy and Solar PV Systems: A Case Study of Songkhla Province, Thailand

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Abstract: A robust cross-technology assessment of renewable electricity systems requires evaluation frameworks that integrate thermodynamic performance, economic viability, and environmental benefits using field data rather than simulation-derived assumptions alone. This study presents a field-based 7E assessment—energy, exergy, economic, environmental, energoeconomic, exergoeconomic, and enviroeconomic—of two operating renewable energy systems in Songkhla Province, Thailand: a 36.0 MW onshore wind farm and a 1.417 MWp rooftop solar photovoltaic (PV) system. The analysis was based on three years of measured operating data (2023–2025) obtained from SCADA systems, revenue meters, and on-site irradiance records under tropical monsoon conditions. Thermodynamic consistency was maintained by applying resource-specific exergy formulations, namely Petela-based radiative exergy for solar PV and kinetic exergy for wind energy. The wind farm outperformed the solar PV system in thermodynamic and normalized environmental dimensions, achieving a higher capacity factor (24.73% vs. 14.40%), exergy efficiency (31.46% vs. 14.86%), sustainability index (1.459 vs. 1.174), and specific emission reduction (1,083.0 vs. 630.7 tCO_2/MW/yr). By contrast, the solar PV system exhibited stronger conventional financial performance, with a lower levelized cost of electricity (2.60 vs. 3.07 THB/kWh), higher internal rate of return (10.16% vs. 8.17%), and shorter simple payback period (8.42 vs. 10.52 years). A ±10% one-at-a-time deterministic sensitivity analysis further showed that Wind Farm feasibility was most sensitive to AEP, tariff, and CAPEX, whereas Solar PV remained financially more robust under the same screening approach. These results demonstrate that the two technologies should be interpreted as complementary rather than competing options: wind is preferable when thermodynamic quality and carbon mitigation are prioritized, whereas solar PV is more attractive for lower-cost, financially more robust, and faster-payback deployment. Nevertheless, the comparison should be interpreted primarily through normalized indicators because the case studies differ substantially in installed capacity, and the selected life-cycle metrics rely on literature-based payback proxy assumptions for comparative life-cycle screening rather than plant-specific life-cycle inventories. Overall, this study provides an empirical 7E benchmark for tropical monsoon conditions in Southeast Asia and offers decision-relevant evidence for renewable energy planning in southern Thailand and the broader Southeast Asian context.

Keywords: 7E analysis, wind energy, solar photovoltaic, sustainability assessment; exergy analysis

Performance Assessment of Rooftop Solar Photovoltaic-Battery Energy Storage Charging Stations for Enhancing Disaster Resilience in Vulnerable Communities: A Case Study of Nakhon Si Thammarat Province, Thailand

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Abstract: Frequent and severe natural disasters in Southeast Asia, particularly tropical storms and severe flooding, continually threaten the stability of centralized power grids. Vulnerable communities suffer disproportionately during these prolonged power outages, losing access to critical communication, medical devices, and emergency lighting. This study assesses the performance of rooftop solar photovoltaic (PV) systems integrated with Battery Energy Storage Systems (BESS) as emergency charging stations to enhance disaster resilience in Nakhon Si Thammarat province, Thailand. Using PVSyst software, high-resolution geospatial and meteorological data were applied to evaluate 10 kWp and 20 kWp PV systems, alongside a 20 kWp PV + 20 kWh BESS configuration, across 23 districts. The results demonstrated robust energy yields, with 10 kWp and 20 kWp standalone systems producing 15,402–16,187 kWh/year and 30,871–32,432 kWh/year, respectively. The coastal district of Sichon exhibited the highest energy generation, while the mountainous Lan Saka district yielded the lowest. The PV-only systems maintained high Performance Ratios (PR) between 84.6% and 85.2%. Integrating a 20 kWh BESS slightly reduced the PR to approximately 80.7–81.2% due to charge/discharge losses, raising total system losses to 18.8–19.4%; however, this configuration successfully stored over 6,000 kWh/year. This stored energy is crucial for supplying uninterrupted power to emergency charging stations during grid failures, capable of replenishing the battery bank daily to support hundreds of devices and critical medical appliances. The findings confirm that PV-BESS micro-infrastructure is highly viable in tropical climates, providing an effective, decentralized strategy to safeguard vulnerable populations and improve overall community resilience against natural disasters.

Keywords: charging station; solar photovoltaic; battery energy storage system; disaster resilience; vulnerable communities.

Techno-Economic Assessment of Grid-Connected and Stand-Alone Hybrid Renewable Energy Systems with Battery and Hydrogen Storages: A Case Study of Southern Thailand

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Abstract
This study conducts a comprehensive techno-economic evaluation of grid-connected (on-grid) and standalone (off-grid) hybrid renewable energy systems (HRES) designed for a large-scale electricity demand site in Songkhla Province, southern Thailand, using the HOMER Pro simulation software. Both configurations include photovoltaic (PV) generation, battery energy storage systems (BESS) with sonnenBatterie units, a hydrogen fuel cell (FC) generator fueled by electrolytically produced and stored hydrogen, and a power converter. The on-grid configuration also incorporates bidirectional grid interaction. Key performance indicators such as net present cost (NPC), levelized cost of energy (LCOE), PV penetration, surplus electricity, CO_2 emissions, and system reliability (unmet load) were evaluated and compared across four simulation scenarios using HOMER Pro. The on-grid system achieves an LCOE of \$0.117/kWh with a total NPC of \$4.50 billion, whereas the standalone system results in an LCOE of \$0.232/kWh and an NPC of \$6.42 billion, underscoring the significant economic cost of complete energy independence. However, the standalone system achieved nearly zero CO_2 emissions owing to its lack of grid dependence. These findings provide valuable insights for microgrid planners, policymakers, and renewable energy investors in tropical regions with high solar irradiance.

Keywords: renewable energy; hydrogen fuel cell; battery energy storage; techno-economic assessment

Development of a $LiFePO_4$ Electric Propulsion System

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Abstract: This study aims to develop a prototype electric boat for water hyacinth collection, with emphasis on designing an appropriate propulsion system and energy management system for community-level applications. The propulsion system employs an 800 W brushless DC (BLDC) motor operating at 24 V, integrated with a lithium iron phosphate (LiFePO4) battery, selected for its high safety and long service life. The battery pack is configured in an 8-series (8S) arrangement, providing a nominal voltage of approximately 25.6 V with a capacity of 50 Ah, corresponding to a total energy of about 1,280 Wh. The system incorporates a motor controller and a Battery Management System (BMS), which monitors the state of charge, performs cell balancing, and disconnects the system under abnormal conditions to enhance operational safety and reliability. Experimental results under real operating conditions indicate that the battery pack can continuously supply a current in the range of 31–33 A at an operating voltage of 22–26 V, while maintaining stable performance throughout the discharge cycle. The prototype provides an average operating time of approximately 1.2–1.4 hours per charge, which is consistent with the usable energy range of approximately 1,100–1,200 Wh. The overall drive system efficiency is estimated to be in the range of 82–85%. In addition, the BMS effectively maintains cell voltage differences within ±20 mV during operation, contributing to improved system stability and extended battery lifespan.

Keywords: Electric boat; Brushless DC motor; Battery Management System; Lithium iron phosphate battery (LiFePO4); Water hyacinth harvesting

Short-Term Solar Radiation Forecasting in Southern Thailand using GFS-Driven WRF-Solar Atmospheric Modeling

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Abstract: Accurate short-term forecasting of surface solar radiation is essential for integrating photovoltaic generation into power systems; however, operational forecasts remain scarce for Southern Thailand, where a narrow peninsula bounded by the Andaman Sea and the Gulf of Thailand and a monsoon-driven climate produce strong spatial and temporal variability in irradiance. In this study, the WRF-Solar mesoscale model, initialized and driven by the 0.25° NOAA/NCEP Global Forecast System (GFS), was used to produce 7-day-ahead forecasts of global horizontal (GHI), direct normal (DNI), and diffuse horizontal (DIF) irradiance over Southern Thailand. A six-domain, one-way, nested configuration was adopted, with the innermost domain covering the lower peninsula of the country. The physics suite combined WDM6 microphysics, the Yonsei University planetary boundary layer, the Kain–Fritsch and University of Washington cumulus schemes, the revised MM5 surface layer, the unified Noah land surface model, and the RRTMG shortwave and longwave radiation scheme. Forecasts were generated for four representative weeks (18–24 March, June, September and December 2025) and examined at the Trang and Songkhla meteorological stations. The forecasts reproduced the expected diurnal bell-shaped irradiance cycles and captured cloud-induced fluctuations, with a peak clear-sky GHI of approximately 1000–1050 W/m². The clearest skies and highest insolation occurred during the December–March period, whereas the southwest monsoon weeks of June and September showed markedly lower and more intermittent irradiance. The GFS-driven WRF-Solar framework produced physically consistent short-term solar forecasts for Southern Thailand and is applicable to solar resource assessment and grid integration in the region.

Keywords: physics scheme; WRF-solar; short-term forecasting; GFS database; solar radiation

A Bibliometric Analysis on Net-Zero Power Sector Research in Thailand: Publication Trends, Intellectual Structure, and Emerging Themes

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Abstract: Thailand has committed to carbon neutrality by 2050 and net-zero greenhouse gas (GHG) emissions by 2065, placing its power sector at the centre of an accelerating policy and research agenda. Despite a rapidly growing body of literature, no systematic bibliometric synthesis of this domain exists. This study maps the intellectual landscape of net-zero power sector research in Thailand through a bibliometric analysis of 465 Scopus-indexed documents published between 1996 and 2026. Following PRISMA 2020 guidelines, 512 records were retrieved via a structured Boolean query and screened to a final corpus of 465 documents for analysis. Using the R bibliometrix package and VOSviewer, we examined publication trends, citation patterns, author and institutional productivity, source journal rankings, co-authorship networks, keyword co-occurrence clusters, and thematic evolution. The annual growth rate reached 14.62%, with publications surging after 2020 and peaking at approximately 120 articles in 2025. The corpus involves 1,607 authors across 253 journals, with 45.38% international co-authorship and an average of 16.2 citations per document. Thammasat University anchors the authorship network; Energy Policy and Applied Energy are the leading publication venues. Keyword analysis identifies five dominant research clusters: decarbonisation pathways and CGE modelling; renewable energy integration and technology assessment; energy efficiency policy; carbon markets and climate finance; and sustainable development frameworks. The thematic map distinguishes motor themes (energy transition, decarbonisation, net zero), niche themes (carbon capture, hydrogen), and emerging themes (AI-assisted grid optimisation, just transition). Four critical research gaps are identified: subnational emission inventories, GIS-based transmission expansion planning, AI/ML-aided siting, and green finance mechanisms. These findings offer a structured roadmap for researchers, policymakers, and practitioners advancing Thailand's net-zero power sector transition.

Keywords: bibliometric analysis; net-zero power sector; energy transition; GHG emissions; renewable energy

Performance Evaluation and Optimization of HFC-Based Microgrid Energy Management Using Deep Learning and Real-Time Operational Data

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Abstract: The intermittent nature of photovoltaic generation presents substantial challenges in sustaining power balance as a result of the increasing penetration of renewable energy sources in microgrid systems. This investigation suggests a hybrid microgrid energy management framework that comprises a PV system, a BESS, and a HFC. The framework is based on deep learning. The proposed framework integrates real-time operational data acquisition, feature engineering, net load forecasting, HFC dispatch optimization, and a MLP neural network within a unified energy management architecture. The experimental results indicate that the forecasting model that was constructed was capable of capturing the overall behavior of net load demand under real operating conditions, as evidenced by an $RMSE$ of 16.105 kW, an MEA of 11.562 kW, and an R^2 value of 0.591. The system's performance was considerably enhanced by the optimized HFC dispatch strategy, which reduced electricity imports from the utility grid from 71.254 kWh to 0.046 kWh, a reduction of approximately 99.94%. The average battery state of charge remained consistent at 58.61%, during which time renewable energy utilization increased from 174.93% to 210.75%. The total hydrogen consumption was 6.72 kg, and the HFC provided 123.11 kWh of electrical energy. Additionally, an emission reduction of approximately 99.94% was achieved by reducing carbon dioxide emissions from 32.06 kgCO_2 to 0.02 kgCO_2. These results indicate that the proposed framework effectively promotes the development of intelligent and sustainable microgrid energy management systems, reduces utility dependency, mitigates environmental impacts, and enhances the utilization of renewable energy.

Keywords: Microgrid; HFC; Deep Learning; Energy Management; Renewable Energy; Battery Energy Storage System

Optimal Day-Ahead Dispatch of a PV–BESS System under a TOU Tariff: A Comparative Study of Evolutionary and Swarm Metaheuristics Benchmarked against MILP

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Abstract: This study presents an optimal charge–discharge scheduling strategy for a BESS integrated with a PV generation system in a campus microgrid. Three conflicting objectives, namely energy cost under a TOU tariff, peak demand charges, and PV self-consumption, were consolidated into a single economic objective function expressed in monetary units THB/day, thereby eliminating the need for arbitrary weighting factors commonly employed in multi-objective optimization. The optimization problem was solved using four metaheuristic algorithms, namely GA, PSO, DE, and L-SHADE, under an identical function evaluation budget. The obtained solutions were benchmarked against the mathematical optimum derived from Mixed-Integer Linear Programming (MILP). Experimental evaluations were conducted using actual campus load and PV generation profiles collected from southern Thailand. The results indicate that L-SHADE achieved the best overall performance and the highest robustness, yielding an objective value of 772.2 THB/day with an optimality gap of only 1.82% relative to the MILP solution. Furthermore, the proposed scheduling strategy reduced the total operating cost by 19.9%, decreased peak demand from 14.9 kW to 3.3 kW (77.9% reduction), and lowered CO_2 emissions by 68.5% compared with the conventional rule-based dispatch strategy. These findings demonstrate the effectiveness of L-SHADE for optimal energy management in PV–BESS microgrid applications under TOU pricing schemes.

Keywords: BESS; PV; Optimal Dispatch Scheduling; TOU Tariff; L-SHADE

III. Environmental Engineering and Climate Solutions

Assessment of the Carbon Offset Requirements for International Routes of Thai-Registered Cargo Airlines

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Abstract: Air Transportation is one of the most popular global logistics, yet the industry accounts for approximately 2.5% of global carbon dioxide (CO_2) emissions. Particularly, the air cargo sector is rapidly growing driven by the expansion of e-commerce and geopolitical factors. The data from the Civil Aviation Authority of Thailand (CAAT) indicates that air cargo volime in 2024 reached 1.51 million tons, marking a 22% year-on-year increase. The numbers have raised an awareness of CO2 emissions on Thai-registered cargo carriers due to their fleets often consist of older aircraft that are less fuel-efficient and emit higher CO2. The research is to focus on the implementation of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) for Thai cargo carriers. The study analyzes greenhouse gas (GHG) emissions from Thai cargo carriers using actual flight data from 2023-2025 to determine the offset demand using the CORSIA Fuel Use Monitoring method and determine the domestic supply of carbon credits that certified under the Premium T-VER standard. The research findings indicate that while Thai-registered cargo carriers remain within CORSIA baseline, the trends have shown a steady rising in GHG emissions due to the growth of the E-Commerce Market increasing the needs for offset. The research also identified a significant supply gap in the domestic carbon market, Premium T-VER credits certified by the Thailand Greenhouse Gas Management Organization (TGO). The research concluded with data-driven policy recommendations for the policy makers and industry stakeholders to align domestic credit supply with international aviation offset demands.

Keywords: Aviation Industries; Carbon Offsetting; Carbon Credits; Thai-Registered Cargo Airlines; CORSIA

Effect of Variable Flow Rates on PET Microplastic Filtration Efficiency Using Quartz Gravel Media in Synthetic Stormwater Runoff

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Abstract: The contamination of aquatic environments by microplastics (MPs) via urban stormwater runoff has gained increasing attention. Granular filter media is considered as a potential mitigation measure. However, the influence of hydraulic variability on the MP retention remains insufficiently characterized. We examined relations between stormwater runoff flow regimes and the breakthrough of polyethylene terephthalate (PET) MPs with an average size of 53.72 ± 12.13 μm through a quartz gravel filter medium with a grain size of 1–2 mm. To simulate a 2-hour stormwater runoff event, each flow condition is divided into four consecutive 30-minute intervals, yielding four flow rate values per condition; i.e., constant low-flow (5-5-5-5 mL/min), initial high-flow (25-5-5-5 mL/min), and intermittent flow (5-25-5-25 mL/min). Effluent samples were collected at the end of each interval to evaluate MP breakthrough over time. The results show that stable low flow conditions produced the lowest breakthrough, while sudden increases in flow rate significantly enhanced particle passage. The initial high-flow condition generated the highest breakthrough during the first interval, whereas intermittent flow conditions resulted in repeated breakthrough peaks. The findings suggest that hydraulic disturbances strongly influence MPs transport and retention in granular filtration systems. This study provides insights into the performance of quartz gravel filters under dynamic stormwater conditions, demonstrating that hydraulic fluctuations significantly compromise the retention capacity of granular filter media. Besides, controlling an influent flow rate is mandatory for the stabilization of filtration system.

Keywords: microplastics, polyethylene terephthalate, stormwater runoff, quartz gravel, filtration

Performance and Energy Saving Analysis of a Chiller after Variable Speed Drive Installation

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Abstract: This research aims to evaluate the energy-saving potential, economic feasibility, and environmental impacts of installing a Variable Frequency Drive (VFD) in a water-cooled chiller system used in a commercial building. A Carrier 19XR water-cooled chiller with a cooling capacity of 500 refrigeration tons was selected as the case study. Actual operating data were collected from the Chiller Plant Management System (CPMS) over a one-year period. The data included operating load, operating hours, electric current, and electricity consumption. These data were analyzed to examine the energy consumption pattern, chiller performance, and the effects of VFD installation. The results showed that the chiller frequently operated under partial-load conditions. Therefore, the installation of a VFD enabled the motor speed to be adjusted in accordance with the actual cooling load. This resulted in a tendency toward reduced electric current and electricity consumption. In addition, the reduction in energy consumption contributed to lower electricity costs, improved economic feasibility, and reduced greenhouse gas emissions associated with electricity use. The findings indicate that VFD installation is an appropriate approach for improving the efficiency of air-conditioning systems in large buildings and supporting sustainable energy management in the long term.

Keywords: Variable Frequency Drive; Water-cooled Chiller; Energy Saving; Economic Feasibility; Greenhouse Gas Emission Reduction

Integrated GIS-Based Assessment of Noise, Shadow Flicker, and Zone of Visual Influence for Utility-Scale Wind Energy Development: A Case Study of Prachuap Khiri Khan Province, Thailand

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Abstract: The rapid expansion of utility-scale wind energy in Thailand has heightened concerns regarding its environmental and social acceptability, particularly with respect to noise emissions, shadow flicker, and visual intrusion experienced by nearby communities. This study presents an integrated Geographic Information System (GIS)-based framework that jointly assesses these three impacts for a proposed 70 MW wind farm comprising 14 GoldWind GW182-5.0 MW wind turbine generators (WTGs) in Prachuap Khiri Khan Province, southern Thailand. A three-dimensional Computational Fluid Dynamics (CFD) wind flow model was coupled with a measured wind dataset at 140 m above ground level (AGL) to characterize the microscale wind resource. Noise propagation was modelled and validated against field measurements at three acoustic monitoring stations. Shadow flicker was simulated for twenty-four sensitive receptors under a worst-case scenario, and the zone of visual influence (ZVI) was derived from a digital elevation model. The microscale wind resource at the 165 m hub height ranged mostly from 3.5–4.5 m/s across the array. The modelled WTG noise at all monitored households remained between 38 and 40 dB(A), below the measured background levels, yielding a 0% disturbance. The shadow flicker at the assessed receptors ranged from 0 to 27 h/yr, while the ZVI indicated that between zero and fourteen turbines were potentially visible across the surrounding landscape. The integrated assessment demonstrated that the proposed development complies with commonly applied noise and shadow flicker thresholds and provides a transferable, spatially explicit decision-support tool for siting utility-scale wind farms in Thailand.

Keywords: noise emission; shadow flicker; wind farm; zone of visual influence; wind flow modeling

IV. Sustainable Materials and Green Manufacturing

Effect of LECA Replacement Level on Physical and Mechanical Properties of Pervious Concrete

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Abstract: This study investigates the effect of LECA replacement level (0%, 35%, 65%, and 100% by volume) on the effective void content, bulk density, permeability coefficient, and compressive strength of pervious concrete at a constant water-to-cement ratio of 0.30. Effective void content rose from 21.5% to 30.9% and bulk density fell from 1,711 to 1,105 kg/m³ with increasing LECA content, attributable to the narrow size distribution and rounded, smooth morphology of LECA particles that prevents tight aggregate interlocking. Compressive strength declined consistently from 6.95 to 3.70 MPa at 28 days due to the lower crushing resistance of LECA and a weaker aggregate–paste interfacial transition zone. The permeability coefficient followed a non-monotonic trend, peaking at 2.879 cm/s at 65% LECA before declining to 2.709 cm/s at full replacement; the decline is attributed to gravity-driven cement paste migration during compaction, which partially blocks the lower pore channels when smooth LECA surfaces offer insufficient resistance. These results confirm that pore connectivity is a more decisive factor than total void volume in governing permeability. The 65% LECA mixture offers the most balanced performance for drainage and light-duty pavement applications, while 35% LECA is recommended where higher compressive strength is the priority.

Keywords: pervious concrete; LECA; lightweight aggregate; void content; permeability; compressive strength

Integrated Assessment of Aged Landfill Plastics: Environmental Implications and Waste-to-Energy Conversion into High-Calorific Solid Recovered Fuel

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Abstract: The accumulation of plastic waste in landfills poses significant environmental challenges due to long-term persistence, degradation into microplastics, and potential contamination of surrounding ecosystems. This study investigated the physicochemical characteristics, environmental impacts, and energy recovery potential of aged landfill plastics collected from an open dumpsite in Saraburi Province, Thailand. Residual plastic samples collected at depths of 0 and 30 cm were characterized using Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), X-ray Fluorescence Spectroscopy (XRFS), and Scanning Electron Microscopy (SEM). The results confirmed that polyethylene (PE) was the dominant polymer in both samples. However, plastics collected from deeper layers exhibited oxidative degradation, reduced crystallinity, increased amorphous structure, contaminant accumulation, and severe surface deterioration associated with long-term landfill exposure. Environmental assessment revealed the presence of landfill gas emissions, elevated particulate matter (PM2.5 and PM10), and contaminated leachate with high total dissolved solids and electrical conductivity, indicating potential environmental risks from unmanaged landfill systems. In addition, aged landfill plastics were successfully converted into solid recovered fuel (SRF) through thermal densification. The produced SRF showed high calorific values ranging from 10,432 to 11,649 kcal/kg, demonstrating strong potential as a partial coal substitute in industrial applications. Optimal fuel quality was achieved at a molding temperature of 100 °C and 30% moisture content. Overall, the findings highlight the potential of transforming aged landfill plastics into valuable alternative energy resources while supporting sustainable waste management and circular economy strategies.

Keywords: landfill plastics; solid recovered fuel; waste-to-energy

Papain Enzyme as a Cleaning Agent for Animal Glue Removal from Unpainted Canvas: A Preliminary Evaluation

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Abstract: Animal glue is widely used as an adhesive in the preparation of canvas for cultural heritage objects, yet its degradation threatens the stability and visual integrity of these artifacts. This study investigates the use of papain enzyme for selective removal of animal glue from unpainted canvas. Cleaning performance was evaluated across treatment time, enzyme concentration, application method, and deactivation strategy. Colorimetric shifts were quantified using the CIE Lab* system, and structural and chemical changes were monitored by FTIR and SEM–EDS analyses. The optimal protocol—0.0192 g/mL papain for 60 minutes—achieved effective glue removal and improved surface brightness without damaging the canvas. Increasing enzyme concentration did not further enhance cleaning and risked residual deposits. Enzyme deactivation proved essential; 0.0750% (v/v) acetic acid reliably inhibited papain with negligible impact, outperforming urea. FTIR and SEM–EDS confirmed the reduction of proteinaceous residues and restoration of the canvas surface. These findings demonstrate that papain, followed by acetic acid deactivation, provides a controlled, efficient, and environmentally responsible method for conserving materials bound with protein adhesives.

Keywords: animal glue removal; conservation science; enzymatic cleaning; papain enzyme

Injection-Based Self-Healing Repair Using *Bacillus sp.* for Impact-Damaged High-Strength Reinforced Concrete Slabs

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Abstract: High-strength reinforced concrete slabs may suffer progressive cracking and localized failure under repeated impact loading, making repair strategies important for resilient and sustainable infrastructure. This study evaluates Bacillus sp. as an injection-based self-healing agent for repairing 85 MPa reinforced concrete slabs previously damaged by impact. Reinforced square slabs with dimensions of 40 x 40 x 4 cm, 60 x 60 x 6 cm, and 80 x 80 x 8 cm were prepared using a high-strength concrete mixture containing cement, silica fume, superplasticizer, fine aggregate, coarse aggregate, and water. Bacillus sp. was applied at 0.6% of cement weight with urea, CaCl2, and nutrient broth, and injected into cracks after initial damage at approximately 70% of ultimate impact capacity. The specimens were immersed for 28 days and then retested under repeated drop-weight impact loading using a 3 kg steel ball dropped from 1 m. The control P8-N slab failed at 1003 blows with absorbed energy of 29,518.29 J, while the injected P8-I specimen reached 1239 blows and 36,463.77 J in the cumulative comparison. Relative cumulative impact-capacity ratios after the injection sequence were 123.53%, 151.80%, and 137.50% for P8-I, P6-I, and P4-I, respectively. The P6 and P4 benchmarks were taken from comparable previous data, while the P8 comparison used the tested P8-N control. The results indicate that Bacillus sp. injection contributed to residual-capacity restoration, but the response should not be interpreted as full recovery to an undamaged state. The findings extend Bacillus-based self-healing research from mainly static crack closure to impact-damaged high-strength slab repair; however, the evidence remains limited by single dosage, limited replication, and the absence of direct microstructural confirmation of $CaCO_3$.

Keywords: *Bacillus sp.*; self-healing concrete; high-strength concrete; impact loading; crack injection

Upcycling Palm Oil Mill Waste in the Development of Artificial Lightweight Expanded Clay Aggregates

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Abstract: This study was conducted to investigate the effects if incorporating various organic pore forming agents; Palm oil meal sludge (POM), Palm kernel meal (PKM) and Palm oil mill effluent (POE) at varying concentration of 5% to 40% on the physical and structural characteristic of clay pellets fired between 600 °C and 1000 °C. The experimental results indicated that the addition of organic pore forimg agents produced lightweight clay pellets. Across all formations, weight loss increased with increasing firing temperatures due to the decomposition of clay body and the burnout of organic matter. Consequently, sammples with high additive contents, specifically POM20 and PKM20, demonstrated an obvious increased in both apparent porosity and water adsorption, while apparent specific gravity decreased compared to pure clay. It is important that micropore structure evolution of lightweight expanded clay aggregate related strongly to firing temperature. Whilefiring temperatures up to 900 °C maintained high porous network generated by the pore forming agents, as the temperature reached 1000 °C caused melting of clay metrix, consequencely the reduction in apparent porosity and water adsorption of all samples. Conclusively, these finding demonstrate that organic wastes are very effective agents to creat a highly lightweight porous materials.

Keywords: Lightweight Expanded Clay Aggregate; pore forming agents; apparent porosity; agricultural waste utilization

Synergistic Effects of Alkaline Treatment, UV Irradiation, and Ozone Exposure on Nitrogen Adsorption by Biomass-Derived Activated Carbon

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Abstract: Methane, the primary component of natural gas, is considered a promising clean energy source due to its abundance and lower carbon dioxide (CO_2) emissions compared to other fossil fuels. In addition, methanation technology enables methane production without direct CO_2 emissions. However, its relatively low volumetric energy density compared to conventional fuels such as gasoline and diesel necessitates the development of more efficient storage methods. This study aims to develop stable and sustainable activated carbon (AC) derived from biomass for gas storage applications. For safety considerations, nitrogen was used as a surrogate gas instead of methane, although methane possesses higher polarizability. The AC was produced from swat bamboo (Gigantochloa verticillata) cultivated in Bali, Indonesia, and subsequently chemically reactivated using potassium hydroxide (KOH) solutions at varying concentrations to enhance its properties. Following chemical activation, selected samples were subjected to ultraviolet (UV) irradiation, and the effects of ozone treatment were also investigated. All samples were characterized to evaluate changes in pore size distribution and surface area using nitrogen adsorption at 77 K based on the Brunauer–Emmett–Teller (BET) method. In addition, surface morphology was examined to provide insight into structural modifications. The results indicate that both alkaline treatment and UV irradiation significantly enhanced the adsorption capacity of AC, with performance increasing over time before reaching a plateau. Ozone treatment resulted in only a slight improvement in adsorption capacity. These findings suggest that combined chemical and UV treatments are effective strategies for improving biomass-derived activated carbon for gas storage applications.

Keywords: Energy storage, Nitrogen adsorption, Bamboo biomass, Activated carbon, Alkaline treatment, Ultra-violet light, Ozone

V. Internet of Things (IoT) and Smart Sensing

Development of a Smart IoT Protection Kit for Real-Time Electrical Fault Detection Using Fuzzy Logic

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Abstract: The purpose of this article is to develop a fault detection system by applying the Internet of Things (IoT) in conjunction with Fuzzy Logic to improve the efficiency of real-time anomaly detection, analysis, and alerting. The developed system consists of sensors for measuring parameters such as voltage and current. The collected data is transmitted to a microcontroller for processing and analysis using Fuzzy Logic before the results are displayed over the Internet network. The experimental results showed that the system was able to detect anomalies and provide alerts quickly and with high accuracy. The application of Fuzzy Logic reduced decision inconsistencies and effectively handled uncertain data. In addition, the system can operate in real time and is suitable for applications in electrical systems, energy systems, and smart industrial systems in the future.

Keywords: IoT; Fuzzy Logic; Fault Detection; Intelligent Systems; Real-Time Alerts

Development of a Real-Time Water Level Monitoring System Using IP Camera and Image Processing on Raspberry Pi 5 for Flood Monitoring Applications

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Abstract: Flood monitoring for disaster risk management and water resource planning in flood prone areas to protect infrastructure, agriculture and communities. Water levels are monitored with float gauges, pressure transducers and ultrasonic sensors. Sediment, corrosion, biological fouling, and harsh environmental conditions reduce performance and increase maintenance costs. An image processing and edge computing-based real-time contactless water-level measurement system is proposed in this paper. The proposed system uses TP-Link Tapo C520WS IP cameras to photograph waterways. The Raspberry Pi 5 processes RTSP-transmitted image data locally. The image processing pipeline includes region-of-interest extraction, greyscale conversion, image enhancement, noise reduction, edge detection, and waterline identification. A calibration relationship between detected pixel coordinates and reference scale water levels estimates water levels. Local database data is displayed on web-based monitoring dashboards. Image and measurement data are automatically archived for historical analysis and long-term monitoring. The field experiments took place in Bang Kaeo District, Phatthalung Province, Thailand, day, night, and rainy. Comparison of image-based and manual measurements assessed system performance. Experimental results show the proposed system has a 1.23 cm MAE and 1.49 cm RMSE. The Raspberry Pi 5 platform processed images in 0.31s and was stable during monitoring. Continuous 30-day field evaluation yielded 98.7% system availability. Results show that the image-processing-based monitoring system can accurately, reliably, and non-contactly measure water levels at low installation and maintenance costs. IP cameras, image processing and edge computing can be used for tropical flood monitoring and community-based warnings. The platform may be useful for rural and remote areas where monitoring infrastructure is limited.

Keywords: Water level monitoring, Image processing, Edge computing, Raspberry Pi 5, IP camera, Flood monitoring, Real-time monitoring.

VI. Appropriated Technology

Automatic G-code Generation for Face Milling on a Small CNC Machine Using a Machine Vision System

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Abstract: Although face milling appears to be a simple task, manual G-code programming can be very time-consuming and difficult for novice users. The main aim of this study is to develop a semi-automatic G-code generation system for face milling operations using a computer vision system. The developed prototype utilises two webcams that are one for the top view and one for the side view, which are mounted onto the work bench of a custom-built, homemade CNC machine. By utilizing the results with dataset training logic, the two real-time images captured from the top and side views are analysed using homography principles via OpenCV and the YOLOv8 model. This setup allows the system to automatically calculate and generate the G-code required for face milling on a small CNC machine. At present, the system is limited to processing only basic geometries, specifically rectangular blocks and cylinders. In terms of physical accuracy, any positional errors on the xy plane do not significantly affect the face milling outcome. However, the average tool position error along the z-axis, which was measured at +0.327±0.037mm, could have a major impact on the final cutting depth. Even though this research is still in initial stages, the system successfully demonstrates that the face milling workflow can be made much more accessible and user-friendly by bypassing the traditional manual programming phase.

Keywords: 1; G-code Generation 2; Face Milling 3; CNC 4; homography

Real-Time Hardware-In-the-Loop Applications for Engineering Research

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Abstract: This paper presents the application of a real-time Hardware-in-the-Loop (HIL) platform for engineering research using MATLAB/Simulink and the DSP TMS320F28335 microcontroller board. The proposed platform aims to provide a practical and cost-effective alternative for engineering research compared to commercial HIL systems that require high-cost specialized hardware. This platform offers a cost-effective, flexible method for validating engineering research. In addition, it can be applied to particularly large-scale systems that cannot be physically implemented in laboratory environments using generally available tools and embedded control hardware. The HIL operation integrates practical engineering hardware systems on the MATLAB/Simulink program with control systems using code on the DSP TMS320F28335 microcontroller board, with real-time data exchange between them. As a result, the hardware model and control system operate in a closed-loop configuration. It allows accurate evaluation of system behavior under realistic operating conditions. Experimental results indicated that the waveforms obtained from MATLAB/Simulink and the DSP TMS320F28335 microcontroller board under the specified test conditions exhibit zero error. These results confirm that the proposed HIL platform can operate in real-time with high accuracy. Consequently, the proposed system serves as an effective tool for the development of engineering knowledge.

Keywords: hardware-in-the-loop, real-time systems, embedded systems, engineering research

VII. Other Related Topics

Greening the Algorithm: A Systematic Review of Artificial Intelligence in Green Marketing

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Abstract: Artificial intelligence (AI) has rapidly migrated from a back-office automation layer into the front line of green marketing, mediating eco-claims, personalising sustainability appeals, and orchestrating circular-economy operations. The literature remains fragmented across consumer-behaviour, technology, governance, and industry silos. This study synthesises the state of evidence and proposes an integrative framework. A PRISMA 2020 systematic review was conducted on a curated corpus of 178 records identified from peer-reviewed journals and IEEE/Scopus-indexed proceedings published between 2020 and 2026. After duplicate removal and full-text screening for explicit AI and green-marketing focus, 28 studies were included in the qualitative synthesis. Eight overlapping clusters emerged: theoretical frameworks; consumer cognition and intentions; generative-AI persuasion; greenwashing and traceability; industry applications; enterprise decision support; engagement and gamification; and meta-research. The findings are integrated into a four-pillar TIBE framework; Technology stack, Influence pathways, Boundary conditions, and Ethical-environmental guardrails. AI is a powerful but conditional accelerator of green marketing because its credibility now depends on transparent governance, balanced human–AI co-creation, and explicit accounting for AI's own environmental footprint.

Keywords: artificial intelligence; green marketing; systematic review; PRISMA 2020; greenwashing; sustainable consumer behaviour

Numerical Sensitivity and Distance-Dependent Optimization of Sprint Force-Velocity Profiles: A Forward-Dynamics Simulation

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Abstract: This study evaluates the numerical sensitivity and structural boundaries of the conventional linear horizontal force-velocity (*F-v*) profiling framework compared to a refined force-driven forward-dynamics numerical integration model using an explicit Euler scheme. To isolate purely mechanical relationships and establish mathematical baselines, a deterministic computational simulation was employed, modeling a full-factorial synthetic cohort of hypothetical athletes across realistic biological and physical distributions ($P_{max} \in [10, 30]$ W·kg^{-1}, $k \in [0.0025, 0.0044]$ N·s^2·m^{-2}·kg^{-1}). The numerical analysis demonstrates that divergence between simplified kinematic-constrained fitting and explicit dynamic modeling scales continuously with acceleration distance. Beyond approximately 20 meters, the discrepancy driven by aerodynamic omission progressively exceeds the upper reference bound of model-approximation root-mean-square error (RMSE > 0.056 N·kg^{-1}) in 54.2 % of the cohort, scaling to 100.0 % at 30 meters, reflecting the cumulative impact of simplified linear assumptions when velocity-dependent resistive forces are completely omitted. Conversely, the newly integrated drag-aware inverse control framework completely eliminated this structural drift (RMSE = 0.0000 N·kg^{-1}) across all distances, confirming that conventional profiling functions accurately when environmental and fluid-dynamic parameters are preserved. Rather than serving as a direct training prescription, this study provides a robust theoretical framework and a set of testable mathematical hypotheses regarding numerical model sensitivity over extended sprint distances. Future empirical research involving human participants is required to validate these simulated discrepancy trends against biological variability and neuromuscular control. These findings are derived from a controlled ablation analysis and should not be interpreted as a limitation of conventional drag-aware profiling methodologies.

Keywords: Aerodynamic drag; Model approximation error; Euler integration; Forward dynamics; Optimization landscape; Numerical sensitivity.

Real-Time Fault Classification of BLDC Motors in Electric Vehicle Based on Vibration Features and Support Vector Machine

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Abstract: This article presents a method for detection and classify defects in brushless DC motors. Brushless Direct Current (BLDC) using vibration signal analysis in combination with artificial intelligence techniques. This study focuses on detecting major motor faults, including bearing faults, open-circuit sensor hall faults and short-circuit stator winding failure. by simulating the operation of the motor. The vibration signal is then generated in both normal and faulty conditions. To analyze and extract signal characteristics. Signal processing uses analytical methods in the time domain and time-frequency analysis with spectrograms and signal envelope spectrum analysis with the Hilbert Transform technique. It also extracted important statistical features, including the Root Mean Square (RMS) and the kertosis value. The use of the Support Vector Machine (SVM) technique to classify the operating conditions of the motor. The results of the experiment showed that the vibration signals of each disorder were clearly characterized. The SVM model can classify the types of defects with high accuracy, which shows that the proposed methods can be applied to monitor the condition and diagnose motor defects. BLDC in electric vehicle systems and unmanned aerial vehicles effectively.

Keywords: Brushless Direct Current; Vibration analysis; Fault detection; Electric Vehicle; Support Vector Machine

Hardware-in-the-Loop Simulation for Harmonic-Based Detection of Transmission Line Faults

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Abstract: This paper presents a Hardware-in-the-Loop (HIL)-assisted modeling and analysis framework for investigating transmission line faults in high-voltage power systems. The study focuses on the simulation and characterization of single-line-to-ground (SLG) and line-to-line (LL) faults using MATLAB/Simulink integrated with real-time HIL implementation. A transmission network model consisting of a hydroelectric generation source, step-up transformers, and a high-voltage transmission line was developed to analyze transient fault behavior under different fault conditions. The proposed framework enables real-time monitoring of three-phase currents, transient responses, and harmonic distortion during fault events. Fault scenarios were introduced at different time intervals to evaluate the dynamic performance and stability of the system. Simulation results demonstrate that SLG faults produce severe current imbalance and transient oscillations, while LL faults generate significantly higher fault currents and harmonic disturbances. The harmonic analysis confirms that abnormal fault conditions substantially increase total harmonic distortion (THD), affecting system stability and power quality. The proposed approach provides an effective platform for power system fault diagnosis, protection coordination, and educational research in modern smart grid applications. The findings contribute to the development of reliable fault monitoring and real-time protection strategies for high-voltage transmission systems.

Keywords: Hardware-in-the-Loop; Transmission line faults; Harmonic Analysis, MATLAB Simulink;

Analysis of Temperature Distribution in a 400 kVA Distribution Transformer Using 3D Finite Element Method

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Abstract: Distribution transformers are critical components of power delivery systems. Internal heat generation, particularly under unbalanced load conditions common in distribution networks, can lead to elevated temperatures that compromise transformer reliability and lifespan. Objective: This study analyzes the magnetic field distribution and thermal profile of a three-phase, 400 kVA distribution transformer, comparing the temperature distribution of two silicon steel core materials under both balanced and unbalanced loading scenarios. Method: A three-dimensional finite element method (3D-FEM) model was developed and implemented in MATLAB. The Galerkin weighted residual technique was applied to discretize the governing partial differential equations for the magnetic vector potential and thermal fields using tetrahedral elements. Six load cases were simulated: balanced loads at 60%, 80%, and 100% of rated capacity, and three unbalanced magnitude cases referenced to phases A, B, and C. Two core materials were evaluated: non-grain-oriented silicon steel (M5 grade) and grain-oriented silicon steel. Results: Under balanced loading, temperature distributed uniformly across all three phases. Under unbalanced conditions, the phase carrying the highest load exhibited the greatest peak winding temperature. The grain-oriented silicon steel core consistently produced a 6% lower peak winding temperature compared to the M5 non-grain-oriented steel. The most severe unbalanced case resulted in maximum winding temperatures of 99.8°C for the M5 steel versus 95.0°C for the grain-oriented steel. Practical Application: These findings provide quantitative evidence regarding thermal performance to support the selection of grain-oriented silicon steel cores in distribution transformer design and offer a reliable thermal simulation framework for pre-installation performance evaluation.

Keywords: Distribution transformer; Unbalanced load; Temperature distribution; 3D-FEM; Grain-oriented silicon steel

Factors Influencing Public Readiness to Use Online Cash Waqf Platforms in Malaysia

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Abstract: The factors underlying Malaysians' readiness to use online cash waqf platforms constitute the main focus of this study. The acceptance of this practice is considered important in driving the socioeconomic development of society. Based on the literature review, six main factors were identified, namely perceived usefulness, perceived ease of use, religiosity, amount of information, trust in waqf institutions, and public knowledge. This study employed a quantitative research design through the distribution of questionnaire instruments to 384 individuals. To evaluate the data obtained, the analysis was conducted using descriptive statistics and inferential tests. The research findings indicate that each variable examined has a positive impact on Malaysians' readiness to use digital cash waqf systems. These findings indirectly demonstrate the potential of this instrument to bridge socioeconomic gaps and promote meaningful social transformation. Therefore, the findings of this study are recommended as a strategic reference for waqf agencies to optimise governance and strengthen the online waqf ecosystem for the benefit of the Malaysian.

Keywords: Online Cash Waqf; Community Readiness; Socioeconomic Development; Waqf Institutions; Social Transformation

Investigation of Magnetic Field Distribution and Vibration Behavior in Induction Motor and Permanent Magnet Synchronous Motors Using 3D-FEM

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Abstract: Electric motors used in traction applications are required to achieve high efficiency, low vibration, and reliable operation. This study investigates and compares the magnetic field distribution and vibration characteristics of a 50 kW induction motor with straight rotor slots and a permanent magnet synchronous motor (PMSM) using a three-dimensional finite element method (3D-FEM). The magnetic vector potential, magnetic flux density, radial magnetic field, magnetic force distribution, and stator vibration response were analyzed under identical operating conditions. The simulation results show that both motors generate stable rotating magnetic fields synchronized with rotor motion. However, the PMSM exhibits a more symmetrical magnetic field distribution and a higher peak radial flux density of approximately 0.8 T, compared with 0.7 T for the induction motor. The smoother air-gap magnetic field of the PMSM results in lower magnetic force harmonics and reduced force ripple. Vibration analysis reveals that both motors exhibit a dominant vibration frequency of approximately 100 Hz, corresponding to twice the supply frequency. The induction motor produces a higher average radial displacement amplitude of approximately 3.02×10^{-5} m, whereas the PMSM exhibits a lower displacement amplitude of approximately 2.24×10^{-5} m. The results confirm that radial magnetic force harmonics are the primary source of stator vibration and demonstrate that the PMSM provides superior vibration performance, improved mechanical stability, and reduced magnetic force ripple compared with the induction motor. These findings provide useful guidelines for the design and optimization of low-vibration traction motors for high-performance electric drive applications.

Keywords: Induction motor; Permanent magnet synchronous motor; Magnetic field distribution; Vibration; 3D-FEM

Innovative Hybrid Activity-Based Learning Workshop Series for Developing Research Competencies in Graduate Engineering Education

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Abstract: Graduate engineering students are expected to conduct independent research; however, conventional lecture-based instruction alone often fails to develop the practical competencies required for thesis work. This study presents the design, implementation, and evaluation of an innovative hybrid activity-based learning workshop series for a graduate Research Methodology course at the Faculty of Engineering, Thaksin University, Thailand. The hybrid model integrates conventional lecture-based learning with a series of 12 hands-on workshops covering contemporary research tools, including systematic literature review, AI-assisted manuscript preparation, computational fluid dynamics, solar and wind energy simulation, geographic information systems, reference management, design of experiments, and intellectual-property mapping. The teaching instrument was validated through Item-Objective Congruence (IOC) analysis by three experts, and its internal consistency was assessed using Cronbach's alpha. Items with an IOC index below 0.5 were removed, yielding a refined nine-item questionnaire that achieved a Cronbach's alpha of 0.844, indicating good reliability. The course outcomes were aligned with an outcome-based education (OBE) framework and assessed through a virtual thesis proposal incorporating both formative and summative rubric scoring. The results demonstrate that the proposed hybrid workshop series provides a valid and reliable approach to strengthening research competencies in graduate engineering education.

Keywords: activity-based learning; workshop series; graduate engineering education; Cronbach's Alpha

Reverse Engineering of CAN Bus Signal for Vehicle Speed and Power Demand Analysis in BYD Dolphin EV

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Abstract: This study presents a reverse engineering approach for identifying and decoding CAN Bus signals associated with vehicle speed and battery %SOC in a BYD Dolphin EV. The CAN Bus, the main communication infrastructure of contemporary EVs, provides access to vital operational metrics for energy analysis and vehicle monitoring; however, manufacturers' proprietary signal encoding algorithms sometimes limit direct access to this data. Using a Makerbase MKS CANable V1.0 adapter and PCAN-View software, real-world driving data was gathered via a USB-CAN interface. A Python-based real-time monitoring system was created for data collection, display, and recording after the detected signals were verified by dashboard measures. After that, driving behavior under situations of acceleration, cruising, and deceleration was examined. Multiple polynomial regression was used to create a data-driven power demand model based on vehicle speed, acceleration, deceleration, and interaction factors. Experimental findings effectively detected vehicle speed at CAN ID 122h and battery %SOC at CAN ID 2F2h. With an $RMSE$ of 4.12 kW, an MEA of 2.45 kW, and an R^2 of 0.912, the suggested model demonstrated strong predictive abilities for estimating power consumption in the actual world. The suggested architecture offers a useful basis for real-time vehicle monitoring applications, energy efficiency evaluation, driving behavior analytics, and EV diagnostics.

Keywords: CAN Bus for EV; Vehicle Speed Identification; Battery %SOC; Power Demand Modeling; BYD Dolphin

An Integrated GIS-Based Multi-Objective Optimization Framework for EV Charging Station Placement and Electric Bicycle Distribution Using A* Shortest Path and PSO

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Abstract: This paper proposes an integrated GIS–A*–PSO optimization framework for determining the optimal locations of electric bicycle charging stations to support battery replacement operations on a smart university campus. Unlike conventional EV charging station planning that primarily targets passenger vehicles, the proposed framework focuses on improving the accessibility and operational efficiency of electric bicycle mobility by minimizing the cumulative travel distance between campus parking zones and charging stations under realistic spatial constraints. The methodology integrates GIS-based spatial modeling, binary occupancy grid generation, graph representation, A* shortest-path planning, and PSO. Accessibility is evaluated using graph-based shortest-path distances, providing a more realistic representation of campus transportation networks than conventional Euclidean-distance approaches. Using the existing charging station configuration as the baseline, the current layout resulted in an average travel distance of 537.29 m per parking zone and a total shortest-path distance of 3,761.00 m. After optimization, the single-, two-, and three-station deployment scenarios reduced the total travel distance to 2,832.95 m (24.66%), 1,744.39 m (53.62%), and 1,274.31 m (66.12%), respectively. The PSO algorithm consistently converged to stable solutions within approximately 20–80 iterations. The optimized charging station configurations also supported efficient electric bicycle distribution for battery replacement operations, demonstrating the practical applicability of the proposed framework for smart campus mobility planning and sustainable electric bicycle charging infrastructure.

Keywords: Electric Bicycle Charging Station; GIS-Based Optimization; A* Shortest Path; Particle Swarm Optimization; Smart Campus Mobility