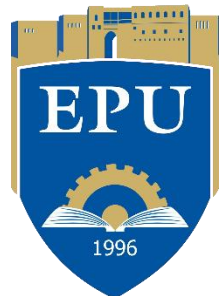


**11th INTERNATIONAL ENGINEERING
CONFERENCE
IEC-2026**

April 29-30, 2026

Erbil, Kurdistan Region-IRAQ

BOOK OF ABSTRACT



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Foreword:

The eleventh International Engineering Conference (IEC'2026) will be held on April 29–30, 2026, under the theme “Innovative Engineering Research for Sustainable Development.” The event is jointly organized by the Faculty of Engineering at Tishk International University (TIU-Iraq), Erbil Polytechnic University (EPU-Iraq), and Nusa Putra University (Indonesia), with technical collaboration from IEEE and the IEEE Iraq Section.

IEC'2026 provides a multidisciplinary forum for researchers, academics, and practitioners to present cutting-edge developments and advanced research across a wide spectrum of engineering disciplines. The conference covers key areas such as construction and structural engineering, structural materials, earthquake engineering, sustainable construction practices, composite materials, and construction management. It also addresses topics including environmental engineering, green and smart buildings, restoration and rehabilitation of historical structures, renewable energy systems, hydraulic engineering, sustainable materials, waste management, transportation engineering, and geotechnical engineering. In addition, emerging and rapidly evolving fields—such as surveying and geomatics engineering, highway engineering, data science, big data analytics, artificial intelligence, robotics, communications, and biomedical informatics—form an integral part of the conference program.

The conference is supported by a program committee of 90 esteemed experts, approximately 85% of whom hold doctoral degrees in engineering disciplines aligned with the conference themes. In line with international academic standards, IEC'2026 is conducted in accordance with the guidelines established in cooperation with IEEE technical partners, as well as the regulations of the Kurdistan Ministry of Higher Education. All submitted papers undergo a rigorous double-blind peer review process, with each manuscript evaluated by at least three reviewers. The review process ensures that contributions meet essential criteria, including relevance, originality, timeliness, technical soundness, clarity of presentation, and appropriate use of references. The paper review process for IEC'2026 demonstrates a rigorous and well-structured evaluation across its co-located conferences and thematic tracks. A total of 53 submissions entered the review phase, of which 37 papers were accepted, 16 were rejected, and 16 were withdrawn at various stages. Excluding withdrawn manuscripts, 44 papers were fully reviewed, resulting in an overall acceptance ratio of 69.8%, reflecting a balanced approach between selectivity and inclusiveness.

At the conference level, the International Conference on Advances in Civil and Infrastructure Engineering (ICACIE'26) recorded a notably high acceptance ratio of 86.7%, with 13 accepted papers out of 15 reviewed submissions, indicating strong alignment between submissions and the conference scope. In contrast, the International Conference on Engineering Technologies and Smart Systems (ICETSS'26) exhibited a more competitive selection process, with 24 accepted papers out of 38 submissions under review, yielding an acceptance rate of 63.2%. The IEC'26 – 11th International Engineering Conference on Emerging Trends in Engineering did not record any submissions during this cycle.

A more granular analysis across tracks reveals varying levels of competitiveness and research activity. Within ICACIE'26, tracks such as Transportation and Geotechnical Engineering, Water, Environmental, and Hydraulic Engineering, and Sustainable and Resilient Built

Environment achieved a 100% acceptance rate for reviewed papers, indicating either highly specialized submissions or strong pre-selection quality. The Structural and Construction Engineering track showed moderate selectivity with a 60% acceptance rate, while the Smart Infrastructure and Intelligent Technologies track had only withdrawals and no completed reviews.

Within ICETSS'26, the Computational Intelligence and Machine Learning track attracted the highest number of submissions (22 under review) but maintained a balanced acceptance rate of 50%, reflecting its competitive nature. Similarly, the Embedded and Smart Systems Design track recorded a 50% acceptance rate, while Robotics, Control, and Automation Systems was more selective with 33.3%. Notably, the Networking, Communication, and Signal Processing track achieved a 100% acceptance rate for reviewed papers, suggesting strong thematic consistency and submission quality.

Overall, the statistics highlight a diverse and active research landscape, with varying degrees of selectivity across tracks. The relatively high overall acceptance rate, combined with track-level variations, reflects both the inclusiveness of the conference and the emphasis on maintaining quality through peer review. During the review process, some submissions are either rejected or withdrawn based on reviewer recommendations or failure to meet pre-review standards, such as plagiarism or falling outside the conference's scope. All manuscripts are screened using iThenticate plagiarism detection software, with only those registering less than 25% plagiarism proceeding to review. Compliance with IEEE and EAJSE journal template formats is also meticulously checked by the Technical Program Committee (TPC). Papers requiring minor or major revisions, as recommended by reviewers, are conditionally accepted, with authors given the opportunity to amend their manuscripts based on feedback. Once revised, these papers undergo additional scrutiny by the track chairs and TPC members to ensure compliance with reviewer recommendations. Final decisions on acceptance or rejection are made accordingly.

We express our deep gratitude to all participants, committee members, keynote speakers, and sponsors for their invaluable contributions to this conference. Through your support, IEC'2026 continues to foster innovation and excellence in engineering research, with a clear focus on sustainable development. Thank you.



Assist. Prof. Dr. Abubakar M. Ashir

Chair of IEC-2026

First Keynote Speech
Beyond Concrete and Code
Designing Smarter Infrastructure for Safety, Sustainability, and Resilience

Dr. *Hemin J. Mohammed*¹

¹*Department of Civil Engineering, Trine University, Indiana, USA*

ABSTRACT

The future of urban development depends not only on stronger physical infrastructure, but also on smarter systems that can help cities observe, understand, and respond to complex challenges more effectively. This keynote examines how data, artificial intelligence, sensing technologies, and engineering judgment can be brought together to connect smart systems with civil infrastructure in ways that improve safety, sustainability, and resilience. Focusing on transportation and urban infrastructure, the talk discusses the role of digital tools in enhancing traffic operations, infrastructure monitoring, decision support, maintenance planning, and public-service reliability. It also addresses a key misconception in developing and emerging urban regions: that smart infrastructure requires high-cost, fully advanced systems from the outset. Instead, the keynote argues for practical, phased, and context-sensitive approaches that begin with real local problems and build capacity over time. Drawing attention to the Kurdistan Region of Iraq and the wider Middle East, the presentation highlights the need for stronger collaboration between computer, systems, and civil engineers to transform fragmented information into meaningful action. The keynote ultimately presents a framework for moving from isolated technologies and traditional infrastructure toward integrated urban systems that are more adaptive, more efficient, and more human-centered.

Second Keynote Speech
FRP solutions for sustainable strengthening and rehabilitation of
Reinforced Concrete Structures

*Professor Dr. Dilshad Kakasor Jaf*¹

¹Department of Civil Engineering, Salahaddin University, Iraq-Erbil

Third Keynote Speech
**On the Asymptotic Stability of Fractional-Order Controllers with
Application to Robotic Rehabilitation Systems.**

Dr. *Nabil Derbel*¹

¹*National Engineering School of Sfax, University of Sfax, Tunisia*

ABSTRACT

A stability-guaranteed fractional-order feedback linearization control framework for rehabilitation exoskeletons is proposed, aiming at accurate joint trajectory tracking across pediatric users with varying limb–robot dynamics. Input–output feedback linearization is employed to compensate for the nominal nonlinearities of the system and to obtain a linearized tracking-error channel.

To enhance the flexibility of the control design, a generalized error formulation is introduced, incorporating fractional integral and derivative actions applied to the tracking error. This formulation provides additional degrees of freedom for controller tuning through the fractional control orders. Although fractional-order PID controllers have been widely investigated in the literature, theoretical stability analysis proofs of generalized fractional PID control structures remain relatively limited. This work establishes a rigorous stability analysis based on Lyapunov theory using the Caputo definition of fractional derivatives.

Fourth Keynote Speech

Robotics Machin Vision Embracing Embedded Design Techniques

Prof. Dr. Mazin R. Khalil¹

¹AI Engineering, Alnor University, Mosul, Iraq

ABSTRACT

Robots usually need a hard machine vision unit to perceive the surrounding environments. The essay includes the machine vision definition, applications of machine in real time then it goes through the most important algorithms that enables the machine perceive the surrounding environments, interpreting the object X, Y, Z coordinates and accordingly computing the distance and the dimensions of the object. The next item is to review the SOTA (state of the art) models of image recognition and classification techniques and finally the essay forwards a description to embedded design techniques and how to accommodate them to construct hardware units that can be tailored to robots forming a hard machine vision unit.

Spoofing Countermeasure for Fake Speech Detection by Using Temporal and Global Representation Features

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ABSTRACT

As deep learning techniques for generating fake speech become more advanced and potentially harmful to society. It is crucial to distinguish between genuine and artificially synthesized audio. Many researchers have concentrated on particular types of features, often by extracting and using these features sequentially or as a global representation. A model proposed that fuses the OpenSMILE-based global feature with a temporal-based model using Mel-Frequency Cepstral Coefficient (MFCC) and Constant-Q Cepstral Coefficient (CQCC) features to detect spoofed speech. Our proposed approach has been evaluated on the ASVspoof 2019 Logical Access (LA) dataset and achieved a 3.84% Equal Error Rate (EER).

Keywords: spoofing countermeasure, temporal feature, global representation feature, ASVspoof 2019, LSTM, BiLSTM, SVM, DNN.

Classification of News Articles Using NLP Techniques and Machine Learning Algorithms: Comparative Study

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ABSTRACT

News primarily aids people in recognizing the events that have occurred in their surroundings. Since news is essential as a venue for social interaction, daily newspapers, whether online or in print, emphasize news. In contemporary times, the majority of individuals access news through online platforms. However, not all readers engage with every news category; instead, each reader tends to exhibit preferences for specific categories of interest. Consequently, the news category is crucial. Getting all the news from a single news website is really challenging. Occasionally, it might not have the category the user wants. To overcome these challenges, news articles are systematically categorized using advanced classification techniques. Accordingly, this paper presents multiple classification methods to categorize news articles into distinct categories, including sports, economy, politics, and business. The dataset undergoes preprocessing by eliminating punctuation, spaces, symbols, and stop words. Subsequently, feature extraction is performed using two techniques: Term Frequency-Inverse Document Frequency (TF-IDF) and Bag of Words (BOW). Following this, three machine learning algorithms—Support Vector Machine (SVM), Random Forest (RF), and Neural Network (NN)—are employed to classify the news articles into their respective categories. A standard dataset called AG news classification is used in this study. The experimental results revealed that the neural network is outperformed in most metrics.

Keywords: Classification, Natural Language Processing, machine learning, SVM, Random Forest, Neural Network.

Applications of Artificial Intelligence in the Arabic Journalistic Field: Survey

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ABSTRACT

Numerous studies have focused on Arabic natural language processing and using techniques of artificial intelligence to enhance several journalistic tasks, from content production to fact-checking. Studies that have advanced from traditional word-based methods to sophisticated deep learning techniques have included semantic similarity in Arabic. However, there are still significant challenges, such as inadequate data quality, tools unsuitable for new subjects, and inefficiencies when handling different Arabic dialects. Due to their propensity to generate inaccurate information, New Arabic Large Language Models (ALLMs) have also been studied, which is an important problem in news reporting. This study aims to provide a comprehensive analysis of the use of AI models in Arabic journalism and evaluate their performance in key journalistic tasks like automated news generation, headline summarization, multi-document summarization, and paraphrasing. This study demonstrates that despite significant advancements in Arabic natural language processing, problems like "noise" and imprecise text formulation continue to impede the widespread use of AI in Arabic news.

Keywords: Text summarization, Transformer, Semantic Textual Similarity (STS), Computational Journalism, Natural Language Processing (NLP), and Large Language Models (LLMs).

Machine Learning and Deep Learning–Based Anomaly Detection In Internet of Things (IoT): A Survey

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ABSTRACT

This One of the most rapidly growing areas of technology in the 21st century is the Internet of Things (IoT). IoT is important for businesses because it drives down costs, increases scalability, and improves flexibility by providing businesses with quick access to elastic computing resources. However, concerns regarding security and other risks remain an issue. IoT is rapidly growing in complexity, which raises the need for anomaly detection. The sheer volume and complexity of IoT data make it difficult to identify the anomalous behavior of data patterns. By identifying anomalous behavior of data patterns, IoT operations can be sustained while eliminating risks. The aim of this survey is to analyze prior research in IoT anomaly detection, to summarize various detection techniques and to analyze anomaly detection datasets, to identify and analyze IoT networks, and to outline the gaps for future research.

Keywords: Internet of Things (IoT), Fog Computing, Anomaly Detection, Machine Learning, Deep Learning

Comparative Analysis of Feature Selection Methods for Machine Learning-Based Threat Detection in IoMT Networks

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ABSTRACT

This study presents a comparative analysis of supervised feature selection methods for machine learning-based intrusion detection within Internet of Medical Things (IoMT) environments. A public CIC IoMT 2024 dataset was utilized, where several feature-selection methods, including Mutual Information, ANOVA F-test, and LDA coefficients, were employed to produce shortened feature collections of varying sizes. Three learning classifiers, Decision Tree, Random Forest, and XGBoost, were trained on every reduced set to inspect how the feature affected the detection behavior. The outcomes show that Mutual Information enhanced the classification results in all models and across feature numbers, with higher accuracies reported for Random Forest at 99.48% and XGBoost at 99.47%. The Decision Tree model appeared to be consistent across all selection approaches, with its highest score achieved using the complete feature list at 99.21%. The results suggest that choosing nearly 44% of the total features yields a reasonable harmony between accuracy and size reduction. These observations highlight that feature-selection decisions are significant for building correct and lightweight IDS designs that are suitable for limited and resource-poor IoMT systems.

Keywords: IoMT security, feature selection, intrusion detection, machine learning, threat analysis.

Preventing Leakage of Network Private Information (NPI) in LLM-Assisted Log Analysis: A Hybrid Regex-NER Pseudonymization Strategy for Unstructured Logs

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ABSTRACT

The use of Large Language Models (LLMs) to automate observability workflows and network troubleshooting is growing, but this adoption runs the risk of inadvertently revealing Network Private Information (NPI), such as internal IP addresses, user identifiers, and infrastructure metadata, to external or untrusted model providers. Current sanitization techniques frequently rely on tight pattern matching or irreversible masking, which might either overlook context-dependent identifiers or lower the forensic value needed for cross-event correlation. A privacy-preserving pre-processing approach that sanitizes unstructured network logs inside a trusted boundary before any LLM interaction is proposed in this paper. The framework utilizes an overlap-resolution policy to reconcile conflicting detections and combines lightweight Named Entity Recognition (NER) for ambiguous tokens with high-precision regular expressions for structured identifiers. The system additionally performs deterministic, consistent pseudonymization, which substitutes stable, format-aware aliases for sensitive values in order to maintain cross-record linkability while avoiding raw-data exposure. The hybrid technique outperforms a regex only baseline, achieving 98.5% recall and 95.9% overall F1 while maintaining approximately 386 records/second throughput, according to experiments conducted on three public LogHub log types (OpenSSH 2k, Linux 2k, and Apache 2k; 2,000 records each).

Keywords: Network Private Information (NPI); Network Logs; Privacy-Preserving Sanitization; Deterministic Pseudonymization; Named Entity Recognition (NER); Regular Expressions; LLM Security; Observability.

A Real-Time Smart Vision System for Visually Impaired Navigation Using Wearable Image Processing and Deep Learning

Mahmood Yashar Hamza¹, Omran Nazhat Mohammed², Mohammad Kamal Hussain³, Rozh Rebwar Omer⁴

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ABSTRACT

The Smart Vision System for Blind Assistance is a new wearable technology that has been designed to help the visually disabled to move around easily. Although commonly used traditional tools like the white cane do not detect overhanging hazards and the knowledge of the area surrounding the user. This work offers a solution that is inexpensive and not too heavy, which uses a tiny camera that is fitted on eyeglasses and connected to the Raspberry Pi 4 Model B. Utilizing the YOLOv8 (You Only Look Once version 8) deep-learning algorithm, the system performs real-time object detection and obstacle recognition with great accuracy and low latency. The aim of this study is to reconcile the gap between costly complex assistive devices and the day-to-day requirement of blind users with a facility that is economical and easy to use. The software architecture developed with Python and OpenCV ensures rapid processing of visuals for immediate audio or tactile alerts concerning possible collisions with furniture, people, or cars. System performance experimental results show that detection accuracy is high and that it works stably in indoor and outdoor environments. The Smart Vision System's incorporation of these advanced computer vision techniques into a portable wearable device drastically diminishes the user's reliance on human guides while improving situational awareness. To sum up, this project illustrates how accessible hardware and optimized AI models can offer a dependable digital eye, enhancing independence and safety for the visually impaired in their everyday life.

Keywords: Computer Vision; Object Detection; Image Processing, Deep Learning; Wearable Computing.

Drone Surveillance System for Portable Weapon Detection: Survey

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ABSTRACT

Drone surveillance technologies have proven to be of great service in reducing riots that may occur in public places, which can achieve better results and overcome human limitations in traditional surveillance, such as fatigue and lack of focus. This survey aims to summarize previous work in the field of surveillance for published work between 2020 to 2025, focusing on the techniques used for detection models and how data has been collected to train the models. As a result, it has been noticed that 80% of previous studies dealt with the usage of the YOLO model to detect weapons in real-time. On the other hand, some studies have used different techniques and algorithms to detect weapons, such as CNN, Faster R-CNN, integration of YOLO with CNN to enhance the detection and classification accuracy. Based on previous work, it became clear that many of them suffered from challenges like the lack of strong and comprehensive data that could be used to train the model, the dim lighting that caused detection failures, and other issues which will be discussed in this work. Finally, this work provides a strategic roadmap for future research, suggesting specific improvements in data collection and augmentation to overcome training limitation.

Keywords: Artificial Intelligence Algorithms, Deep Learning, Real-time, and Weapon Detection.

A Unified Object–Field–Record Authorization Engine for SaaS Platforms: Policy Compilation, Caching, and Auditability

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ABSTRACT

Modern software as a service environment have difficulty with fragmented access control models that view structural objects, granular fields, and specific records as silos. In this paper, we propose a common authorization engine which aims to overcome these gaps via a simplified policy compilation and intelligent caching architecture. The study deals with performance bottlenecks inherent in high volume cloud environments where authorization check takes place millions of time per second. By taking advantage of centralised logic gate, the proposed system guarantees consistent security posture across the entire data stack. Our methodology makes use of a rich data set of four hundred and fifty-four unique access request instances, simulating different kinds of user roles with complex data hierarchies. The research used advanced simulation tools such as custom-built performance monitoring frameworks and database clusters to measure the latency and throughput. Results show that combining record-level filtering with field level masking into one compilation step has significant overhead reduction. Furthermore, the engine has a strong audit trail, which means that each access decision is tracked with full context. This research shows that the approach of uniting security and system performance is not only useful for better security but also for optimizing the performance of these systems, making it a viable blueprint for the next generation of cloud security architectures.

Keywords: Cloud Security, Access Control, Policy Compilation, SaaS Architecture, Data Privacy

LLMOps for GxP Systems: Continuous Validation, Model Drift Controls, and Audit-Ready Evidence

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ABSTRACT

The application of Large Language Models (LLMs) in life sciences would have to be regulated by Good Practice (GxP) standards to guarantee patient safety and quality of products. This paper examines a dedicated LLMOps model that can be used to perform continuous validation and strict drift management. We deal with the problem of the state of validity in non deterministic systems. The study uses a synthetic data set of 407 data items of medical queries and regulation documentation. Such tools as MLflow to track the lifecycle, DeepChecks to validate and Great Expectations to verify data integrity are used. The results of our study show that audit requirements can be fulfilled with the help of automated evidence generation and real time monitoring, and at the same time the model performance can be sufficiently high.

Keywords: LLMOps, GxP Compliance, Continuous Validation, Model Drift, Regulatory AI.

A Focused Web Crawler for Kurdish Text Collection with Bloom Filter–Based Deduplication

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ABSTRACT

Kurdish, spoken by an estimated 30–32 million people across several countries, remains significantly underrepresented in web search platforms and digital linguistic resources. This underrepresentation poses barriers to information accessibility, natural language processing (NLP) research, and digital preservation. This study introduces Agabot, a focused web crawler developed in Python to collect and index Kurdish-language web pages efficiently. Agabot integrates a Bloom filter for duplicate URL prevention and employs ethical crawling practices that respect website restrictions. Trials with varying crawl depth limits demonstrated a strong correlation between crawl depth and the number of URLs successfully indexed, with the crawler retrieving up to nearly 2,000 URLs at higher depths. The system’s design emphasizes simplicity, modularity, and adaptability for low-resource contexts, providing a reusable framework for future Kurdish-centric digital tools. Agabot represents an initial but crucial step toward building a sustainable Kurdish web corpus to support search engines, NLP applications, and the preservation of Kurdish digital heritage.

Three Phase PV System Grid-Connected System Using Finite Control Set Model Predictive Control

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ABSTRACT

In order to enhance the power quality, dynamic response and grid synchronization a grid connected photovoltaic (PV) system with FCS- MPC based control scheme is proposed in this paper. An MPPT algorithm, a DC-link voltage controller, and a FCS-MPC-controlled VSI are integrated for interfacing the PV array with grid and local loads. Compared to traditional PWM/PI based control schemes, FCS-MPC can make a direct optimization of the inverter switching state and possesses fast transient response and simple control implementation. Simulation results indicate mitigation of current THDs at the PCC, increased stability and better grid synchronization. The system can also operate in dual power-feeding mode, thereby applicable to smart-grid applications.

Keywords: Grid-connected photovoltaic system , Finite Control Set Model Predictive Control (FCS-MPC) ,Model predictive control ,Maximum Power Point Tracking (MPPT) ,DC-link voltage controller.

Hybrid CNN and Multi-Head Attention for Enhanced Massive MIMO Channel Estimation

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ABSTRACT

Massive MIMO systems are the essential enablers of (5G) and future (6G) wireless communication networks. Achieving the theoretical spectral efficiency of those systems depends on accurate acquisition of channel state information (CSI). Traditional estimators, inclusive of minimum mean square error (MMSE), face excessive scalability issues due to the high dimensionality of the channel matrix, leading to $O(N^3)$ computational complexity, which is often infeasible for real-time processing. Furthermore, the unfavorable impact of pilot Contamination (PC) limits overall performance in multicell deployments, main to capability losses of up to 80% in congested scenarios. This paper introduces a novel hybrid convolutional neural (CNN) and multi-head interest (MHA) structure (Hybrid-CE-Net) that correctly exploits each local spatial correlation (CNN) and global nonnearby dependence (MHA) in the huge MIMO channel domain. Hybrid-CE-Net suggests advanced capacity to map the noisy received sign to the actual channel, leading to a mean 29.1% discount in normalized mean square errors (NMSE) as compared to the conventional MMSE estimator over an extensive SNR range from 0 dB to 30 dB. At a critical duty factor of 15 dB SNR, the proposed model achieves an NMSE (dB) of approximately -18.5 dB, which outperforms the natural CNN baseline with a resource of 7.5%. Importantly, the attention mechanism effectively isolates and reduces the consequences of infection, increases resistance to PC, and reduces degradation by more than 36.0% compared to MMSE in simulated intervention scenarios. The results confirm Hybrid-CE-Net as a high-precision, low-latency, and robust solution for Challenging channel estimation tasks for modern wireless system.

Keywords: Massive MIMO, Channel Estimation, Convolutional Neural Network (CNN), Multi-Head Attention (MHA), Pilot Contamination, Normalized Mean Square Error (NMSE), 5G, 6G.

Design and Implementation of a General Hardware Binary Exponentiation Circuit Based on Combinational Logic

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ABSTRACT

Exponentiation is a basic requirement in most of the modern cryptographic algorithms as well as advanced scientific calculations. Several attempts tried to work out fast algorithms and specialized digital circuits based on sequential logic. This work presents a novel proposal of a general hardware exponentiation circuit based completely on combinational logic. By making use of our earlier design of recursive binary combinational multipliers, a three-stage architecture that computes the binary integer exponent of a binary integer base. After generating all required powers of two in a parallel way in the first stage, a single bit exponentiation is calculated in the second stage, while a tree of multipliers is computing the final result. Dissimilar to previous implementations, utilizing sequential circuits that require multiple clock cycles and storages units, our purely combinational design performs the job in a single-cycle operation with further propagation delay overhead. The circuit has been implemented and tested using “LogicCircuit” free simulator. Implementation results prove accurate system operation. The proposed architecture is scalable to any bit width of 2^n and represents the first entirely combinational approach to integer exponentiation hardware.

Keywords: Hardware exponentiation, Combinational circuits, Binary Multiplier, DSP, VLSI design, Low-latency computation.

Integrating Exploiting Modification Direct and Improved LSB Methods in Data Hiding Approach*

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ABSTRACT

The swift expansion of covert operations through communication networks has created a growing demand for effective data hiding techniques to safeguard confidential information from harmful intrusions. The effectiveness of data hiding is determined by three critical factors: payload, imperceptibility, and robustness, which inherently involve a trade off relationship. Therefore, this study aims to propose a model to embed secret data in cover image without sacrificing image quality and enhancing robustness against security threats. To obtain the goal, a new technique is exploited by leveraging Exploiting Modification Direction (EMD) and Least Significant Bit (LSB) methods. First, the secret message is converted into secret digits, where each digit is converted to a maximum of five bits to increase the payload inside the cover image. Second, the cover image is divided into parts: the first part is to embed data using EMD method, and the second one is to embed data using LSB method. In the first part, the cover image is partitioned into groups of 13 pixels. The secret digits are embedded in the groups by modifying one grayscale value at most to hide the code in a $(2k_i + 1)$ -ary notational system. In the second part of the cover image, the rest of the secret digits are embedded using LSB method. Moreover, the Knight tour technique is applied with LSB method to increase the robustness factor. The experimental results demonstrated that the proposed method exhibits greater robustness and imperceptibility compared to both least significant bit embedding and the original EMD technique.

Keywords: Steganography, LSB, EMD, Data Hiding.

Lightweight SCNN-GRU Attention for Multi-User Activity Recognition Using CSI with Variational Mode Decomposition

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ABSTRACT

Multi-user human activity recognition using Channel State Information (CSI) is proved to be highly challenging due to wireless signal interference, environmental noise, and the need for lightweight models for edge deployment. In this work, a lightweight SCNN-GRU-Attention model is evaluated on raw multi-user CSI signals. Then, Variational Mode Decomposition (VMD) as a preprocessing step is introduced to extract human-motion-related components. Experimental testing on the WiMANS dataset shows that the studied model, without VMD, achieves 92.30% identity, 76.79% location, and 63.97% activity recognition accuracy outperforming state-of-the-art baseline models for activity recognition. By utilizing VMD, the simulation results demonstrated that the performance is greatly improved to 99% accuracy across all three tasks. With fewer than a million parameters and an inference time of only 0.26 seconds, the proposed framework achieves a highly efficient and accurate solution for real-world multi-user sensing in IoT environments.

Keywords: Human Activity Recognition, CSI, Wi-Fi Sensing, Multi-User Sensing, Variation Mode Decomposition, Sliding Window, SCNN-GRU-Attention Model.

Performance of Long-Reach IM/DD WDM-PON Systems in C/L-Bands with 50/100 GHz Spacing

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ABSTRACT

The sustained increase in bandwidth demand of access networks has led to the development of wavelength division multiplexed passive optical networks (WDM-PONs) of longer reach and higher capacity. This paper numerically examines the operation of a long-reach intensity modulation/direct-detection (LR-IM/DD) WDM-PON system in the C/L-bands transmission window. A 50 GHz receiver sensitivity and a 100 GHz receiver sensitivity are tested with transmission distances of 40 km to 120 km, with a target bit error rate (BER) of 1×10^{-3} . The findings demonstrate that the C-band transmission system is more robust than the L-band transmission system, and the minimized channel spacing increases the performance over long distances of 100 km. Nonetheless, none of the studied configurations can achieve the desired BER at 120 km without inline amplification, revealing one of the inherent limitations of the LR-IM/DD WDM-PON system without amplification extending to longer wavelengths: this results in a fundamental limit of reach. The results provide a precise baseline reference and encourage the application of amplification and more sophisticated methods in future LR-access networks.

Keywords: PON; WDM; SDM; Long Reach; MCF.

UAV-Enabled Wireless Communication Systems

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ABSTRACT

This paper develops a real-time three-dimensional (3-D) trajectory generation scheme for a Unmanned Aerial Vehicle (UAV), which serves as a micro base station in heavily congested urban areas. Moreover, a Light Detection and Ranging (LiDAR) equipped airship is constantly scanning the surrounding to create an accurate 3D map that is fed to the UAVs for safe navigation. The proposed method uses the A* algorithm in conjunction with voxel-based terrain representation for UAV path planning. The framework is evaluated in a realistic urban scenario with 88,310 obstacles, compared to 10,567 obstacles for the particle swarm optimisation (PSO) benchmark, representing an 8.4-fold increase in environmental complexity. Despite this significantly higher complexity, the method achieves a planning time of only 0.04 seconds to generate collision-free paths and outperforms the PSO algorithm in terms of energy efficiency. These results demonstrate the proposed method's robustness, scalability, and suitability for time-critical, safety-sensitive Wireless communication systems operated by UAVs in challenging urban environments.

Keywords: UAV, 3D path planning, A* algorithm, LiDAR.

Adaptive Performance Engineering of Low-Power Duobinary Free-Space Optical Links Using a Hybrid OptiSystem–Python Framework for Realistic Atmospheric Deployment

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ABSTRACT

Free-space optical (FSO) communication is conceivable for high-capacity wireless connectivity, but dependable performance under actual atmospheric propagation and power restrictions is a major engineering challenge. A low-power duobinary FSO system operating at 20 Gbps with a realistic launch power of 20 dBm is adaptively designed using Python-based data-driven statistical analysis and OptiSystem 23 physical-layer modeling. With pseudo-random bit generation, duobinary encoding, predistortion, Mach Zehnder modulation, and atmospheric channel modeling at 20 dB/km, the suggested architecture While optimizing extinction ratio configurations, system behavior is assessed throughout 1.5–3 km propagation distances. Unlike fixed parameter selection FSO research, hybrid physical simulation and statistical analysis show distance-dependent adaptive zones as best operating conditions. Low power allows long-distance communication while peak mean Q-factors approach 489 at shorter distances, signifying error-free transmission. By combining statistical variability with performance magnitude, Python-based stability analysis finds stable operating points, enabling engineering decision-making beyond simulations. For scalable, adaptive, energy-efficient, high-data-rate FSO communication in actual atmospheric deployment scenarios, the hybrid OptiSystem–Python framework combines simulation-driven research and system design.

Keywords: Free-space optical communication (FSO), low-power optical links, duobinary modulation, hybrid OptiSystem–Python framework, adaptive performance optimization, high-speed optical communication, energy-efficient optical wireless systems.

A Decision-Based Adaptive and Availability-Aware Receiver Aperture Framework for Fog-Resilient MIMO Free-Space Optical Systems

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ABSTRACT

This paper presents a decision-based adaptive and availability-aware receiver aperture framework for fog resilient multiple input- multiple output free space optical communication (MIMO- FSO) systems. The proposed method changes the size of the receiver's aperture based on the quality of the signal, such as the Q-factor and bit error rate (BER), in different fog attenuation scenarios. The framework is tested by running OptiSystem 23 simulations in light, medium, and heavy fog. When there is little fog, performance saturation happens; when there is moderate fog, perfect aperture adaption happens; and when there is a heavy fog, reliable outage detection happens. The suggested strategy makes connections more reliable and resources more efficient without making the system more complicated or increasing transmit power. In foggy conditions, decision-driven adaptation enhances the robustness of MIMO-FSO systems in a practical and comprehensible way.

Keywords: Free-space optical communication; Decision- Based Adaptive receiver aperture; MIMO-FSO; Fog attenuation; Bit error rate; Q-factor. nonlinearity, nonlinear analysis, Statical analysis, Spherical.

Multi-Frequency Elliptical Ring Resonator for Systematic Evaluation of Frequency-Dependent Microwave Glucose Sensing

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ABSTRACT

This paper presents a five-frequency microwave sensing platform that uses an elliptical ring resonator for investigating frequency-dependent glucose sensing behavior. A unified resonator topology is employed and geometrically scaled to realize five operating frequencies at 1.83, 2.47, 3.5, 4.5, and 5.4 GHz, enabling a fair comparison of sensing performance under identical excitation and measurement conditions. The elliptical geometry is selected to enhance coupling with the microstrip feed line and to ensure a symmetric interaction between the resonator and the material under test (MUT). The sensing performance is evaluated using the reflection coefficient $|S_{11}|$ under unloaded conditions and in the presence of an elliptically shaped dielectric sample representing glucose-dependent media. Simulation results reveal a clear frequency-dependent sensing behavior. At higher operating frequencies (4.5 and 5.4 GHz), the resonator exhibits stable single-mode operation with smooth and monotonic resonance shifts. In contrast, lower frequencies (1.83 and 2.47 GHz) demonstrate multi-mode behavior, leading to mode transition and reduced response stability. A regression-based analysis is further employed to quantify sensitivity, linearity, and stability across operating frequencies. Isolating the base have become a crucial element in enhancing quality stability during a seismic earthquake. In the present day, base detachment is routinely utilized as an essential arrangement technique for structures and frameworks in seismically active zones. The important objective of earthquake engineers is to design and build a structure in such a way that damage to the structure and its structural components during an earthquake is minimized. This paper aims towards the dynamic analysis of a multi-story RCC building with various parameters. For the sake of study and verification, a model of a ten-story RCC building with a symmetrical floor plan is considered. The study was conducted using SAP 2000's time-history-based software. In this paper, 72 models were studied based on various parameters such as bay width (4 m, 5 m, and 6 m), number of bays (3 and 4), number of floors (7, 10, and 13), and various isolators (Lead Rubber Bearings (LRB), Friction Pendulum Bearing, Fixed, and Hinge). The reaction of the structure, for example, time period, base shear, and story displacements are studied and a comparison is made. The paper showed the clear superiority of isolation methods in resisting earthquakes. The friction pendulum support has been the preferred type due to the lowest drift story of the building when it was compared with other support systems. Also, as the results showed a high time period when using the lead rubber bearings (LRB), which shows the model's ability to withstand earthquakes.

Keywords: Non-invasive glucose monitoring, microwave biosensors, planar resonators, dielectric properties of biological tissues.

Design and Simulation of Glucose Microstrip Sensor at Microwave Frequencies

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ABSTRACT

Microwave sensing techniques that able to measure glucose concentrations, which are impacted by changes in dielectric properties. This paper presents a microwave substrate sensor for measuring the glucose concentration based on the variation of reflection coefficients. The sensor was tested in the frequency range 3.52-3.55GHz where full-wave electromagnetic simulations report the strongest response. The concentration dependent dielectric properties were modeled to observe the glucose-water solutions within the 0-500 mg/dL range. The sensor behavior differs from frequency-shift approaches, as there are minimal variations in resonance frequency across all concentrations where the glucose concentration the reflection coefficients. Several calibration curves were developed establishing a direct relation of $|S_{11}|$ to the concentration of glucose, relative permittivity, and average conductivity of the solution. Several loading effects of electromagnetic radiation were assessed, although the measurement of the sensor function remains within the reflection-based parameters.

Keywords: Microwave, glucose, sensor, Reflection coefficient $|S_{11}|$, Dielectric characterization, Glucose concentration. users; Historic buildings; Conservation approaches; Accessibility.

Design and Performance Analysis of ANFIS-Based and Deep Learning Controllers for Tower Crane Systems

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ABSTRACT

Ensuring safety, productivity, and efficiency in construction and industries is a significant task. Loads on tower cranes must be applied with high precision, and the swing angle must be carefully controlled. Intelligent controllers for tower cranes that don't need a mathematical model have been developed and evaluated in this study. Two intelligent control systems were investigated: one using a deep learning controller (DLC) and the other employing an adaptable neuro-fuzzy inference system (ANFIS). These controllers have been evaluated on tower cranes using the commonly used proportional differential (PD) controller. Simulations have been used to test how well the suggested intelligent controllers react to different working situations. The tests showed that the DLC was better at handling disturbances, accurate tracking, and responding quickly. As a result, the DLC made it easier to control the crane's swing angle and position, which improved security, reliability, and operating efficiency. The DLC is ideal for complicated crane control tasks as it can adapt to different operating conditions and disturbances.

Keywords: Tower crane, intelligent control, ANFIS-based controller, deep learning controller, PID controller.

Comparative Analysis of the Effectiveness of Expanded Polystyrene (EPS) Blocks and Concrete Hollow Blocks (CHBs) for Building Construction in the Philippines Using Compressive Strength Test and Water Absorption Test

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ABSTRACT

This study presents a comparative analysis of Expanded Polystyrene (EPS) blocks and Concrete Hollow Blocks (CHBs) for building construction in the Philippines, focusing on compressive strength and water absorption characteristics. The research aims to evaluate and compare the performance of EPS blocks and CHBs through standardized testing methods, with the objective of determining which material offers superior structural and durability attributes in the context of the Philippines' construction needs. Statistical analysis, including t-Test, confirmed that the differences in both compressive strength and water absorption between the two materials are statistically significant, with p-values well below the 0.05 threshold. These results support the hypothesis that EPS blocks offer enhanced performance over CHBs in terms of strength and durability. The findings indicate that EPS blocks are a more effective choice for construction in the Philippines, given their superior compressive strength and moisture resistance. This study highlights the potential benefits of using EPS blocks in improving the resilience of building structures, particularly in regions prone to natural disasters such as earthquakes and heavy rainfall.

Keywords: Expanded Polystyrene (EPS) Blocks, Concrete Hollow Blocks (CHBs), Compressive Strength, Water Absorption, Construction Materials in the Philippines.

Proposed Design Equation for One-Way RC Walls with Openings Strengthened Using CFRP

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ABSTRACT

Openings significantly reduce load-carrying capacity of reinforced concrete (R.C.) walls and adversely affect their stiffness. To ensure structural safety, strengthening techniques proved efficiency in enhancing capacity of R.C. walls with openings. In this study, a proposed finite element modeling approach is validated using two experimental programs reported in the literature, showing very good agreement between numerical predictions and experimental results. A parametric study is subsequently carried out, and results are utilized to develop an empirical design equation that accounts for key influencing parameters to estimate the axial capacity of one-way R.C. walls with a single rectangular/square opening strengthened using externally bonded (EB) CFRP sheets.

Effect of Current, Time, and Powder Addition on Nugget Size in Resistance Spot Welding

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ABSTRACT

This paper examines how the main welding variables, i.e., welding current, welding time, and titanium powder addition, affect the nugget size in resistance spot welding of advanced high-strength steels DP600, DP800, and TRIP. Three current levels (5, 7, and 9 kA), three welding times (0.2, 0.3, and 0.4 s), and three titanium powder additions (0, 0.5, and 1 g) were used to conduct experiments related to welding. There were three dissimilar joint combinations tested, which were DP800 + DP600, DP600 + TRIP, and DP800 + TRIP. The findings showed that the nugget diameter increase was progressive as the welding current and time increased, as a result of increased heat introduction and accelerated localized melting. This has been achieved by adding titanium powder, which has helped in enhancing the nugget formation and stability, and the growth behavior is slightly different based on the combination of the materials. The results show that both welding parameters and the amount of additives are to be strictly controlled in order to control the size of the nuggets and produce consistent weld quality in high-strength steels that are resistance spot welded at advanced levels.

Keywords: Resistance Spot Welding (RSW), Nugget Size, Welding Parameters, Experimental Study, Powder Addition.

Accessibility for People with Disabilities in Erbil, Iraq: Architects' point of view

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ABSTRACT

Erbil, the capital of the Kurdistan Region in Iraq, has seen notable architectural growth in recent years. However, access to public buildings and open spaces remains challenging for individuals with disabilities, revealing a gap between inclusive ideals and practical design implementation. This research aims to evaluate the extent to which accessibility requirements for individuals with disabilities are applied in Erbil, Iraq, and the main factors influencing their implementation from the perspective of architects in the city. A quantitative approach was adopted, using a structured questionnaire distributed to 174 architects in Erbil. The survey focused on two areas: the degree of implementation of accessibility standards and the reasons behind their limited application. The findings indicate that forty seven percent of projects meet accessibility requirements. The illustrated that non-compulsory regulations is the highest reason of insufficient application of disabled people requirements in Erbil, followed by the cost, then lack of local specifications, and lastly, a general lack of knowledge and awareness of these requirements among key local stakeholders. This study provides quantitative evidence on the current state of accessibility in Erbil and the key factors influencing the application of disabled people requirements. It offers valuable insights for urban planners, policymakers, and authorities aiming to improve access and enforce inclusive design regulations.

Keywords: Accessibility, Architectural projects, Built environment, People with disability, Erbil, Iraq.

BIM-Based Reinforcement Detailing in Compliance with ACI 318-25

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ABSTRACT

Building Information Modeling (BIM) has emerged as an effective digital platform for improving coordination and efficiency in structural engineering workflows. Nevertheless, reinforcement detailing for reinforced concrete (RC) structures is still frequently performed using conventional two-dimensional CAD methods, which are time-consuming and susceptible to manual errors. This study evaluates the performance of CAD-based and BIM-based reinforcement detailing workflows for RC structural elements designed in accordance with the provisions of ACI 318-25. A 12-story reinforced concrete residential building located in Erbil, Iraq, was selected as a case study. Structural analysis and design were carried out using ETABS, and reinforcement detailing was subsequently implemented using both AutoCAD-based drafting and BIM-based parametric modeling in Autodesk Revit. The two workflows were compared in terms of detailing time, quantity accuracy, code compliance, and constructability. The results show that the BIM-based workflow reduced the total reinforcement detailing time by 31%, while the deviation between BIM-generated quantities and ETABS design outputs was only 0.3%, compared with approximately 15% deviation in CAD-based calculations. Constructability evaluation further demonstrated that reinforcement conflicts were reduced from 12.1% in CAD models to 0.8% in BIM models due to automated clash detection and rule-based reinforcement modeling. The findings indicate that BIM-based reinforcement detailing provides significant improvements in efficiency, accuracy, and constructability while supporting systematic compliance with ACI 318-25 requirements.

Keywords: Reinforcement Detailing; ACI 318-25; Reinforced Concrete; Constructability; Quantity Take-Off; Structural BIM.

Assessment of Asphalt Pavement Distress Severity Using Visual Survey: A Case Study of Soran City

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ABSTRACT

Transportation networks play a major role in determining sustainable development, especially in urban areas where road transport is mostly used. The rapid urbanization and the growing number of vehicles in Kurdistan Region of Iraq have put excessive strain on flexible pavements. This paper aims to assess surface distresses along Kawa Street, a major arterial road in Soran City, to identify its structural and functional status. The analysis of a 2-km divided section was performed according to the ASTM D6433-20 standard based on a manual visual survey. The most common identified types of distress were block cracking, fatigue (alligator) cracking, edge cracking, longitudinal cracking, transverse cracking, patching, and potholes. The distresses were quantified, classified in terms of severity, and compared on the eastbound (R₁) and the westbound (R₂) carriageways. The results revealed that the westbound carriageway (R₂) had higher proportions of medium and high severity defects consisting primarily of patching, longitudinal and transverse cracking. These findings indicate that localized reconstruction and drainage enhancement are needed in R₂, whereas the eastbound carriageway (R₁) could be maintained using preventive strategies that include the use of seals and thin overlays. Overall, the study demonstrates that despite the absence of advanced technologies, frequent visual evaluations can be used to assist in the prioritization of maintenance and give a foundation to pavement management planning to improve the infrastructure resilience of the secondary cities in the Kurdistan Region of Iraq.

Keywords: Pavement, distress, Visual survey, Soran City, Flexible pavement, ASTM D6433.

Localized Instance-Segmentation-Based Pavement Distress Detection for Urban Roads Using YOLOv8 in Soran City

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ABSTRACT

Monitoring urban pavement conditions is essential for sustainable road management. However, the current ASTM D6433 survey of pavement condition is time consuming, subjective, and not often performed. This study proposes a low-cost, multi-class pavement distress detection and instance-segmentation framework for urban roads in Soran City, Kurdistan Region of Iraq. A localized dataset of 1,120 daytime smartphone images was manually annotated into eleven ASTM D6433 distress categories and used to train a YOLOv8-based instance-segmentation model on the Roboflow platform with a 70/20/10 train-validation-test split. The trained model achieved a test Precision of 89.9%, Recall of 80.6%, F1-score of 83.2%, and mAP@0.5 of approximately 84%, with higher performance for potholes, alligator cracking, and patching, and lower recall for longitudinal and transverse cracks. The proposed framework provides a scalable, region-specific solution that supports GIS-based Pavement Condition Index (PCI) mapping and cost-effective urban pavement monitoring.

Keywords: pavement distress detection, Roboflow, instance segmentation, smartphone photo, Soran City.

Machine Learning-Enhanced Prediction of Delimiting Particle Size of Granular Materials

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ABSTRACT

The Engineering behavior of granular soils is significantly affected by their grain size distribution (GSD). In some GSD curves, all the soil particles are contributing to the stress transmission and the total volume. In others, however, only the large particles contribute to the stress transmission and the total volume, forming the main soil skeleton, while the finer particles are loosely distributed within the voids between the larger particles. The particle size that separates the larger particles from the fine ones is referred to as the delimiting particle size (DPS). This paper presents simple equations for determining the DPS from selected particle sizes obtained from the grains size distribution taking into account the densification (dense or loose states) of the soil. The equations were derived from Åberg model using a wide range of GSD shapes, maximum particle sizes, and minimum particle sizes. Multiple linear regression (MLR) analysis produced excellent correlations (R² about 0.99) for most of cases, except for gap graded soils, which showed a slightly lower correlation coefficient of about 0.93, still indicating good agreement. To further investigate the gap-graded soils, artificial neural network (ANN) analyses were performed to determine the delimiting particle size. The results showed a strong correlation between the actual and the predicted values. The proposed equations were validated using experimental data and by comparison with other DPS prediction methods. The new equations yielded the lowest mean absolute error (MAE).

Keywords: Delimiting particle size; Åberg model; Artificial neural network; Grain size distribution; Machine learning.

A Critical Review of Iraqi Building Code No. 302: Foundations and Retaining Walls Code

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ABSTRACT

The Iraqi Building Code No. 302 (IBC 302), titled "Foundations and Retaining Walls Code," presents key topics of geotechnical engineering, including subsurface soil investigation, excavations and backfilling, soil reinforcement, foundation design and strengthening, settlement criteria, bearing capacity calculations for both shallow and deep foundations, as well as the design of retaining walls. A detailed review of the code found several limitations and areas requiring revisions and more clarifications. This study presents the major concerns, including provisions related to the number and depths of boreholes, the allowable total and differential settlement specifications and the calculation of the modulus of subgrade reaction, comments on the bearing capacity factors, and general guidance for pile groups and dynamic pile testing. Based on the assessments, recommendations are given to improve the code for give recommendations for safe and reliable geotechnical design and construction.

Keywords: building code, foundation manual, soil subsurface investigation, critical review.

A Survey-Based Bus Headway and Fleet Planning Method for Cities Without AVL/APC Data

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ABSTRACT

Many mid-sized developing cities attempting to formalize bus services face difficulties in headway planning because conventional frequency-setting methods often rely on operational datasets, such as automatic passenger counts (APC) and automatic vehicle location (AVL), that are unavailable in emerging transit systems. This study presents a survey-based, rule-driven method to determine bus headways for the AM peak, midday off-peak, and PM peak, and to estimate minimum fleet requirements using cycle time–headway relationships. Using 974 valid public travel survey responses, an OD matrix was developed for a seven-line (A-G) bus network in Soran, Iraq. Demand was distributed across time periods and the Visum network assignment was used to derive line level boarding indicators. These boardings were classified into demand tiers and combined with line roles to guide final headway selection. The method produced headways of 15–35 min in the AM peak, 25–50 min in the midday off-peak, and 30–50 min in the PM peak. The minimum fleet requirement was 23 buses in the AM peak and 16 buses in both the midday off-peak and PM peak. These findings show that the workflow provides a practical basis for initial headway and fleet planning where operational datasets are unavailable.

Keywords: bus headway, fleet sizing, OD matrix, survey based planning, fixed-route bus network, data-scarce cities.

Removal Efficiency of Groundwater Contamination Using Partial Sparging through LTV

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ABSTRACT

This study examines the impact of air sparging on DNAPL remediation in a double-porosity medium (LTV) using a light transmission visualization approach. To achieve twofold porosity, local silica sand and sintered kaolin spheres were stacked in a periodic manner. Trichloroethylene (TCE) was used to simulate DNAPL. Various volumes of TCE were introduced to the system, and sparging was used to remove the TCE. Ten pore volumes of CO₂ were used for air sparging. TCE mass balance was computed for the initial TCE saturation distribution before and after each sparging, and the LTV approach was used to examine the elimination of TCE saturation in the models. The DNAPL increased disintegration and mobilization could be seen thanks to the LTV data. Image analysis showed that the highest DNAPL removal effectiveness of 83% was attained in the double-porosity medium. However, the removal effectiveness dropped to 61% in the case of silica sand, which stands in for the single-porosity media. Subsurface heterogeneity, which is crucial in regulating down gradient effluent mass discharge, may be the cause of these findings. Overall, this work showed that the LTV approach is a practical laboratory instrument that can properly reflect increased DNAPL mobilization and dissolution due to air sparging.

Keywords: Air sparging, double porosity, light transmission visualization, NAPL, porous media.

Assessing the impacts of urbanization and climate variability on land use dynamics using LSTM networks and satellite remote sensing data

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ABSTRACT

This research uses the climate variables and changes in urbanization to explore the vegetation dynamics in Diyala city, Iraq. Remote sensing data and deep learning techniques have been used in this study. Data from 2014 to 2024 were extracted using Google Earth Engine (GEE). The data were collected from Sentinel-2, CHIRPS, and MODIS to provide LST (land surface temperature), NDVI (normalized difference vegetation index), and NDBI (normalized difference built-up index). To calculate changes in LULC (land use land cover), vegetation, built-up area, and crop cover, the data from the dynamic world dataset were used. The deep learning LSTM (Long Short-Term Memory) model was used to predict NDVI in interest. The LSTM model is an effective tool for predicting NDVI in built-up areas and providing valuable insights about the region. The results show that there is more than 60% increase in built up areas compared with vegetation area and crop cover, especially in the central part of Diyala. The NDVI results show lower and very low vegetation classes than NDBI and LST. This study provides a comprehensive analysis of using remote sensing data and deep learning techniques to predict NDVI in a specific area. The results of this research can be used in future work to ensure the model's generalizability across different areas.

Index Terms: NDVI, LSTM, Deep Learning, Land Surface Temperature, Remote Sensing, Google Earth Engine.

A WEAP for Water Scarcity in Erbil: Projecting the Demand-Supply Deficit

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ABSTRACT

Erbil is facing a severe water shortage. This study presents a long-term adaptation strategy to ensure adequate water supplies for all consumers from 2025 to 2065. Using the Water Evaluation and Adaptation Planning (WEAP). The study analyzes scenarios that predict population growth and increased demand across water systems. It predicts a balance between water delivery and consumption for different population growth rates of 3% and 5%. Overall, the findings indicate that relying solely on existing projects will lead to water shortages in 2047 under a growth rate (3%) and problems with adequate water supply in 2038 under a high growth rate (5%). In addition, the results indicate that 1,600 deep wells require a reserve. The results show a water shortage of 11.58 million cubic meters in March 2047 under a 3% population growth scenario, and a water supply shortfall of 7.63 million cubic meters in July 2038 under a 5% population growth scenario, including the use of the wells. This means that the government must find a solution to the water problem. This paper concludes with a three-stage, time-constrained adaptation scheme that prioritizes immediate demand control and wastewater reuse, and the requirement to develop a new project by 2045.

Keywords: Erbil Water Security, WEAP Model, Supply-Demand Scenarios, Groundwater Depletion, Adaptation Planning Framework.