FACULTY OF ENGINEERING AND ARCHITECTURE

3rd ISEDIR 2025

3rd INTERNATIONAL SYMPOSIUM ON ENGINEERING, DESIGN AND INNOVATIVE RESEARCH 2025

ABSTRACT BOOK

-SINOP UNIVERSITY PUBLICATIONS-

SINOP UNIVERSITY

3rd INTERNATIONAL SYMPOSIUM ON ENGINEERING, DESIGN AND INNOVATIVE RESEARCH

ABSTRACT BOOK

24-25 DECEMBER 2025 / SINOP

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ABSTRACT BOOK

24-25 DECEMBER 2025 / SINOP

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PREFACE

The 3rd International Symposium on Engineering, Design, and Innovative Research (3rd ISEDIR 2025) was held on December 24-25, 2025, organized by the Faculty of Engineering and Architecture at Sinop University. This symposium aimed to provide a platform for researchers, professionals, and students to exchange ideas, discuss challenges, and explore innovative solutions in various engineering and design fields.

During the symposium, a total of 159 oral presentations were delivered, covering a wide range of disciplines including Environmental Engineering, Computer Engineering, Metallurgical and Materials Engineering, Mechanical Engineering, Aerospace Engineering, Civil Engineering and Architecture and Energy Systems Engineering. The multidisciplinary nature of the symposium encouraged cross-disciplinary collaboration and fostered an environment of knowledge-sharing and innovation.

The abstracts of the presented papers were published in this "Abstract Book," ensuring the dissemination of the valuable findings and insights shared during the symposium. Furthermore, participants have the opportunity to publish their full papers in peer-reviewed journals affiliated with Sinop University, providing a broader platform for their research contributions.

We would like to express our sincere gratitude to all authors, reviewers, session chairs, participants, and organizing committee members whose dedication and efforts have made 3rd ISEDIR 2025 a memorable and impactful event. Their contributions have been pivotal in fostering academic and professional growth through this symposium.

Prof. Dr. Mustafa Can CANOĞLU
December 2025

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Kemal Tuşat YUCEL[1] and Anıl SARTEKIN[1*]

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Abstract

Nowadays, the effects of digital technology on the construction industry are increasing day by day. In particular, the impact and change of artificial intelligence in the application processes of civil engineering are observed quite frequently. Artificial intelligence (AI) has rapidly transformed modern civil engineering by introducing data-driven analytical capabilities, automated design tools, and predictive modeling techniques that enhance decision-making across all project phases. This study examines these advancements through the example of NEOM's The Line project, one of the most significant global applications of AI-assisted engineering. Within this megastructure, AI-supported Building Information Modelling (BIM), generative design algorithms, and digital twin technologies played essential roles in optimizing structural systems, predicting soil–structure interaction, and coordinating complex construction sequences. Machine learning models (such as artificial neural networks, random forest algorithms, and support vector machines) were applied to forecast material behavior, assess geotechnical risks, and reduce design iteration cycles. Meanwhile, automated clash detection, robotics-based site coordination, and real-time monitoring systems improved construction accuracy, safety, and schedule reliability. Additionally, AI-driven energy modeling and environmental analyses have contributed to The Line's sustainability objectives by minimizing carbon emissions and optimizing lifecycle performance. The findings of this study highlight that the integration of AI in large-scale civil engineering projects significantly reduces cost and time, enhances structural performance, and supports resilient and environmentally responsible design. Overall, AI stands as a transformative force that reshapes traditional engineering processes and sets new standards for innovation in the built environment.

Keywords: Artificial Intelligence, Civil Engineering, NEOM The Line, BIM, Digital Twin

Studies Emphasizing the Importance of Statistical Analyses and Artificial Neural Networks in Yarn Production

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Abstract

The textile industry is an indispensable part of society and holds significant importance from economic, cultural, etc., perspectives. While the textile industry is shaped by various components, the fundamental component is fiber. The characteristics of fibers and their role in yarn production are crucial for the quality and productivity of textile products. The aim of this study is to predict yarn properties from fiber properties in the textile industry using data-driven techniques such as statistical methods and artificial neural networks. Regression analysis, a statistical method, is suitable for understanding the relationship between fiber properties and yarn properties, quantitatively expressing this relationship, and predicting the properties of the produced yarn. On the other hand, artificial neural networks, increasingly used nowadays, are methods that process large amounts of data and reveal complex relationships, being effective in predicting yarn properties from fiber properties. Through the use of statistical methods and artificial neural networks, yarn properties can be determined more accurately from fiber properties, improving yarn quality, increasing production efficiency, and contributing to the sustainability of industrial processes. Additionally, examples of regression analyses and artificial neural networks processed and evaluated in the continuing master's degree thesis are included in this presentation.

Keywords: Yarn Production, Statistical Analysis, Artificial Neural Network, Prediction

Design of an Ultra-High-Bandwidth Polarization Rotator Enabling Broadband Operation in Photonic Integrated Circuits

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Abstract

Polarisation management is a critical task in photonic integrated circuits, especially since silicon is a polarisation-dependent material. To achieve polarisation-consistent operation and eliminate associated on-chip losses, polarisation controller devices have gained increasing interest. Various technologies—ranging from multimode interference designs to adiabatic and plasmonic structures—have been proposed in the literature, each involving trade-offs among efficiency, footprint, and operational bandwidth. Considering these trade-offs, we propose a new design that offers a compact footprint of 1.2 × 29.5 μm², high efficiency with a polarisation conversion efficiency (PCE) of 96%, a polarisation conversion loss (PCL) of 0.18 dB, and an extinction ratio (ER) of 16.7 dB across a 150 nm bandwidth spanning 1.45–1.6 μm. Therefore, it is believed that this study will serve as a valuable reference for future research in the field.

Keywords: Polarisation Control, Photonic Devices, PIC

Artificial Intelligence Supported Battery Management System

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Abstract

The proliferation of electric vehicles and renewable energy storage solutions has made it essential for high-capacity battery packs to operate reliably, efficiently, and with long service life. Battery Management Systems (BMS) ensure safety and performance by monitoring cell voltage, current, temperature, and charge/discharge parameters. However, traditional BMS structures are often limited to methods such as threshold-based control and Coulomb counting, and are insufficient for long-term lifespan prediction and performance analysis under different operating conditions. This study proposes an AI-based BMS design. The system design integrates hardware components (sensors, current/voltage measurement circuits, microcontroller-based control unit) with software components (data acquisition, filtering, SOC/SOH estimation, and protection algorithms). Among the AI algorithms, the remaining battery lifespan is estimated using support vector machines (SVM), and temperature and capacity changes are modeled using long-short-term memory (LSTM) networks. The findings demonstrate that AI-supported BMS provides higher accuracy, more efficient energy use, and safer operation compared to traditional structures. In particular, the significant reduction in error rates in SOC and SOH estimations and the early detection of critical risks such as overheating and cell imbalance have increased the system's effectiveness. Consequently, the proposed AI-based BMS approach offers a significant contribution to sustainability, safety, and efficiency in electric vehicles and renewable energy storage applications.

Keywords: Battery Management System, Artificial Intelligence, SOC, SOH, Energy Efficiency

Insights into Regional Climate Change: A Trend Analysis of Meteorological Data from TR82 Region

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Abstract

This study evaluates climatic variations in Turkey's TR82 Region by analyzing annual average temperature and total annual precipitation data recorded from 1989 to 2023 across nine meteorological stations: Çankırı, Tosya, Çerkeş, Ilgaz, Kastamonu, Devrekani, İnebolu, Sinop, and Erfelek. Identifying long-term trends in temperature and precipitation is essential for understanding regional climate change dynamics. To this end, non-parametric statistical tests including Mann-Kendall, Spearman's Rho, and Sequential Mann-Kendall were employed to assess the direction, statistical significance, and temporal onset of observed trends.

The temperature data analyses revealed high consistency between Mann-Kendall and Spearman's Rho test results, indicating statistically significant positive trends at the 5% significance level across all stations except Erfelek. Sequential Mann-Kendall testing suggested that these warming trends predominantly commenced prior to 1989.

Precipitation trends exhibited more spatial variability, with Mann-Kendall and Spearman's Rho tests yielding parallel results. Statistically significant trends were identified only at the Çerkeş and Kastamonu. Sequential Mann-Kendall analysis pinpointed the onset of the precipitation trend in Kastamonu to 2007, whereas in Çerkeş, the increasing trend began before 1989.

The findings highlight a pervasive warming trend throughout the TR82 Region, while precipitation trends remain localized and less consistent. These results underscore the prominence of temperature as a key indicator of climate change within the region, providing valuable insights for future environmental planning and adaptation strategies.

Keywords: TR82 Region, Regional Climate Change, Climate Variability, Trend Analysis

Design Proposals for City Promotion Stands as a Pattern of Public Space within the Historical Fabric

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Abstract

This study aims to comprehensively examine the projects titled "Design Proposals for City Promotion Stands as Public Space Patterns within Historical Fabric," developed by students as part of the "Stand Design" elective course offered in the 4th year of the Interior Architecture Department at Atatürk University. In this context, the research aims to develop solutions on how temporary and modular structures can be designed in environments with a dense historical fabric, to present ideas on how user interaction can be increased in these structures, and to analyze how such structures can be more effectively integrated into the surrounding public space layout. During the study process, it was observed that applied education provided students with a wide range of skills, from a strong understanding of the historical context to the correct interpretation of spatial scales and the integration of decisions made in the design process with sustainability principles. A detailed examination of the results revealed that the proposals developed by the students offered innovative solutions that were sensitive to the historical environment, based on contemporary architectural principles, and focused on the needs of users. These proposals contained creative approaches that were noteworthy in both theoretical and practical terms, taking the relationship between design and environment to an advanced level.

Keywords: Historical Fabric, Public Space, Promotional Stand, Interior Design Education, Modular Design.

Development of a Non-Marketing Two-Layer Surface Cleaning Towel

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Abstract

With the high demand for more practical and disposable products for daily cleaning, wet wipes that can be used for many surfaces have entered the market. Previously, these products were generally separate products for a single surface or purpose; kitchen, glass surfaces, oily surfaces, etc. Today, multi-purpose products that can be used on many surfaces have been introduced to the market and have started to create a new market. Spunlace non-woven fabric, whose main raw materials are petroleum-based fibers (mainly polyester fibers) and bio-based fibers (mainly viscose fibers), is the dominant component for wet surface cleaning wipes. In addition, preliminary research has shown that cleaning agents and polishing chemicals also have an important place in the solutions used to wet the fabric. Today, a market with a large product line has emerged due to the increasing demand for disposable hygiene products. Within the scope of this study, it was aimed to produce surface cleaning towels that can be used on many surfaces such as glass, wooden surfaces, mirrors, metal surfaces, etc. Here, both the fabric variety to be used and the solution content to be soaked were investigated and the effects on the most suitable cost and best performance were examined.

Keywords: Wet Wipes, Non-Woven Fabric, Polyester, Surface Cleaning

Quantitative and Spatial Analysis of Forest Ecosystem Degradation Using Remote Sensing Data: The Case of Sinop (2023–2024 Period)

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Abstract

This study aims to demonstrate the effectiveness of remote sensing data in detecting sudden ecosystem degradation through a case study of significant vegetation health decline in Sinop forests during 2023–2024. The analysis was performed on the Google Earth Engine (GEE) platform using Sentinel-2 satellite imagery from the peak growth season (June–August) of each year. Median Normalized Difference Vegetation Index (NDVI) composites were generated, and temporal difference analysis was conducted to quantify and map the spatial distribution of degradation. Results indicate that forest health reached its peak in 2023, followed by a marked decline in 2024. While most forested areas (≈272,000 ha) remained stable, degraded areas accounted for approximately 176,035 ha, and improved areas only 3,365 ha. The dominance of negative change was statistically confirmed by the NDVI difference histogram, with the peak clearly shifted to the left of zero. Spatial analysis revealed that degradation was widespread across the province, with hotspots concentrated primarily in the central and southern regions. In conclusion, although Sinop forests maintained overall stability, a pronounced and spatially clustered degradation trend emerged in 2024. This study highlights the utility of Sentinel-2 data and GEE-based workflows for rapid detection and mapping of sudden ecosystem stress events, providing critical information for regional forest management and emergency response planning.

Keywords: Forest Degradation, Remote Sensing, NDVI, Sentinel-2, Google Earth Engine

The Stage V Transition in Tractors: Evolution of Emission Standards, Innovative Technologies, and Performance Analysis

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Abstract

Emission standards for non-road mobile machinery have undergone a continuous evolution since the introduction of Stage I in 1999, with progressively stricter limits on Nitrogen Oxides (NOx) and Particulate Matter (PM) at each phase. The Stage V standard, which represents the technological pinnacle of this process and has also been adopted in Turkey, marks a revolutionary departure from previous regulations. In addition to lowering the PM mass limit by a further 40%, Stage V is the first to regulate the Particulate Number (PN), targeting ultra-fine particles that pose a critical risk to human health. This has made the use of a Diesel Particulate Filter (DPF) mandatory.

This study provides a holistic analysis of the Stage V transition in tractors, examining its historical context, technological infrastructure, and performance impacts. Compliance with the standard has necessitated the integration of advanced after-treatment systems, including the DPF, Selective Catalytic Reduction (SCR), and Diesel Oxidation Catalyst (DOC). While this integration has presented manufacturers with significant engineering challenges in tractor design optimization, these have been coupled with in-engine improvements, such as Common Rail fuel systems, enabling Stage V engines to offer significant advantages. Analyses show that next-generation engines produce higher torque at lower speeds, possess increased power density, and deliver optimized fuel efficiency compared to previous standards.

This paper presents the technical details of Stage V technologies, the evolution of the standards, the effects of the transition on tractor performance and operational costs (e.g., AdBlue, maintenance), and the resulting environmental benefits from a comparative perspective. The study aims to highlight the importance of this technological transformation for the sustainability of agricultural mechanization.

Keywords: Stage V, Tractor, Emission Standards, After-Treatment System, Sustainable Agriculture

Effect of Moisture Absorption Properties of Castamide and Lubricant Filled Castamide on Wear Behaviour

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Abstract

In line with rapid technological advancements, polymers have gained increasing importance in engineering applications and machine design. Their low density, self-lubricating capability, and cost-effective manufacturability make them highly attractive as structural materials. Among these, cast polyamides (commonly known as castamide) represent a class of polyamides that can be synthesized under atmospheric conditions and exhibit superior mechanical and tribological properties compared to conventional polymers. The incorporation of various solid and liquid lubricants into castamide further enhances its wear resistance, thereby extending the operational lifetime of machine components produced from this material. However, the pronounced moisture absorption tendency of polyamides is known to adversely affect their mechanical strength and dimensional stability. In the present study, wear specimens fabricated from unmodified castamide and solid-lubricated castamide were subjected to hydrothermal conditioning by immersion in water for 10, 20, 30, and 60 days. Moisture uptake behaviour and wear characteristics were systematically evaluated as a function of immersion time. The results revealed that both materials exhibited a maximum moisture absorption after approximately 20 days, followed by a decline at longer exposure periods, indicating a diffusion–desorption equilibrium. Under a 5 N applied load, a noticeable increase in mass loss was observed after prolonged immersion, suggesting a softening effect due to moisture ingress. Conversely, at a higher load of 15 N, post-immersion drying was found to significantly reduce the mass loss, demonstrating that controlled dehydration can partially restore matrix compactness and improve wear resistance.

Keywords: Castamide, Cast Polyamide, Lubricant Filled Cestamide, Moisture Absorbing, Wear

Simulation-Based Reconstruction of Motorcycle Traffic Accidents

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Abstract

Motorcycle accidents are among the most critical issues in traffic safety due to the vehicle's open structure, limited stability, and high sensitivity to external factors. This study aims to analyze the causes and dynamic behavior of motorcycle traffic accidents through simulation-based reconstruction methods. Within the scope of the research, a longitudinal dynamic model of a motorcycle was developed in MATLAB/Simulink to examine the effects of various parameters such as speed, collision angle, braking force, driver reaction time, and road friction coefficient on accident dynamics.

The model was established using Newton's second law and incorporated aerodynamic drag to represent realistic motion resistance. Several simulation scenarios were conducted, including thrust cut-off, active braking, and variable collision angles (0°, 30°, and 60°). The results indicate that increased collision angle and decreased road friction coefficient significantly reduce stability and increase stopping distance. Furthermore, a two-second delay in driver reaction time notably extended the stopping distance, emphasizing the importance of human response in crash avoidance.

The developed MATLAB/Simulink model successfully replicates the longitudinal dynamics of a motorcycle and provides a reliable, low-cost approach for accident reconstruction and safety assessment. The proposed framework can also be adapted for testing advanced rider-assistance systems such as ABS and emergency braking. This research contributes to traffic safety engineering by introducing a flexible and generalized model for understanding motorcycle accident mechanisms.

Keywords: Motorcycle Dynamics, Accident Reconstruction, Simulation Analysis, MATLAB/Simulink, Traffic Safety

Flood Risk Analysis Using Geographic Information Systems and Remote Sensing Methods the Case of Dereli District, Giresun Province

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Abstract

This study aims to identify the areas at risk of flooding in the Dereli District of Giresun Province and to analyze their spatial distribution using Geographic Information Systems (GIS). In recent years, the impacts of climate change and irregular precipitation patterns have increased the frequency of flood events, especially in the Black Sea Region. For this reason, Dereli District, which has experienced several destructive flood events in the past, has been selected as a critical study area.

Satellite images and digital elevation models were used to evaluate parameters such as slope, aspect, flow accumulation, land use, and rainfall intensity. These parameters were combined using the GIS-based Weighted Overlay method to create a flood hazard map. The analysis results reveal that the town center and some riverside settlements fall within the high-risk category.

This study provides an important database for local governments in flood risk management and landscape planning processes. It also demonstrates the effective use of GIS and remote sensing technologies in natural disaster risk assessment.

Keywords: GIS, Giresun, Dereli, Flood Risk

The Evolution and Recent Advances of the Agile Approach in Modern Software Engineering over the Last Five Years

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Abstract

The Agile approach, which has shown significant development in modern software engineering in recent years, focuses on creating and maintaining a continuously evolving product that gains new features through short iterations by working collaboratively with the customer rather than dividing the development phase into consecutive stages. As a result, the product adapts and evolves throughout the project lifecycle in response to system variations and changing customer demands and expectations. In recent years, advances related to the Agile approach have rapidly become widespread and are now almost a standard practice in modern software engineering. Following the publication of the *Agile Software Development Manifesto* in 2001 and the subsequent adoption of Agile methods by major software companies such as Microsoft, SAP, and Adobe, the Agile methodology has become a mainstream software development paradigm. By 2015, 95% of developers had started to apply Agile software development practices. The remarkable growth of Agile implementations parallels the evolution of Agile-related research, which has emerged as a significant subdiscipline of modern software engineering over the past two decades and continues to expand today. In April 2018, a search on *Google Scholar* using the keywords "Agile Software Development" for studies up to 2001 returned slightly over 13,000 results, whereas the same search today yields more than 260,000 results. Based on this observation, the present study aims to investigate the transformation and progress of the Agile approach within modern software engineering over the past five years. One of the main motivations for this study is the finding that Agile software development processes are still not sufficiently taught in universities, and as a result, necessary efforts to enhance knowledge and experience in this field remain limited. In summary, this study aims to serve as a guiding resource in addressing the knowledge gap and academic deficiency regarding Agile methodologies within the academic community.

Keywords: Software Development, Software Engineering, Agile Approach

Occupational Safety Training in Türkiye

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Abstract

One of the priorities of working life is ensuring a safe work environment. To prevent occupational accidents and diseases, eliminating hazards, protecting employees against these hazards, educating and training them, and providing warnings are essential. Warnings are important as a form of prevention, acting as invisible guardians. Even if hazards can be largely eliminated, and even if protective equipment is effective, individuals should be made aware of these hazards through information and training. While the basic expectation is that employees make using personal protective equipment a habit, this habit is instilled in them through training and persistent supervision. Proper information and training are crucial for early recognition of hazards, prioritizing personal safety, and ensuring appropriate behavior in unexpected situations, minimizing adverse outcomes. Preventing occupational accidents and diseases is possible by establishing an occupational health and safety (OHS) culture, raising awareness, and disseminating it throughout society. Establishing this culture will foster an environment of continuous improvement and development in occupational health and safety. Establishing a safety culture within an organization can reduce occupational accidents, but to establish a safety culture, a safety climate must first be established. The dimensions of safety climate can be expressed as management values, management and organizational practices, employee training adequacy, provision of safety equipment, the quality of safety management systems, communication, and employee participation in workplace health and safety. This article investigates the training of occupational safety specialists, occupational health and safety board members, employees, and employees requiring specialized training. It has been revealed that the quality and quantity of education and training at occupational safety training levels in Turkey needs to be increased.

Keywords: Accident, Culture, Climate

The Use of Pareto Analysis in Quality and Productivity-Oriented Production: A Statistical Process Control Approach

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Abstract

Manufacturing companies should integrate strategies aimed at increasing process efficiency and reducing defect rates in order to gain a competitive advantage and ensure sustainable quality. High defect rates not only increase the costs of enterprises but also directly affect process efficiency and product quality, thereby reducing customer satisfaction. This situation poses a significant risk factor for enterprises, especially in sectors with intense competition. Ensuring the balance between quality and productivity is critically important for enterprises to achieve long-term sustainable success. In this context, Statistical Process Control (SPC) techniques are powerful tools used to monitor, control, and stabilize process performance over time. Through SPC, it becomes possible to identify deviations that negatively impact quality early on by determining whether the process is affected solely by natural variations or by special causes. Once process control is achieved, the root causes of any defects or errors must be analyzed. The Pareto principle, often referred to in the literature as the “80/20 rule” suggests that in most cases, approximately 80% of the results stem from 20% of the causes. In this study, Pareto analysis was used to investigate the primary fundamental problems that have the greatest impact on the total defect rate calculated in the production process. Thus, a representative company can achieve maximum improvement impact by directing its resources to the most critical areas. It is anticipated that the findings will contribute to the targeted execution of process improvement activities, reducing costs, optimizing resource utilization, and increasing customer satisfaction. In conclusion, the holistic use of SPC and Pareto analysis offers an effective approach to achieving lean and sustainable production goals.

Keywords: Defect Rate, Pareto Analysis, Statistical Process Control

Flight Data Recorder (FDR) Prototype for Avionics Systems Integration

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Abstract

This study presents the design and implementation of a functional prototype of a Flight Data Recorder (FDR) that demonstrates the working principles of modern aviation data recording systems. The developed system aims to collect, process, and reliably store essential flight dynamic parameters using a high-performance microcontroller platform. The prototype integrates two key avionics subsystems. The Navigation and Timing Unit obtains latitude, longitude, speed, and time data via a GNSS module communicating through the UART protocol. Simultaneously, the Static System acquires atmospheric pressure and temperature values using a barometric sensor connected over the I2C protocol. The microcontroller continuously integrates and synchronizes these parameters under a unified timestamp before storing them in CSV format on an external SD card via the SPI interface. This design ensures consistent and loss-free data recording, even under power interruptions, by using data buffering and error-check mechanisms. The proposed prototype successfully simulates the core architecture of an aviation-grade data recorder, providing a reliable educational model for understanding real-world avionics systems. In addition to its technical value, the system serves as a low-cost, modular, and scalable platform for future research and educational use in flight data acquisition and embedded avionics applications.

Keywords: Flight Data Recorder, Avionics Systems, Data Logging, Microcontroller, Embedded Systems

Robot Hand for Sign Language Recognition and Voice Response System

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Abstract

This work presents an innovative and socially responsible engineering project that combines mechatronics and artificial intelligence to facilitate daily communication for individuals with hearing and speech impairments. The primary goal is to establish a two-way communication bridge by recognizing a person's sign language movement (Turkish Sign Language) via a camera and converting it into both vocal and visual output. The system processes captured images using a hybrid model that utilizes Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) layers, ensuring high-accuracy recognition of both static and dynamic signs. Conversely, the system uses a robot hand (designed using CAD Software and controlled by an ESP8266 microcontroller with servo motors) to translate text information into a physical sign language demonstration. The integration of AI tools like TensorFlow Lite (TFLite) ensures real-time, low-latency operation on the embedded platform, optimized for the ESP8266 system. This project offers a practical, low-cost solution and represents a significant step toward a future that breaks down communication barriers and promotes greater social inclusion.

Keywords: Sign Language Recognition, Robot Hand, Deep Learning, Social Inclusion, ESP8266

Recent Innovations in the Biological and Physicochemical Remediation of Petroleum Pollutants

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Abstract

Petroleum-derived contaminants, particularly polycyclic aromatic hydrocarbons (PAHs) and aliphatic compounds, pose persistent environmental risks in soil and aquatic ecosystems. Conventional remediation techniques often face limitations due to high costs and low efficiency, leading to growing interest in integrated biological and physicochemical approaches. This study comprehensively reviews recent advancements in biotechnological (microbial degradation, phytoremediation, genetically engineered microorganisms) and physicochemical (adsorption, photocatalysis, electrokinetic remediation, nanotechnology-based methods) strategies for the removal of petroleum pollutants. Emerging trends highlight the enhancement of microbial activity through nanocatalyst-assisted bioreactors and the improvement of metabolic adaptation within microbial consortia. Moreover, hybrid systems such as bioelectrochemical reactors have demonstrated promising outcomes in achieving rapid and sustainable degradation of petroleum-derived compounds. The study emphasizes that the integration of biological and physicochemical processes offers significant potential for developing next-generation, sustainable remediation technologies.

Keywords: Petroleum Pollution, Bioremediation, Nanotechnology, Hybrid Systems, Environmental Remediation

Between Innovation and Dependence: A Multi-Dimensional Study on ChatGPT Users' Perceptions

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Abstract

The rapid evolution of artificial intelligence has transformed generative AI (GenAI) from a technical innovation into a social phenomenon that reshapes how individuals learn, create, and think. Tools based on large language models (LLMs), such as ChatGPT, enable fast information access and time efficiency but also raise debates over creativity, ethics, and cognitive dependency. Recent studies indicate that GenAI improves productivity in academic and professional settings, yet may reduce critical thinking and deep learning. This study explores perceptions of GenAI use by evaluating ChatGPT experiences across diverse age groups and professions. Conducted in 2025, it collected data from 245 participants through an online survey, including mostly university students (over 60%) as well as engineers, lecturers, healthcare professionals, and public employees. Alongside quantitative findings, 95 open-ended responses were thematically analyzed to capture users' reflections. Results show that ChatGPT is primarily used for information retrieval, academic writing, and time management, while concerns include creativity loss, cognitive laziness, ethical risks, and information reliability. Participants view ChatGPT both as a "revolutionary tool" and a "threat that devalues human labor," echoing the ambivalence found in prior literature. The study's novelty lies in its holistic assessment of ChatGPT's social, cognitive, and ethical dimensionsacross sectors. Findings highlight that users' awareness and digital ethics strongly shape the benefits of AI use. Sustainable adoption, therefore, depends on fostering critical thinking, digital literacy, and ethical awareness within educational and professional systems.

Keywords: ChatGPT, Generative Artificial Intelligence, User Perception, Digital Ethics, AI Literacy

An Applied Approach to Teaching HR Concepts: Use of ERP System

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Abstract

Enterprise Resource Planning (ERP) systems are integrated, software-based solutions designed to manage complex organizational processes within a unified digital framework. These systems cover a wide range of business functions—including finance, logistics, production, and human resources while ensuring seamless data exchange across departments. By fulfilling key information system requirements, ERP platforms enhance operational efficiency, transparency, and consistency. Built on globally recognized "best practice" methodologies, they serve as benchmarks for strategic and operational excellence.

In recent years, academic institutions have recognized the educational potential of ERP technologies as effective tools for linking theory with business practice. Integrating ERP systems into higher education enables students to develop practical skills in enterprise management, data analysis, and decision-making. Responding to this need, a dedicated curriculum was created to embed ERP tools into business and management education, preparing students for technology-driven work environments. Many organizations have already realized substantial benefits from ERP adoption, particularly in improving coordination and reducing operational costs.

Among ERP components, the Human Resource Management (HRM) module plays a vital role in streamlining recruitment, training, and performance management. However, its educational use remains limited within Australian universities. To address this, the University of Victoria integrated SAP Human Resources capabilities into its HRM curriculum, allowing students to gain hands-on experience with real ERP systems. Early outcomes showed improved understanding of HR processes and increased student engagement with technology-based learning. This initiative provides a valuable model for other institutions seeking to align education with digital transformation in the workforce.

Keywords: Enterprise Resource Planning (ERP), Human Resource Management (HRM), Digital Transformation, Higher Education Curriculum, Pedagogical Integration

Investigation of Quenching Medium Effects on the Mechanical Properties of AISI 4340 Steel

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Abstract

AISI 4340 steel is a widely used low alloy high strength material in aerospace, automotive, and particularly defense sectors, where structural components must endure extreme mechanical loads even under thermal stresses. Its application in the steel structure of penetrator type warheads places needs both toughness and strength which are strongly designed by the heat treatment route. Among the variables that control the behavior of 4340 during heat treatment, the quenching medium is an important factor because they affect the cooling rate and the resulting phase transformations. This study aimed to investigate the effect of water and oil quenching on the mechanical performance of AISI 4340. For this work, cylindrical specimens were austenitized under identical conditions, quenched in either water or oil, and subsequently tempered to relieve stresses while retaining a predominantly martensitic matrix. Specimens were tested for yield and tensile strengths, impact toughness, and Rockwell hardness to observe whether the required mechanical properties have been achieved. Optical microscopy was used for the evaluation of microstructure, with particular attention to martensite morphology, prior austenite grain size, and any retained austenite or bainitic regions that arise from differential cooling.

Keywords: Heat Treatment, Impact Toughness, Steel, Microstructure

Cascade Refrigeration System for Low Cabin Temperatures in a Closed Loop Recirculating System

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Abstract

The aim of this study is to design and experimentally evaluate the cooling system of a test chamber capable of simulate extreme atmospheric temperature conditions**.** The prototype results are compared with theoretical data to calculate the deviation rate and demonstrate the consistency and reliability of the system.

With the designed cooling system, the test chamber can be gradually cooled within a range of +40 °C to -55 °C. This chamber enables the analysis of material reactions under decreasing temperature conditions equivalent to an altitude of 22,000 ft, and it can serve as a reference system for industrial and military applications**.**

Currently, applications such as vaccine preservation typically operate around -40 °C, yet sustainable systems capable of reaching -55 °C are extremely rare. In this study, a Cascade Refrigeration Cycle (two-stage system) was used to extend the temperature range below the -40 °C limit reported in the literature.

System components — including the compressor, expansion valve, evaporator, dryer, condenser (heat exchanger), and particularly the cascade condenser — were selected and optimized to achieve the desired performance values. The cascade configuration was chosen because it is the most suitable cycle for low-temperature cooling applications**.**

In the cascade condenser, which acts as the evaporator of the high-temperature cycle (HTC) and simultaneously as the heat exchanger of the low-temperature cycle (LTC), the heat transfer process allows the refrigerant circulating in the LTC to condense by using the cooling capacity provided by the HTC. This is made possible by the difference in the freezing points of the two refrigerants.

The selected refrigerants are R404a for the HTC and R508b for the LTC, chosen for their low Global Warming Potential (GWP) and compliance with European safety standards.

Keywords: Cascade Refrigeration Cycle, Subcooling, Superheat, Condenser, Evaparator

Exploring the Bioactive Landscape of *Polygala myrtifolia*: Antibacterial, Antifungal, and Antibiofilm Activities

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Abstract

Plants produce numerous secondary metabolites that do not directly contribute to their growth and development but play essential roles in adaptation to environmental conditions and defense mechanisms. Among these compounds, saponins, xanthones, and alkaloids have significant importance both in protecting plants against microorganisms and in medical applications. *Polygala myrtifolia* is rich in these constituents and stands out for its notable antimicrobial potential.

Antimicrobial analyses revealed that the extract was effective against both Gram-positive (*S. aureus, B. subtilis, E. durans*) and Gram-negative (*E. coli, E. aerogenes, S. enteritidis*) bacteria. The MIC and MBC values indicated that *E. aerogenes* and *E. durans* strains were inhibited at 125 ppm, and the low MBC values demonstrated strong bactericidal activity.

In antifungal tests, the extract showed inhibitory effects against *Candida albicans* and *Candida utilis*, with the highest activity observed at a concentration of 1000 mg/mL. However, the effect did not increase linearly with concentration, suggesting that it may be influenced by the diffusion or interaction properties of the components.

Antibiofilm analyses showed 85–90% inhibition in all bacterial species at high concentrations (500–250 µg/mL), with *E. coli* and *B. subtilis* identified as the most sensitive species.

In conclusion, this study demonstrates that *P. myrtifolia* possesses promising potential for the development of natural antimicrobial and antifungal agents. The findings provide a foundation for further molecular studies aimed at identifying the biologically active compounds of the plant and support the therapeutic potential of natural products.

Keywords: Antifungal Effect, Antimicrobial Activity, Biofilm İnhibition, *Polygala myrtifolia*

Hybrid Machine Learning and GIS Approach for Real Estate Valuation

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Abstract

Real estate valuation enables accurate and reliable price estimations in the property market. Traditional valuation approaches, commonly including comparative market and income methods, are widely used to determine property values. However, subjective evaluations and the insufficient consideration of spatial variables often reduce the accuracy of valuation results. In this context, Geographic Information Systems (GIS) have been effectively utilized to enhance model accuracy, where spatial, physical, socio-economic, and environmental data related to properties are analyzed and integrated into valuation processes. Numerous studies have demonstrated that the integration of spatial data layers significantly improves model performance.

In addition to GIS-based analyses, machine learning models have emerged as powerful tools for establishing more objective and reliable valuation frameworks. The integration of modern analytical techniques—such as decision trees, random forests, support vector machines, gradient boosting, XGBoost, artificial neural networks, k-nearest neighbors, and fuzzy logic—with spatial data in a GIS environment has further enhanced the success of real estate valuation models.

In this study, spatially contextual data influencing real estate values were structured within a GIS environment, and a valid hybrid model for valuation prediction was developed using machine learning techniques. Among the algorithms evaluated, XGBoost, artificial neural networks, and random forests were identified as the most suitable machine learning approaches for real estate valuation. The results indicate that the XGBoost algorithm provides higher accuracy and spatial consistency in predicting property values compared to other models. Artificial neural networks and random forests also achieved similarly strong performances. Overall, the developed hybrid model can be considered an effective tool that enhances both accuracy and decision-making efficiency in real estate valuation processes.

Keywords: Real Estate, Machine Learning, GIS, Valuation, XGBoost

V2G Applications of Electric Vehicles in Renewable Energy Integration: Impacts on Power Stability and Techno-Economic Outcomes

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Abstract

As awareness of the negative impacts caused by the depletion of fossil resources increases worldwide, the motivation to use clean and sustainable energy sources continues to grow. Along with the aim of promoting clean and green energy usage, the deployment of electric vehicles (EVs) as the primary transportation platform has increased both the number of EVs and their share in total energy consumption. Vehicle-to-Grid (V2G) technology shows great promise in optimizing power demand and enhancing the sustainability of smart grids. Through V2G-enabled applications, electric vehicles can operate as a distributed energy storage system, thereby providing flexibility to the grid. However, the simultaneous connection and disconnection of large numbers of EVs to and from the grid can cause significant fluctuations in energy parameters. As V2G becomes more widely integrated and smart grids grow increasingly complex, energy management, optimization, power system stability, and sustainability gain greater importance.

In this study, a comprehensive overview of V2G technology is presented by analyzing the development of electric vehicles in Türkiye and around the world, as well as their integration with smart grids based on existing research. The challenges associated with integrating V2G into the power grid and the advantages it provides to smart grid operations are examined. Additionally, the effects of V2G applications on voltage and frequency stability in power systems are investigated in detail, and both the positive and negative impacts on grid parameters are discussed based on the findings obtained.

Keywords: Smart Grids, Electric Vehicles (EVs), Vehicle-to-Grid (V2G), Voltage and Frequency Stability, Distributed Energy Storage

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Dust Detection on Photovoltaic Panels Using Deep Learning

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Abstract

In recent years, countries have been increasingly interested in renewable energy sources due to the detrimental effects of fossil fuel-based power generation, such as global warming and carbon emissions. Among renewable energy sources, solar energy is quite popular, considering the ease of installation and low installation costs of solar power plants. However, solar power plants, requiring open areas to maximize irradiance, are exposed to environmental factors such as dust. These dust accumulations on photovoltaic panels reduce power generation efficiency, leading to a decrease in energy production. Therefore, regular monitoring and cleaning of photovoltaic panels are of great importance. In this study, an AlexNet based deep learning approach is proposed for the detection of dust on photovoltaic panel surfaces. Experimental studies were conducted using a publicly available dataset containing labeled images of dusty and clean photovoltaic panels under different viewing angles and lighting conditions to encompass dust densities. The AlexNet model was retrained with transfer learning and achieved an accuracy rate of 92.94%. Consequently, the AlexNet-based approach appears to be applicable as a decision support component for pollution monitoring of panels in solar power plants and target selection for autonomous cleaning robots.

Keywords: Photovoltaic Panels, Dust Detection, Deep Learning

Achieving Time and Cost Efficiency by Ensuring the In-House Production of Special Cutting Tools

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Abstract

Ensuring the desired tolerances in the production of special tools is possible through the optimization of correct material selection, appropriate tool geometry, cartridge precision, and production parameters as an integrated whole. The performance of each tool varies depending on the application area and the properties of the material to be machined. Therefore, the mechanical properties of the material used in the production process directly affect tool life, machining accuracy, and overall efficiency. In production lines requiring high precision, tool rigidity, vibration-damping capacity, and wear resistance become particularly important.

In this study, the production process of special tools used in machining equipment was examined in detail, and material and cartridge selections were determined in accordance with the intended application. The manufactured parts were analyzed and machined in line with predefined tolerances. Post-production heat-treatment processes enhanced material strength, while grinding operations improved surface quality and dimensional accuracy. As a result of the performance tests carried out, it was observed that the production approach implemented within the company provided significant advantages in terms of time and cost. Moreover, with the reduction of dependency on external suppliers, time, cost, and quality-control processes became more efficient. The findings demonstrate that this method not only increases production efficiency but also contributes to a sustainable and economical production model.

Keywords: Time, Cost, Cartridge, Special Tool, Machining Equipment

Comparison of Castings Produced with 3D-Printed Sand Molds and Conventional Sand Molding Methods

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Abstract

The traditional sand molding method has been widely used in the casting industry for many years and provides advantages in terms of cost and flexibility, especially for high-volume production. However, it also has several disadvantages, such as long lead times for model manufacturing and machining, geometric limitations, and the fact that model modifications are costly and time-consuming. In recent years, with the advancement of additive manufacturing technologies, it has become possible to directly produce sand molds using 3D printers with systems such as Binder Jetting. This method eliminates the need for physical patterns, shortens the transition from design to production, and enables the manufacturing of complex geometries as a single piece. It has been shown that 3D-printed sand molds can compete with conventional methods in terms of surface quality, dimensional accuracy, and geometric flexibility. However, issues such as the thermal behavior of binders, gas generation, and brittleness still need to be addressed. In addition, differences in thermal conductivity and cooling characteristics can influence post-casting mechanical properties, microstructure, and potential casting defects. Therefore, research continues on topics such as binder development and design optimization.
In this study, the aim is to evaluate and improve the performance of sand molds produced by 3D printing technology as an alternative to the traditional sand molding method. The casting quality and mechanical properties of molds produced with a 3D printer are intended to be compared with those produced using conventional techniques.

Keywords: 3D Printer, Additive Manufacturing, Binder Jetting, 3D Printing, 3D Printer Technology

Design, Prototype Production and Testing of 67 MVA 154/13.8 KV Power Transformer Using Heat Exchanger with OFAF Cooling System

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Abstract

Efficient thermal management plays a crucial role in ensuring the reliable and long-term operation of high-power transformers. During operation, significant heat is produced, which must be effectively dissipated to maintain efficiency and extend service life. Among available cooling methods, Oil Forced Air Forced (OFAF) systems equipped with heat exchangers are distinguished by their high efficiency, flexible structural design, and lower operating and maintenance costs.

In this project, an OFAF cooling approach was designed and optimized for a 67 MVA, 154/13.8 kV power transformer to achieve superior cooling performance. Both the electrical and mechanical aspects of the transformer were optimized by taking thermal and operational parameters into account. The designed system incorporates three heat exchangers, two in operation and one in reserve, to prevent energy losses in case of a malfunction and to ensure uninterrupted service continuity.

Compared with conventional radiator-type systems, the OFAF configuration provides greater cooling capacity owing to forced oil circulation and an expanded heat exchange surface. It allows faster heat removal, occupies less installation space, and offers design flexibility for compact and thermally efficient transformer structures. Enhanced cooling performance also reduces winding temperatures, enabling the use of smaller conductors and more compact winding arrangements.

This study emphasizes the optimization of transformer cooling systems through a combined electrical, thermal, and mechanical design approach, with the goal of increasing efficiency, improving reliability, and extending the operational lifespan of high-power transformers.

Keywords: Transformer, Heat Exchanger, Cooling System, Efficiency

Integration of a Self-Regenerating Moisture Control System into High-Power Transformer Design

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Abstract

Power transformers play a vital role in ensuring the stability and reliability of electrical transmission and distribution networks. The operational life of a transformer is closely linked to the quality and moisture content of its insulating oil. Traditional air-drying systems gradually lose their absorption capacity and require frequent maintenance, which increases operating costs and causes unplanned service interruptions.

This project focuses on the design, prototype manufacturing, and comprehensive testing of a 50 (63) MVA 115/33 kV power transformer designed in accordance with a maintenance-free air-drying system. The transformer has been structurally optimized so that its piping arrangement, conservator connections, moisture control lines, and pressure-balancing configuration work in harmony with the automatic moisture-regeneration mechanism. The study integrates mechanical, electrical, and control disciplines to ensure compatibility between the transformer and the drying unit while maintaining high dielectric and thermal performance.

Experimental work includes material selection, prototype fabrication, and a complete test program covering routine, type, and special tests under IEC 60076 and IEC 60214 standards. Field evaluations confirm that the automatic moisture-balancing mechanism minimizes the need for human intervention and stabilizes oil properties under variable ambient conditions. Additionally, the system's digital monitoring and remote-control capability provide continuous observation of insulation performance and enable predictive maintenance planning.

The outcomes of this research demonstrate that integrating a self-regenerating drying system within transformer design can substantially increase reliability, extend service life, and reduce total ownership costs. The project also contributes to local R&D capacity by developing a scalable, environmentally sustainable, and export-ready solution for next-generation high-voltage transformers.

Keywords: Power Transformer, Moisture Regulation, Maintenance-Free Drying System, Prototype Development, Energy Reliability

Meteorological Forecasts with an Ensemble Learning Method

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Abstract

Meteorological forecasting is widely acknowledged as one of the most formidable scientific issues due to the atmosphere's complexity and unpredictability. Researchers have investigated both conventional physics-based models and contemporary data-driven methodologies over the years. This study introduces a machine learning approach aimed at categorizing everyday weather conditions into four distinct classifications: bright, overcast, rainy, and snowy. The procedure encompassed data cleansing, feature transformation, model training, and performance assessment. We chose Random Forest as the primary approach due to its adaptability to noisy data, capability to handle both numerical and categorical variables, and its interpretability via feature importance scores. The model achieved a total accuracy of 91.2%. Sunny and snowy days were categorized with good reliability. The overcast and precipitation-laden conditions were occasionally misidentified. The Random Forest analysis indicated that temperature and visibility were the most significant factors in the predictions, contributing around 19.5% and 15% to the overall impact, respectively. These data indicate that Random Forest may serve as an effective tool for practical applications in agriculture, transportation, and urban planning.

Keywords: Machine Learning, Meteorological Forecast, Random Forest, Ensemble Learning

Next-Generation Firewalls for the Financial Sector: The Fortigate Security Profile Approach

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Abstract

The increasing digitalization in the financial sector has made data security a critical priority and necessitated the effective use of next-generation firewalls. Next-generation firewalls provide a flexible and modular security profile architecture that can be centrally managed to prevent threats within corporate networks. This integrated structure consists of independent yet coordinated profiles such as Antivirus, Web Filter, IPS, Application Control, and DNS Filter. Each profile focuses on a specific threat vector, enabling network administrators to identify and separate cyber threats targeting organizational data traffic. The ability to configure profiles independently strengthens the rule-based security approach and allows financial institutions to exercise more precise control over network traffic. In this way, the balance between performance and security is maintained, and unnecessary resource consumption is prevented by activating only the required profiles. The security profile architecture offers a scalable, optimized, and threat-oriented protection model as a next-generation approach.In this study, the security profile architecture of Fortigate firewalls,widely used in financial institutions,was examined, and the impact of antivirus, web filtering, intrusion detection and prevention (IPS), and DNS filtering modules on device resource usage and threat-prevention effectiveness was evaluated. Experimental tests conducted on FortiOS 7.4.8(M) showed that enabling security profiles resulted in a 10–45% increase in CPU utilization and a 4–19% increase in memory usage. However, the modules were found to significantly improve threat detection and prevention performance. The results of the study indicate that, with proper configuration, security profiles can be deployed in financial institutions without causing performance degradation.

Keywords: Security Profiles, Next-Generation Firewalls, Fortigate, Intrusion Prevention Systems, Financial Sector Cybersecurity

Effect of Superabsorbent Polymer (SAP) on the Marshall Stability and Flow of Hot Mix Asphalt

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Abstract

Superabsorbent polymers (SAPs) are hydrophilic, cross-linked materials widely applied in cementitious systems for internal curing, shrinkage mitigation, and durability enhancement. Their incorporation into bituminous mixtures, however, remains relatively new, and the underlying mechanisms governing their effects are not yet fully understood. This study investigates the impact of SAP on the Marshall stability, flow, and volumetric characteristics of a dense-graded hot mix asphalt (HMA) mixture designed for wearing course applications. A traditional Marshall mix design determined the optimum bitumen content (OBC) as 4.80%. Four mixtures—0%, 0.5%, 1.0%, and 1.5% SAP—were produced and evaluated. The findings indicate that SAP positively influences load-carrying capacity, with stability increasing steadily with SAP content. However, higher SAP contents reduced flow values, suggesting increased stiffness and potential implications for flexibility. This study contributes experimental data and mechanistic insights supporting the feasibility of SAP as a performance-modifying additive in HMA mixtures.

Keywords: Superabsorbent Polymer (SAP), HMA, Marshall Stability and Flow

Optimization-Supported Machine Learning Model for Breast Cancer Recurrence Prediction

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Abstract

The recurrence of breast cancer after treatment represents a critical clinical challenge in terms of patient management, treatment planning, and survival. This study proposes a machine learning-based decision support model for predicting the likelihood of recurrence. The study utilizes the Wisconsin Prognostic Breast Cancer (WPBC) dataset, which consists of real patient records collected for clinical follow-up purposes. The dataset was created to predict recurrence risk after surgical treatment and contains 2 classes (N = nonrecur, R = recur), a total of 198 patients (N: 151, R: 47), and 33 features. In this respect, the dataset presents a challenging structure with both significant class imbalance and high variability. A review of the literature reveals that various classification methods have been tested on the WPBC dataset. In this study, to improve classification performance, the Random Forest (RF) model was combined with an optimization process applied in feature selection, thereby developing a decision support system that predicts recurrence risk more accurately. In the data preprocessing phase of the study, missing data were imputed, categorical variables were converted to numerical format, and normalization was applied to all variables. The class imbalance in the dataset was addressed using the Synthetic Minority Oversampling Technique (SMOTE). In the feature selection process, Bayesian-based statistical evaluation and Gorilla Troops Optimizer (GTO) methods, inspired by the leadership and following behaviors of gorilla troops in nature, were used separately to determine the relationship between variables in the dataset and recurrence probability. RF models were trained using the feature subsets obtained from each method, and performance was evaluated through 5-fold cross-validation. Results showed that the RF model achieved 80% accuracy with Bayesian-selected features, whereas the GTO-based subset increased accuracy to 81.81%. The results highlight GTO as an effective and promising feature selector for recurrence prediction.

Keywords: Breast Cancer Recurrence, Machine Learning, Optimization, Feature Selection

High-Durability Black Marking with Picosecond Lasers

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Abstract

In this study, black marking on metal surfaces was carried out using a picosecond laser for permanent identification and coding applications. High-contrast and durable black markings were realized through the laser-induced formation of micro- and nanoscale surface textures and oxide layers, which produced significant modifications in the material's optical response.Thanks to the minimal heat-affected zone characteristic of picosecond lasers, no surface deformation or unwanted discoloration was observed, demonstrating excellent performance on heat-sensitive materials such as stainless steel.
A systematic parameter optimization study was performed by examining the effects of laser power, repetition rate, scanning speed, and focal position on marking contrast and durability. Optimized parameter sets enabled the production of repeatable, high-clarity black markings. Durability tests conducted on processed components revealed strong resistance to abrasion and chemical exposure, reinforcing the suitability of this method for applications requiring long-term traceability, including medical devices, defense components, and industrial parts.
Compared to conventional printing or chemical marking techniques, picosecond laser black marking offers significant advantages, such as the absence of consumables, no chemical waste generation, and the capability to produce high-resolution micro-patterns. Overall, the results confirm that picosecond laser marking is a reliable, environmentally friendly, and highly efficient method for industrial applications demanding superior durability and visual quality.

Keywords: Picosecond Laser, Laser Marking, Laser Parameter Optimization, Black Marking

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Laser-Based Wettability Control and Stability on Stainless Steel

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Abstract

In this study, laser-induced surface modification was employed to control the wettability of stainless steel surfaces. By applying various laser parameters and surface patterning strategies, controlled changes in surface morphology were achieved, enabling the formation of both superhydrophilic and superhydrophobic characteristics. Contact angle measurements revealed that laser parameters strongly affect wettability, with optimized patterns and energy densities resulting in minimized water–surface interaction and contact angles within the superhydrophobic range.

To improve the long-term stability of laser-induced superhydrophobicity under ambient conditions, the processed samples were treated with a chemical coating. Sixty-day aging tests demonstrated that coated surfaces preserved their superhydrophobic properties, whereas uncoated surfaces showed a notable decrease in contact angle after 20 days, transitioning from superhydrophobic to hydrophobic behavior. This finding indicates that although laser processing is effective for initial wettability modification, chemical coating is essential for maintaining long-term performance. In contrast, superhydrophilic surfaces exhibited no significant changes during stability testing.

Overall, the results show that stainless steel surfaces can be engineered to achieve tailored wettability through laser-based surface modification, while chemical coatings significantly enhance the durability of these functional properties. The presented approach offers strong potential for industrial applications requiring improved corrosion resistance and long-lasting wettability control.

Keywords: Laser, Surface Modification, Superhydrophobicity, Superhydrophilicity, Wettability

Stacking Ensemble–Based Short-Term Wind Speed Forecasting

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Abstract

This study develops a comprehensive artificial intelligence model for short-term wind speed forecasting using hourly wind speed and direction data collected from seven districts in the Bingöl region between 2018 and 2023. The primary goal is to enhance prediction accuracy by integrating the physical characteristics of atmospheric processes with modern deep learning techniques. The dataset underwent an extensive preprocessing pipeline, including missing data handling, filtering anomalous measurements, timestamp decomposition, and STL-based extraction of trend and seasonal components. Furthermore, wind direction was re-encoded through trigonometric transformations, and U–V vector components were computed to strengthen the physical consistency of the model.

Feature engineering expanded the predictive capability of the model by incorporating kinetic-energy-related variables, momentum terms, time–frequency characteristics, and additional thermodynamic and astronomical features. The modeling framework employed a hybrid deep learning architecture that combines Conv1D, LSTM, and Attention layers. In parallel, a stacking ensemble model was implemented, integrating multiple regressors such as Ridge Regression, Random Forest, XGBoost, LightGBM, CatBoost, SVR, MLP, and Gaussian Process Regression.

Experimental results show that model performance differs across districts due to local topography and microclimates. On average, the system reached an RMSE of 0.54 and an R^2 of 0.25. In Bingöl's central district, the stacking ensemble performed best with an R^2 of 0.42. Certain districts showed overfitting, likely caused by data imbalance and localized atmospheric variability.

Overall, the study demonstrates that combining physics-informed features with deep learning and ensemble techniques offers strong potential for improving regional wind speed forecasting. Future work is expected to benefit from incorporating physics-based constraints and integrating numerical weather prediction (NWP) data to further enhance model robustness and accuracy.

Keywords: Wind Speed Forecasting, Physics-Informed Artificial Intelligence, Deep Learning, Stacking Ensemble.

Thermal Field Stability and Comparative Evaluation of Laser Types in PID-Controlled Fiber Laser Hardening Processes

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Abstract

This study investigates a fiber laser–based surface hardening system with a PID-controlled closed-loop architecture on the Siemens 840D sl platform. Fiber lasers, with their high beam quality and concentrated energy, enable localized hardening of complex components. However, their rapid thermal response poses a control challenge, as sudden temperature rises can compromise microstructure, dimensional stability, and process reliability. Therefore, fiber laser hardening is both an optical/thermal and real-time control problem.

Surface temperature is measured via a high-speed pyrometer and fed to the embedded PID controller, which continuously adjusts laser power to maintain the desired austenitizing range. Experiments show that the PID-based system suppresses temperature fluctuations, creates a uniform thermal field, and ensures stable martensitic layer formation, reducing overheating, cracking, and uncontrolled heat-affected zone expansion.

The study also compares diode, CO_2, disk, and Nd:YAG lasers in terms of beam profile, absorption on steel, thermal penetration, and controllability under feedback. Diode lasers offer predictable thermal behavior, CO_2 lasers have limited steel hardening performance, and disk lasers provide stable energy over large areas. Fiber lasers, while thermally aggressive, achieve the highest spatial precision when coupled with effective control.

In conclusion, effective fiber laser hardening requires integrating laser type selection, numerical control architecture, and PID temperature regulation. The synergy of these elements ensures repeatable, high-quality, and industrially viable hardening outcomes.

Keywords: Laser-Based Surface Hardening System, PID Temperature Regulation, Industrial Viable Hardening

Experimental Analysis of the Energy Consumption Effects of Low-Complexity Code and High-Complexity Code on the Raspberry Pi 5

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Abstract

The way software shapes micro-architectural processor behavior is a fundamental determinant of energy efficiency. The superscalar architecture, pipeline structure, and out-of-order execution units of the Raspberry Pi 5 provide a suitable experimental platform for examining how differences in code structure influence power consumption. In this study, the energy consumption of the Raspberry Pi 5 was experimentally investigated using two software approaches that execute the same computation but differ in algorithmic complexity: Low-complexity code (LCC) characterized by optimized control flow, regular memory access patterns, and low instruction density—and High-complexity code (HCC), which features irregular memory access, higher branching cost, and increased instruction count.

Energy measurement was performed using a USB power meter connected in series to the system's 5 V supply line, and high time-resolution current–voltage data were used to compute power and total energy values. The processor's micro-architectural behavior was analyzed via the Linux perf infrastructure, evaluating L1/L2 cache hit–miss rates, branch misprediction values, CPI (cycles per instruction) distributions, and instruction mix. The results indicate that LCC reduces pipeline stalls and shortens the processor's residency at high frequencies due to its regular memory access patterns and lower branching overhead. In contrast, HCC increases cache misses, reduces speculative execution efficiency, and elevates CPI values, leading to a significant increase in overall energy consumption.

This study demonstrates that even modest differences in algorithmic complexity can meaningfully influence the energy profile of modern embedded processors and provides a quantitative foundation for energy-oriented software design.

Keywords: Low-Complexity Code, High-Complexity Code, Energy Consumption, Micro-Architectural Analysis, Embedded Systems

Comparative Analysis of Nature-Inspired Optimization Algorithms for Hyperparameter Tuning in Convolutional Neural Networks: An Application of PSO, GA, and GWO

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Abstract

The success of deep learning models, particularly Convolutional Neural Networks (CNN) widely used in image classification problems, relies heavily on the accurate selection of hyperparameters (learning rate, number of filters, layer structure, etc.) that constitute the model architecture. Traditional methods such as trial-and-error or Grid Search incur high computational costs in vast search spaces and often fail to provide the global optimum by getting trapped in local optima. This study aims to comparatively analyze the performance of three different nature-inspired meta-heuristic algorithms to automatically optimize the hyperparameters of a CNN architecture and maximize classification accuracy. The algorithms to be examined are Particle Swarm Optimization (PSO), Genetic Algorithm (GA), and Grey Wolf Optimizer (GWO).

Experimental studies are planned to be conducted on standard image classification benchmark datasets widely used in the literature to evaluate model performance and generalizability. Within the scope of the study, each optimization algorithm will be configured to optimize the number of filters in convolution layers, the number of neurons in fully connected layers, the dropout rate, and the learning rate of the CNN model. It is anticipated that meta-heuristic-based hybrid approaches will improve model accuracy and convergence time compared to manual tuning or random search methods. This study aims to demonstrate the effectiveness of automated systems that minimize human intervention in the design of deep learning models.

Keywords: Deep Learning, Hyperparameter Optimization, Genetic Algorithm, Particle Swarm Optimization, Grey Wolf Optimizer.

Neutronic Analysis of Alternative Fuel Assembly Designs for the NuScale Reactor Using the Serpent Monte Carlo Code

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Abstract

Small Modular Reactors (SMRs) have assumed a critical role in modern energy infrastructures regarding the sustainability and safety of nuclear energy. The NuScale design, distinguished by its scalable architecture and passive safety systems, represents one of the most prominent examples of this technology. In this study, alternative fuel assembly designs aimed at enhancing reactor performance were developed and neutronically analyzed, utilizing the NuScale reactor core as a reference. The Serpent Monte Carlo code, capable of modeling complex geometries and neutron transport with high precision, was employed during the analysis process. Within the scope of the study, various fuel enrichment levels, burnable poison distributions, and pin configurations were investigated. To effectively manage numerous parametric studies and repetitive computational tasks without error, a Python-based automation system was developed. Through this system, Serpent input files were dynamically generated, and simulation outputs were automatically processed. The developed alternative designs were evaluated based on the infinite multiplication factor (k_∞), power distribution, spectral characteristics, and burnup behaviors. The obtained findings demonstrated that the proposed fuel assembly configurations provided potential neutronic improvements compared to the reference design while remaining within safety limits.

Keywords: NuScale, SMR, Fuel Design, Serpent, Neutronic Analysis

Measurement and Sizing of Hydrogen Sulfide (H_2S) Emissions in Geothermal Fluids

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Abstract

Hydrogen sulfide (H_2S), commonly dissolved in geothermal fluids under high temperature and pressure, rapidly exsolves into the gas phase during production, flashing, and cooling operations, creating significant environmental and occupational safety concerns. This study presents an integrated assessment of H_2S dissolution–degassing behaviour, field and laboratory measurement techniques, mass-flux calculations, and engineering-based sizing methods for emission control systems in geothermal environments.

The geochemical dynamics of H_2S and its transition from the liquid to gas phase within separation units (flash tanks, separators, cooling towers) are described in detail. Field measurement practices—including passive/active H_2S monitoring, gas–liquid sampling protocols, and flux computation procedures—are introduced. International case studies (The Geysers, Tuscany geothermal fields) are compared with the geochemical and operational characteristics of geothermal systems in Türkiye.

Furthermore, Fe(III)-based oxidation processes and other engineering solutions for H_2S abatement are evaluated. Using a representative geothermal field scenario, annual H_2S emissions were estimated and design recommendations for mitigation technologies were proposed. The findings highlight the necessity of a scientifically grounded and engineering-integrated strategy to effectively manage H_2S emissions in geothermal operations.

Keywords: Hydrogen Sulfide (H_2S), Geothermal Fluids, Degassing Dynamics, Mass Flux Calculation, Emission Control

Geometrical Optimization of Damping Elements at High Frequencies

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Abstract

This study investigates the enhancement of vibration damping performance in rubber mounts by engineering the geometry–frequency relationship. One of the most effective natural damping mechanisms is the branch–trunk interaction in trees, which behaves like a natural Tuned Mass Damper (TMD) under wind loads. Through the distribution of branch mass, joint stiffness, and frequency separation, energy is dispersed over a wide bandwidth. Inspired by this biological principle, the geometry of rubber mounts including height, cross-sectional shape, volume distribution, and internal cavity design is optimized to match target vibration frequencies. Using the Den Hartog Optimum / Equal Peak criterion, resonance peaks are balanced, and the effective damping ratio is improved. Analyses show that geometric manipulation influences not only the stiffness of rubber but also its effective viscoelastic energy distribution. Multi-mass energy dissipation patterns similar to those in trees can be achieved using shell–core structures or segmented rubber geometries, enabling wider-band vibration control. In conclusion, combining a biomimetic approach with Den Hartog TMD optimization transforms rubber mounts into more efficient and tunable dampers for low-frequency vibrations, offering a robust design framework for automotive and machinery applications.

Keywords: Rubber Mount Vibration Damping, Tuned Mass Damper Optimization, Geometry–Frequency Relationship, Biomimetic Vibration Control

Dam Safety Analysis with Numerical Modeling: Inspection, Calculation and Spillway Investigations

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Abstract

Dams are important engineering structures that play a role in water supply, energy generation, flood control, irrigation, and the sustainable development of societies. However, due to engineering problems and deficiencies in dams, the risk of collapse may arise. Therefore, it is important to identify these deficiencies and take preventive measures. Through the risk and safety assessments conducted on existing dams, efforts are made to determine their current condition, safety levels, and any deficiencies. Taking necessary precautions beforehand is vital to prevent such deficiencies from turning into catastrophic failures. Dam safety is directly affected by factors such as the aforementioned deficiencies, seepage in the dam body with foundation, slope stability, and spillway behavior. Numerical modeling methods have become increasingly important in recent years in identifying and analyzing these processes. Furthermore, not only classical engineering approaches but also Numerical Modeling and Risk-Based Analysis Methods have been widely used in the design, operation, and maintenance processes of dams. However, due to limited field measurements, the complexity of load changes over time, and varying soil conditions, classical calculation methods are often inadequate. In this regard, numerical modeling methods are increasingly being used in engineering decision-making processes. Numerical modeling is based on simulating the behavior of complex engineering systems using mathematical equations. In dam engineering, these models can analyze water movement in the dam body with foundation, material deformations, slope stability, and flood flows.
In this study, dam safety research conducted using HEC-RAS, PLAXIS, and CFD-based approaches was examined through literature-based review. The findings indicate that evaluating dam safety using multi-model approaches and risk-based analyses yields more reliable results. Moreover, the combined use of experimental and numerical analyses provides the most dependable outcomes for ensuring dam safety.

Keywords: Dam Safety, Water, Diseaster, Numerical Modeling

The Ecological Importance of Nature-Based Practices in Sustainable Dam Design

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Abstract

While dams provide numerous benefits, such as energy production, irrigation, flood control, and drinking water supply, they are engineering structures that can also have negative impacts on ecological and biological systems. Dam designs have focused primarily on technical and economic criteria, while ecosystems, biodiversity, and environmental sustainability have often been overlooked. Failure to consider ecological factors during the construction of hydroelectric dams leads to habitat loss, threatening the lives, especially aquatic species. Regulated water flows without ecological consideration disrupt aquatic ecosystems and damage the services these ecosystems provide (fish breeding cycles, aquatic species migration routes, water utilization, nutrient cycling, productivity, wildlife, etc.).

According to new modeling, additional dam construction may lead to a decrease in seasonally inundated habitats due to changing flood regimes, while also contributing to the expansion of ecosystems that depend solely on rainfall. This poses a serious threat to ecological balance and biodiversity. In recent years, the increasing impact of climate change and the resulting loss of biodiversity have made it essential to prioritize sustainability in water structures. In this context, nature-based solution methods offer a new paradigm in dam design, enabling sustainable and environmentally sound approaches that prioritize ecological balance.

This study examines the fundamental principles of sustainable dam design, the application areas of nature-based solutions, ecosystem-based approaches, climate adaptation in water management, and multifaceted components such as interaction with local communities.

Keywords: Dam Design, Nature, Living Organisms, Ecosystem.

Intelligent Rail-Based Tea Harvesting Robot (ARÇAR)

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Abstract

This project focuses on the development of the Intelligent Rail-Based Tea Harvesting Robot (ARÇAR), a robotic tea harvesting system designed to address key problems such as labor shortages, high production costs, and quality losses in tea harvesting. Although Türkiye is one of the leading tea-producing countries in the world with an annual production of approximately 259 thousand tons, the harvesting process is still predominantly carried out manually. This reliance on human labor increases operational costs and causes quality losses, as the ripeness levels of tea leaves cannot always be accurately distinguished by the human eye. Furthermore, the slow, labor-intensive, and inefficient nature of traditional harvesting methods negatively affects the sustainability of tea production.

Within the scope of this project, the system will incorporate an artificial intelligence–based image processing module capable of analyzing data obtained from cameras and sensors to determine the ripeness of tea leaves. After identifying suitable leaves for harvesting, a robotic arm equipped with a vacuum-assisted pneumatic end-effector will collect the selected leaves. The system is designed to operate on a rail mechanism, enabling fast, consistent, and controlled harvesting across large tea fields while significantly reducing the need for human labor.

The prototype to be developed will play a crucial role in verifying the system's working principles and evaluating its applicability. Upon completion, the project is expected to reduce labor costs, improve product quality, and establish a more standardized harvesting process. The development of ARÇAR will support the integration of modern technologies into tea farming, provide producers with a competitive advantage, and contribute to sustainable agricultural practices.

Keywords: Automation, Robotics, Harvesting, Sustainability, Precision Agriculture

The Green Revolution in Agriculture: Environmental Transformation for Sustainability

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Abstract

The agricultural sector has become one of the most critical areas in global environmental policies. In the past, Stage-IV engines offered limited improvements in emission control, primarily relying on Selective Catalytic Reduction (SCR) to reduce NOx emissions. However, they fell short in controlling particulate matter and significantly reducing the carbon footprint. This resulted in deteriorating air quality and created ecological pressures that conflicted with global sustainability goals.

Stage-V engine technology marked a decisive breakthrough. Unlike Stage-IV, Stage-V introduced the mandatory integration of Diesel Particulate Filters (DPF) alongside SCR systems. This combination drastically minimized both NOx and particulate emissions, setting a new benchmark for environmental responsibility in agricultural machinery. Yet, Stage-V is not the ultimate solution, it represents a critical step toward a broader sustainability vision.

The future points to an even more transformative shift. Electrification, hybrid power systems, and alternative fuels such as biodiesel and hydrogen will pave the way for carbon-neutral agriculture. Furthermore, advanced sensor networks and digital monitoring platforms will enable engines to minimize environmental impact throughout their entire lifecycle, not just during operation. The Green Revolution is no longer an option; it is an imperative paradigm shift that will secure the future of agriculture by fostering eco-friendly, efficient, and responsible practices.

Keywords: Carbon Footprint, Diesel Particulate Filter (DPF), Emission Standards, Selective Catalytic Reduction (SCR), Sustainable Environment

Design, Production and Testing of Transformer Suitable for FR3 Vegetable Oil Dual Voltage (High Voltage1 and High Voltage2 Ratio is Less Than 2) Solar Power Plant System

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Abstract

This study presents the design, manufacturing, and testing processes of a 33 kV – 4000 kVAr without tap changer shunt reactor developed to address the increasing need for reactive power control and voltage regulation arising from growing energy demand, long transmission lines, and the integration of renewable energy sources. Shunt reactors play a critical role in modern power systems by absorbing capacitive reactive power, mitigating voltage rise on long cables and overhead lines, and enhancing overall grid stability. Although they share certain structural similarities with transformers, shunt reactors require specialized engineering in magnetic core configuration, winding geometry, loss optimization, and current-limiting behavior. In this project, the reactor was designed in accordance with IEC 60076 standards, utilizing low-loss grain-oriented silicon steel cores, insulated conductors, an optimized insulation system, precision mechanical construction, and vacuum oil filling techniques. The manufactured prototype underwent routine tests including no-load loss, impedance and short-circuit measurements, DC resistance, applied voltage, and induced voltage tests, and the results were evaluated for design verification. The developed reactor represents a significant R&D output aimed at expanding the company's product portfolio, reducing external dependency, and providing energy utilities with a durable, stable, and reliable solution suitable for modern transmission systems and the growing renewable energy market.

Keywords: Shunt Reactor, Magnetic Core Design, Reactive Power Compensation

Design, Production and Testing of 6000 kVA 30/0.8-0.8 kV Oil Type Distribution Transformer Suitable for Solar Power Plants

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Abstract

This project focuses on the design, production, and testing of a cost-effective and space-efficient three-winding oil-immersed transformer suitable for Solar Power Plants (SPPs). In recent years, the rapid expansion of SPP installations has increased the demand for advanced transformer technologies specifically optimized for solar applications. The objective of this study is to develop a transformer that reduces installation area and overall system cost while improving operational reliability and control performance in solar energy systems.

The proposed 6000 kVA, 30/0.8–0.8 kV transformer consists of two independent 3000 kVA low-voltage windings integrated within a single magnetic core, enabling dual LV output. This configuration allows simultaneous feeding of two separate lines, offering significant space savings especially when installed inside compact substations and reducing investment cost compared to using two separate transformers. To mitigate waveform distortion (harmonics) commonly observed in solar fields, an electrostatic shield is placed between the LV and HV windings to improve harmonic attenuation and protect sensitive consumer electronics.

Additionally, the project contributes to reduced product variety by enabling the use of standardized conductors and materials, which helps minimize factory inventory costs. The development and validation of this transformer were carried out as part of Beta Enerji's R&D activities, supporting both national and international market competitiveness in renewable energy applications.

Keywords: Three-Winding Transformer, Solar Power Plants, Dual-Output LV Winding, Oil-Immersed Transformer

A Data-Driven Approach to Playground Planning Based on The Demographic Structure of Izmir

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Abstract

This study presents an assessment centered on social inclusion, accessibility, and social equality in the planning of children's playgrounds, based on Izmir's demographic and socioeconomic structure. Based on 2023–2025 data from the Turkish Statistical Institute (TÜİK), Izmir's child population, family structure, unemployment, and income levels were examined. Demographic indicators (age distribution, unemployment rate, household size, income level, and divorce rate) were analyzed to determine the need for parks for the 2–5 and 5–12 age groups.The obtained data show that the 5–12 age group constitutes 70% of the total child population, while the 2–5 age group constitutes 30%, with divorce (3.05%) and unemployment (11.4%) rates above the Turkish average. This reinforces children's need for safe, free, and accessible playgrounds. Based on this, the park distribution recommendation was set at "70%–30%."Furthermore, the study demonstrates the necessity of modular and multifunctional park designs in urban areas, given the high population density (372.92 people/km²) and small household sizes (2.79 people). Recognizing that playground planning is not only a process of creating physical space but also of establishing social justice, social welfare, and urban identity, the study demonstrates the feasibility of child-centered urban planning by increasing the spatial efficiency and accessibility of playgrounds.

Keywords: Demographic Analysis, Child-Friendly City, Playground Planning, Urban Planning

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Supporting Children's Mental, Cognitive, Physical, Social and Sensory Development through Playgrounds: A Review of Cemer City Equipment

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Abstract

This study examines how children's mental, cognitive, physical, social, and sensory development can be supported through play, focusing on the evaluation of playground equipment produced by Cemer Kent Ekipmanları A.Ş., one of Turkey's leading urban equipment manufacturers. Based on the theoretical frameworks of Piaget, Vygotsky, Erikson, Ayres, and Bronfenbrenner, the research analyzes the developmental contributions of play environments from a multidimensional perspective. Using literature review and design analysis methods, the study evaluates the extent to which Cemer's playground structures support children's developmental domains. The findings indicate that while Cemer's products effectively promote physical development, they show limitations in cognitive, social, and sensory development. The study concludes that playgrounds should be designed not merely as recreational spaces but as pedagogical and inclusive learning environments.

Keywords: Child Development, Playground Design, Urban Equipment, Cognitive Development, Sensory Integration

Designing Inclusive and Accessible Playgrounds: A Study on the Needs of Children with Special Requirements

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Abstract

This study examines children's experiences in playgrounds through the lens of inclusivity and accessibility. The research focuses on the necessity of playground designs that support the physical, cognitive, sensory, and social development of children with special needs. A comprehensive literature review was conducted on inclusive design, sensory integration, play therapy, and universal design frameworks. Additionally, the current conditions of urban playgrounds were analyzed in terms of developmental contribution and inclusivity. Findings indicate that while most playgrounds meet certain physical accessibility criteria, they often fall short in sensory and social inclusivity. The study highlights the significance of multisensory and universally designed play environments in fostering equal participation, social interaction, and holistic child development.

Keywords: Inclusive Design, Accessibility, Special Needs Children, Playground, Sensory Integration

Pittosporum tobira (Thunb.) W.T. Aiton Leaves: Investigation of the Relationship Between Diurnal Chlorophyll Variations and Color Parameters

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Abstract

This study investigated the relationship between chlorophyll content and color parameters (L*, a*, b*) at two different times of day (13:30 and 18:00) in order to reveal diurnal chlorophyll dynamics in the leaves of *Pittosporum tobira*. Paired measurements were obtained from the same 30 leaves at both time points, and it was evaluated whether fluctuations in leaf chlorophyll intensity were reflected in color parameters. The findings showed diurnal variability in chlorophyll and L* values; however, these changes did not result in statistically significant differences. In contrast, a statistically significant change was detected in the a* parameter toward the later time of day, indicating that leaf coloration along the green–red axis exhibits higher sensitivity to chlorophyll dynamics. No significant diurnal change was detected in the b* parameter. Overall, the study demonstrates that colorimetric measurement technologies can serve as a complementary and non-destructive tool for monitoring leaf pigment dynamics—particularly through the a* parameter—and for assessing the physiological status of landscape plants within the context of intra-day variation.

Keywords: CIELab, Chlorophyll, *Pittosporum tobira*, Leaf Color

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A Parameter-Driven Analysis of Porosity Formation by Simulation Validation in High-Pressure Die Casting (HPDC) Processes

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Abstract

This study presents a comprehensive literature review and simulation validation to investigate the effects of modified process parameters in the cold-chamber high-pressure die casting (HPDC) of aluminum and its alloys on casting quality, microstructural characteristics, and defect formation. Data obtained from various experimental studies in the field were comparatively evaluated to establish an integrated review of general trends. The analyzed studies revealed that critical process variables—such as injection pressure, plunger (shot) velocity, die temperature, melt temperature, intensification pressure, filling time, cooling channel temperature, and lubrication interval—were systematically examined. The effects of these parameters, particularly on defects such as porosity, cold shuts, gas voids, and surface cracks, were thoroughly analyzed.

A review of fundamental research in the literature indicates that variations in process parameters significantly affect porosity levels, surface integrity, and overall casting quality. Based on these findings, general trends were identified, and a comprehensive assessment of the influence of process parameters on defect formation was established. Among the most frequently studied and experimentally tested parameters in industry—casting pressure, casting velocity, and die temperature—were prioritized within this study. The selected parameters were modeled and virtually verified using Altair Inspire Cast 2025.1 simulation software.

A high level of similarity was observed between the simulation outputs and experimental data reported in the literature. Accordingly, the simulation was found to reliably predict process behavior and to serve as an effective tool for parameter optimization. Overall, the study demonstrates that simulation-based optimization in HPDC processes holds strong potential for improving casting stability, reducing production defects, and enhancing process repeatability.

Keywords: High Pressure Die Casting (HPDC), Casting Defects, Numerical Modeling, Porosity Formation, Optimization

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Movable Personnel Platform with Adjustable Sliding Table Slices Capable of Synchronized Operation on the X and Y Coordinates

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Abstract

In this study, Önder Group Inc. Design Center an innovative working platform system has been designed to provide safe, ergonomic, and flexible use in industrial maintenance, production, and assembly processes. The foundation of the design is a steel construction body with high load-bearing capacity. This structure has been optimized to ensure durability in long-term use while maintaining stability under vibration and load conditions.

The system possesses both horizontal and vertical movement capabilities. The drive system with a lead screw mechanism on the Y-axis enables precise vertical positioning, while the wheel-based movement system on the X-axis allows the platform to be easily relocated to different working points. This feature provides significant flexibility during maintenance and assembly operations.

Operator safety and ergonomics are the focal points of the project design. Wide walkways, safety railings, and dual-side stair access ensure that users can access the platform safely and comfortably. In addition, the integrated sensor-based safety systems detect potential collisions or instabilities and activate the emergency stop function, thereby protecting both personnel and equipment.

The two-level modular design of the platform allows multiple operators to work safely at the same time. Furthermore, speed control mechanisms in compliance with international standards guarantee safety under varying load and speed requirements.

In conclusion, the project stands out as a highly secure, ergonomic, durable, and standards-compliant mobile platform solution, suitable for use in industrial automation, production lines, and heavy maintenance operations.

Keywords: Lead Screw Mechanism, Sensor-Based Control, Steel Construction Design, Speed Control System

Revisiting Human Endogenous Retrovirus K (HERV-K) in Cancer Genetics: Its Potential Role in Bladder Cancer

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Abstract

Bladder cancer constitutes a growing global health concern and ranks in the 10th most commonly diagnosed cancer worldwide, according to Global Cancer Statistics (GLOBOCAN). The search for biomarkers with diagnostic value in bladder cancer continues rapidly. The potential role of Human Endogenous Retroviruses (HERVs) in cancer development has become an attractive research field. Approximately 45% of human genome is composed of or derived from virus-like transposon-related elements. HERVs, which are remnants of ancient viral infections integrated into the human genome, make up approximately 8% of our DNA. They are accepted as surrogate markers for genetic instability and a driving force of genetic variation. Among the various human endogenous retroviral families, the K series was the latest acquired by the human species, between three and six million years ago. It constitues 1–2% of the human genome. HERV-K is the most complete and biologically active retroviral family that has retained functional full-length open reading frames (ORF) coding for structural and enzymatic proteins. Thus, they have the potential to affect human health from many aspects. HERV-K expression has been detected in a wide range of cancers. The studies focusing on the role of HERV-K in bladder cancer are quite limited and in need of enrichment. Very limited studies indicate the possible role of DNA hypomethylation and changes in gene expression. In this context, the possible genetic and epigenetic mechanisms of HERV-K in bladder carcinogenesis were aimed to be presented and discussed. Since molecular pathogenesis of all human cancers is associated with alterations in gene and/or gene product activities, the involvement of transposable elements (TEs) in bladder carcinogenesis must be taken into account with a critical viewpoint.

Keywords: Bladder Cancer, Retroelements, Human Endogenous Retrovirus (HERV), HERV-K, Oncogenesis

Determination of the Influence of Temperature Variation on Index Values in the Cerchar Abrasiveness Test

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Abstract

During mining and tunneling, complex mechanical interactions between cutting tools and rock surfaces lead to substantial tool wear. This wear significantly increases operational costs, demands more frequent maintenance, and ultimately reduces overall efficiency. Therefore, accurately predicting the wear rates and service life of cutting bits is crucial for economic performance. The Cerchar Abrasiveness Index (CAI) is the standard laboratory method used to estimate cutter wear by measuring the scratch made by a steel tip at room temperature. However, this method has a critical limitation: it ignores the thermal effect. In real-world field conditions, the friction between the cutting bit and the rock generates a significant temperature increase at the interface. This temperature rise profoundly alters the mechanical properties of both the rock and the cutting tool material, meaning the standard CAI test often fails to adequately reflect actual wear mechanisms. This study addresses this fundamental oversight by modifying the standard Cerchar test procedure to incorporate the effect of elevated cutting tip temperature. The main objective is to quantitatively assess how this temperature factor influences abrasiveness and wear behavior. Elevated temperatures are known to soften cutting materials, which typically increases wear. Conversely, high temperatures can also weaken certain rock minerals due to thermal expansion differences, potentially making the rock easier to cut and reducing tool wear. Understanding the precise balance between these opposing effects is essential for accurate wear characterization. The research aims to propose a Thermally-Adjusted Cerchar Abrasiveness Index (TCAI). This new index will utilize experimental data that more accurately represents realistic field conditions, thereby significantly enhancing the prediction of service life for drilling and cutting tools. The study emphasizes that cutting tool temperature is a critical parameter that must be integrated into future abrasiveness assessments, with preliminary results presented based on tests conducted on 21 different rock types.

Keywords: Cerchar Abrasion Index, Equipment Wear, Drill Bit Temperature, Cutting Tool Life, Excavation Efficiency

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The New Course of Technology-Driven Agriculture

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Abstract

As digital transformation in agriculture accelerates in line with increasing efficiency and sustainability goals, automatic steering systems have emerged as one of the most critical components of this evolution. By digitalizing positioning and steering processes in tractors, this technology leverages GNSS-based positioning and RTK correction signals to achieve an accuracy of approximately ±2.5 cm, ensuring maximum precision in operations such as planting, fertilizing, and spraying. The system consists of a high-torque electric motor, an advanced control unit, a GNSS receiver and an intuitive tablet interface. These components, integrated via CAN-Bus communication and real-time data transfer, automatically manage the tractor's steering movements.

Automatic steering minimizes operator intervention, enhances labor efficiency and optimizes fuel consumption, thereby delivering both economic and environmental sustainability. Furthermore, features such as headland turn automation, terrain compensation and path planning enable uninterrupted operation even under complex field conditions. In the literature, these systems are regarded as a pivotal step in agricultural digitalization, with future advancements expected through data-driven management, IoT integration and autonomous driving technologies.

In conclusion, automatic steering is not merely a guidance solution but a strategic technology for precision, productivity and sustainability in agriculture. This innovative approach provides significant economic benefits to producers while reducing environmental impacts, shaping the future of farming.

Keywords: Automatic Steering, Sustainability, Precision Agriculture, GNSS, RTK

Extended Reality (XR) Technologies in Military Training: An Assessment from Türkiye and World Perspectives

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Abstract

This study aims to systematically examine the use of extended reality (XR) technologies in military training. The research is based on international and national studies published between 2015 and 2025, evaluating the impact of XR on learning performance, operational readiness, stress management, and psychological resilience in military training. The findings indicate that XR applications worldwide have rapidly advanced through integration with artificial intelligence, multi-user and distributed training infrastructures, and the widespread use of advanced technologies such as biometric measurements and adaptive scenarios. In Turkey, XR-based military applications are primarily concentrated in training- and maintenance-oriented solutions developed by the defense industry; however, academic research remains limited, and there is a notable gap regarding pedagogical and psychological effectiveness. This study provides a pioneering literature review within the Turkish context, aiming to guide future research.

Keywords: Extended Reality, Virtual Reality, Military Training, Defense Technologies, Simulation-Based Learning

Geographic Information System-Supported Asset Management in Municipalities

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Abstract

Municipalities face increasing pressure to manage their real estate and infrastructure assets more effectively due to rising service demands, limited budgets, and long-term sustainability goals. Traditional, fragmented, and non-spatial asset management processes are often insufficient to meet these requirements. This study examines the transformative role of Geographic Information Systems (GIS) in this process. GIS collects and analyzes essential asset data—such as inventory, precise location, maintenance history, and condition assessments—integrating them into a unified spatial platform. This holistic perspective allows municipalities to obtain a comprehensive view of their entire asset portfolio. The integration of GIS with asset management creates an effective decision-support framework for prioritizing maintenance, identifying underperforming or at-risk assets, optimizing resource allocation, and planning capital investments. The study further emphasizes the importance of open-source GIS solutions due to their inherent cost-effectiveness and flexibility, making them suitable for municipalities with limited capacity. In conclusion, GIS-based asset management is a fundamental component of sustainable municipal governance and Smart City development, successfully enhancing operational efficiency, reducing maintenance costs, and ensuring transparent public resource management.

Keywords: Asset Management, Geographic Information Systems, Smart Cities, Open Source Geospatial, Geomatics.

Use of Hydrogen Energy in Aviation

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Abstract

Growing environmental concerns and the increasing demand for sustainable aviation have accelerated the development of hydrogen energy and fuel-cell-based propulsion systems. Hydrogen, with its high energy density and environmentally friendly characteristics, is considered a promising alternative to fossil fuels. Fuel cells, which convert chemical energy directly into electrical energy, offer high efficiency and zero-emission operation, making them suitable for future aircraft applications. This study examines hydrogen production, storage methods, and its use as a clean aviation fuel, alongside an analysis of various fuel cell types and their operational principles. The historical development of hydrogen in aviation, hydrogen-powered aircraft concepts such as Airbus ZEROe, and the potential benefits and challenges associated with their implementation are discussed. While hydrogen use in internal combustion engines can increase efficiency, controlling NOx emissions remains essential. Hydrogen fuel cells, however, enable fully emission-free flight, significantly reducing environmental impact. Despite advantages, challenges such as infrastructure requirements, cost, storage technologies, and safety standards must be addressed to enable large-scale adoption. The findings highlight that hydrogen energy and fuel-cell technologies will play a transformative role in achieving carbon-neutral aviation, with widespread adoption expected after 2035.

Keywords: Hydrogen Energy, Fuel Cells, Aviation, Sustainable Energy

Development of an Innovative Self-Cleaning Filtration Module Ensuring Continuous Production for the Dairy Industry

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Abstract

During milk processing, high-particle-load streams generated in yogurt, ayran, whey and UHT production lines lead to rapid clogging of existing cartridge and basket filters due to casein fragments, fat globules, curd residues and colloidal structures. These issues cause pressure build-up, frequent CIP requirements and production interruptions, thereby negatively affecting both product quality and process continuity while increasing energy and water consumption as well as maintenance costs. Within this project, the design and prototype manufacturing of an innovative filtration module featuring a rotor-based, high-shear, self-cleaning surface mechanism is targeted to ensure uninterrupted, non-clogging and hygienic handling of these challenging process streams. Through this mechanism, the particle layer accumulating on the filtration surface will be continuously removed, resulting in reduced differential pressure, delayed filter blockage and long-term stable operation. The module provides a versatile process solution by reducing lump formation in yogurt and ayran lines, controlling particle load in whey streams, minimizing fouling and sediment formation in UHT systems, and enabling the recovery and reuse of water employed during CIP cleaning processes. Pilot-scale tests are expected to demonstrate significant improvements in filtrate clarity, particle load reduction, system stability and overall operational efficiency. In conclusion, this domestically developed module will reduce process dependence, lower maintenance and operating costs, enhance production continuity and contribute to the competitiveness of the national dairy industry.

Keywords: Self-Cleaning, Rotor-Based, Anti-Fouling, Dairy Processes, Continuous Operation

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Comparative Modal Analysis of a Seismic-Isolated Building in Openseespy and Seismostruct

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Abstract

This study conducts a comparative modal analysis of a seismic-isolated reinforced concrete building modeled using two independent structural analysis tools: OpenSeesPy and SeismoStruct. In SeismoStruct, the isolators are represented through nonlinear link (NLlink) elements that capture bidirectional nonlinear force–displacement behavior, while in OpenSeesPy, the singleFPBearing command is used to model the same isolator type with equivalent mechanical properties. Prior to eigenvalue extraction, the nodal masses in OpenSeesPy are calculated manually from the applied gravity and live loads, whereas SeismoStruct automatically computes mass based on the defined geometry and material properties. Eigenvalue analyses are performed in both software packages, and the first ten natural periods are compared. The natural periods results exhibit acceptable agreement, with differences ranging from 0.99% to 4.00%. Several modes show identical periods due to the geometric symmetry of the structure. This close correspondence demonstrates the reliability of both modeling approaches and confirms that the isolator representations in each platform produce nearly identical modal responses. The mode shapes further validate the model accuracy, most of the deformation in the first three modes occurs at the isolation layer, exhibiting large lateral displacement at the isolation interface and nearly rigid-body motion of the superstructure. Higher modes involve deformation within the upper structure, as expected for seismic-isolated buildings. Overall, the comparative analysis confirms that OpenSeesPy and SeismoStruct provide stable and accurate predictions of the dynamic characteristics of seismic-isolated structures, forming a strong basis for subsequent nonlinear and seismic demand studies.

Keywords: Modal Analysis, OpenSeesPy, SeismoStruct, Seismic-Isolated Structures, Friction Pendulum Bearings

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Design of an Innovative Exothermic Heating Mechanism for a Flameless Heater Kit

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Abstract

This study presents the development of a compact Flameless Heating Kit designed to heat ready-to-eat meals safely and rapidly without the need for any external heat source. The motivation behind the design stems from the demand for a practical, hygienic, and reliable hot-meal solution in environments where conventional cooking methods are unavailable, such as camping areas, military operations, and emergency or disaster zones. Many existing flameless heating systems require additional steps including assembling multiple components, adding water, or activating pull-cord mechanisms, which introduce challenges such as spillage, mechanical failure, and reduced usability. The proposed design addresses these limitations by integrating all essential components into a single, self-contained unit.The Flameless Heating Kit operates based on an exothermic reaction mechanism capable of heating meals within approximately 5–8 minutes. The system features a novel single-step activation method: when the user rotates the activation knob, an internal cutting element pierces the liquid pouch; the released liquid then interacts with a specialized chemical powder located at the base of the container. This reaction produces heat without requiring any external water supply. The reaction is formulated to avoid unpleasant odors, and the rotating activation structure minimizes the risk of food spillage, ensuring safe and user-friendly operation. Findings indicate that the developed system provides significant advantages compared to similar technologies, including enhanced compactness, built-in water supply, single-motion activation, and reduced operational risks. Inspired by the intuitive action of turning on a stove burner, the rotational activation design enhances user experience and improves the product's ergonomic and intuitive qualities. In conclusion, the Flameless Heating Kit offers a practical, durable, and user-friendly solution for obtaining hot meals under field conditions. The proposed design introduces a novel approach to ready-meal heating technologies and contributes to safer and more efficient food-heating mechanisms for mobile and emergency applications.

Keywords: Flameless Heating System, Ergonomic Design, Technology and Innovation

Investigation of the Radiopacity Properties of PLA/Metal Oxide Composites for Computed Tomography Phantom Applications

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Abstract

In this study, the X-ray attenuation (radiopacity) behavior of polylactic acid (PLA)-based radiopaque composites intended for computed tomography (CT) use was investigated both theoretically and experimentally. For this purpose, the PLA matrix was modified with different metal oxide additives—antimony oxide (Sb_2O_3), titanium oxide (Ti_2O_3), lanthanum oxide (La_2O_3), and gadolinium oxide (Gd_2O_3)—at 1, 3, and 5 wt%. Theoretical mass attenuation coefficients (μ/ρ) for each metal oxide at 120 keV were obtained from the NIST XCOM database. PLA pellets were embrittled using liquid nitrogen and finely ground to promote homogeneous mixing with the metal oxide powders; the ground PLA and metal oxides were then dried at 40 °C for 48 h and processed in a twin-screw extruder (50–170–170–180–175–175 °C) to produce composite pellets. These pellets were dried again at 40 °C for 48 h and injection-molded in an Xplore IM12 machine into cylindrical specimens with 30 mm diameter and 8 mm thickness (mold temperature 50 °C, barrel temperature 185 °C, injection pressure 9 bar). CT images of the specimens were acquired using a Toshiba Asteion scanner operated at 120 kVp and 100 mA, and the corresponding Hounsfield Unit (HU) values were determined. Theoretical results indicated the following order of mass attenuation coefficients at 120 keV: $Gd_2O_3 > La_2O_3 > Sb_2O_3 > Ti_2O_3$; CT measurements confirmed this trend, yielding HU values of 1707.60 for PLA/5Gd_2O_3, 1311.27 for PLA/5La_2O_3, 1202.61 for PLA/5Sb_2O_3, and 95.10 for PLA/5Ti_2O_3. These findings demonstrate that high-effective-atomic-number metal oxide fillers markedly enhance the radiopacity of PLA, and that particularly, Gd_2O_3- and La_2O_3-filled PLA composites are promising candidates for CT phantom fabrication and related medical imaging applications.

Keywords: PLA-Based Radiopaque Polymer Composites, Fused Filament Fabrication Applications, Computed Tomography Phantoms

Comparative Nonlinear Time-History Analysis of a Masonry Structure Retrofitted Using Tie Members

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Abstract

Masonry structures generally exhibit inadequate performance under seismic loading due to their low tensile strength and limited ductility. In such systems, the cracking patterns and damage mechanisms that develop under lateral forces directly influence the global behavior of the load-bearing structure. In this study, the nonlinear structural response of a masonry building retrofitted with tie members is investigated through nonlinear time-history analysis. A hypothetical masonry structure with arbitrary dimensions and representative material properties is considered. Two numerical models are developed: one representing the unretrofitted configuration and the other incorporating tie members as a retrofitting measure. Nonlinear time-history analyses are conducted using an advanced finite element analysis (FEA) platform. A macro-modelling strategy is adopted, in which the nonlinear behavior of the masonry material is represented using the Concrete Damaged Plasticity (CDP) model. This approach captures damage evolution and consequently enables simulation of strength and stiffness degradation. The tie members are modeled as one-dimensional axial elements with appropriate cross-sectional properties, and the tie material is assumed to be AISI 316 stainless steel. Seismic loading is applied as a base excitation using real ground motion records from the November 12, 1999 Düzce earthquake. The analysis results indicate that roof-level displacements remain nearly unchanged after retrofitting, and base shear forces exhibit only negligible reduction. These outcomes suggest that, for masonry structures, retrofitting using tie members alone provides limited improvement to the overall seismic performance.

Keywords: Masonry Structures, Tie Members, Seismic Retrofitting, Time-History Analysis

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Digital KPI Management and Smart System Integration in Production Processes: A Factory Application

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Abstract

Increasing competitive pressures in the manufacturing industry necessitate the strengthening of data-driven decision-making processes and the systematic monitoring of performance indicators. Traditional manual KPI tracking methods introduce significant limitations, including delays, human-induced errors, inefficiencies, and challenges in ensuring traceability. This study presents a comprehensive digital transformation initiative implemented in an automotive supplier facility, in which the performance monitoring process of 110 production lines was transitioned from manual practices to a fully digital KPI management framework. The digital architecture was constructed through the integration of Google Drive, Google Forms, Google Looker Studio, and Google Script, enabling automated data acquisition, centralized storage, advanced visual management, and real-time performance analysis. The system further incorporates smart visualization dashboards comprising SQCDM indicators, line-specific KPI links, and interactive display screens positioned throughout the production environment.

As will be demonstrated through real application examples during the presentation, the developed digital dashboard provides rapid and integrated access to production data, thereby enhancing process transparency and significantly improving decision-making accuracy. Pilot implementations were conducted on selected production lines, followed by iterative system refinement based on user feedback, while comprehensive training programs supported operator adaptation. This methodological approach enabled the successful deployment of the digital solution across all production lines.

The findings indicate that digital KPI tracking substantially increases production visibility, deepens root-cause analysis, and strengthens continuous improvement initiatives. Moreover, the integration of smart systems into daily operational routines enhances user performance, reduces manual recording errors, and accelerates deviation detection. The study demonstrates the practical effects of an Industry 4.0-aligned digitalization model in a real factory setting, offering an accessible and scalable implementation approach and providing a meaningful and original contribution to the existing body of literature.

Keywords: Digital KPI Management, Industry 4.0, Smart Systems, Data Visualization, Manufacturing Performance

The Role of MPht, ZnPht and PEI on the Flame Retardant Properties of ST/APP/TPU Composites

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Abstract

In this study, the effects of melamine phytate (MPht), zinc phytate (ZnPht), and polyethyleneimine (PEI), which are used to create a synergistic effect on the flame-retardant properties of starch (ST)/ammonium polyphosphate (APP)/thermoplastic polyurethane (TPU) composites, were investigated. The flame-retardant properties of the produced composites were determined by vertical burning (UL-94) and limiting oxygen index (LOI) tests. Based on the test results, the highest flame-retardancy level (V0) was obtained in composites containing 25 and 30 wt% APP; therefore, the synergistic effect studies were conducted on composites containing 20 wt% APP. According to the synergistic effect studies, the flame-retardancy performances were as follows: ZnPht > MPht > PEI.

Keywords: Thermoplastic Polyurethane, Starch, Ammonium Polyphosphate, Synergistic Effect, Flame Retardancy

Evaluation of the Tribological Performance of Nano hBN-Reinforced Automatic Transmission Fluid at High Temperatures: An Experimental Study

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Abstract

This study experimentally investigates the effects of adding different concentrations of nano-sized hexagonal boron nitride (hBN) to Automatic Transmission Fluid (ATF II) on friction and wear behavior. Two weight ratios of hBN (0.1% and 0.5%) were prepared using 2% oleic acid as a surfactant. The mixtures were mechanically stirred at 7000 rpm for one hour and then ultrasonically dispersed for another hour. Tribological tests were performed at room temperature and 80 °C under 5 N and 20 N loads, using 8 mm diameter steel balls. The results revealed that increasing the hBN concentration significantly reduced the coefficient of friction and wear. Compared with base oil, the 0.5% hBN-added ATF II showed a 48% reduction in the friction coefficient at room temperature and 38% at 80 °C. The lowest wear scar diameters were also observed in the 0.5% hBN sample, confirming the formation of a protective tribofilm layer on the contact surfaces. Overall, the use of nano hBN as an additive improved the tribological performance of ATF II, especially under high temperature and load conditions, suggesting its potential application in enhancing transmission efficiency and component durability.

Keywords: hBN, Friction, Nanolubricant, Automatic Transmission Fluid

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Analysis of the Mechanical Overload Protection Safety Pin in Pellet Mills Using the Finite Element Method and Calculation of Fatigue Strength

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Abstract

Pellet mills are used to obtain pellets from woodchips. If a foreign object gets between the die and the roller in the pellet press, or if the roller cannot rotate on its own axis for any other reason, the safety pin is broken to allow the press to rotate normally and prevent damage to the press. If the pin does not break at theright time, the press and transmission components may be damaged. The premature breakage of the pin without excessive load also halts production and causes time loss. Therefore, under normal production conditions, the pin must not break, and under excessive load, the pin must break; thus, the optimal design of the safety pin is required. For this purpose, the fatigue life of the designed safety pin under variable loads was analyzed using the finite element method, and the design was validated. From the load data collected from the actual operating conditions of the press, the cycles causing the most damage were identified using a cycle counting algorithm, and fatigue analysis was performed using the developed software, confirming that no damage occurred to the pin under normal operating conditions.

Keywords: Pellet Mills, Shear Safety Pin, Finite Element Analysis, Fatigue Analysis

Application of Finite Difference Method in Thermal Modeling of Friction Stir Welding: Aluminum-Copper Example

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Abstract

Friction Stir Welding (FSW) has established a significant position, particularly in sectors such as automotive and aerospace where strength-to-weight ratio is critical, due to its high weld efficiency (strength) and broad material applicability. In determining the optimum welding conditions for different material pairs and process parameters, mathematical modeling and simulations are of great importance alongside experimental studies. In this study, the time-dependent temperature distribution in the weld zone was analyzed using the heat inputs measured in an experimental study from the literature on FSW of an aluminum-copper material pair as a reference. To capture the fundamental heat transfer mechanism of the welding process while reducing computational cost, a two-dimensional (2D) finite difference model was developed. In the model, consistent with the experimental setup, the points where two thermocouples were positioned were defined as monitoring points, and the time-dependent temperature changes at these points along with the global maximum temperature value were obtained. The analysis results were compared with experimental data, and an error rate of approximately 4% for the maximum temperature and around 3% between the point temperatures was calculated, thus successfully validating the model. This validation demonstrates that even a simple 2D heat transfer model, which does not incorporate complex effects such as material flow, can reliably predict the temperature profile in Al-Cu FSW. The study presents an effective and efficient tool for parameter pre-selection or for quickly understanding the thermal character of the process prior to complex and expensive 3D simulations.

Keywords: Friction Stir Welding, Heat Simulation, Finite Difference Method

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Utilization of Recycled Concrete Aggregate in the Sustainable Built Environment

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Abstract

In recent years, the increasing demand for sustainable construction, the integration of circular economy principles into the construction sector, and the growing focus on value-added waste reuse have renewed interest in construction and demolition waste (CDW). As a major component of global solid waste, CDW can cause significant environmental problems when not properly managed. In this context, research has increasingly focused on the reuse of CDW as a raw material. This study investigates the usability of CDW-derived concrete waste as recycled concrete aggregate (RCA). Although these materials can be used without processing, their properties improve considerably after carbonation. Carbonation was found to reduce key drawbacks of RCA—such as high water absorption, high porosity, increased permeability, and weak mechanical performance due to multiple interfacial transition zones. Carbonation products fill microcracks and pores, enhancing the physical and mechanical behavior of RCA and mitigating many of its inherent limitations. With global CO_2 emissions continuing to rise, there is a growing need for construction materials that promote circularity while offering carbon-sequestration capability. The findings indicate that RCA can function not only as a secondary aggregate but also as a potential component of urban carbon-sink infrastructures. Carbonated RCA can be used in various applications—from subbase layers to precast elements—contributing to active carbon storage within cities. Overall, the carbon capture potential of RCA positions it as a promising material for future strategies aimed at sustainable urban development, emission reduction, and efficient resource use.

Keywords: Recycling, Circular Economy, Carbonation, Sustainable Built Environment

Development of an Iot-Based Digital Solution Architecture for Residential Construction Sites

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Abstract

This study investigates the architectural, operational, and managerial implications of digital transformation in residential construction sites through the integration of Internet of Things (IoT) technologies and proposes a comprehensive digital site solution architecture. The increasing demands for efficiency, occupational safety, effective resource utilization, and sustainability within the construction industry have accelerated the adoption of digital ecosystems and markedly elevated the importance of real-time, data-driven decision-making processes. Meeting these sectoral requirements necessitates the deployment of integrated technological infrastructures capable of supporting continuous monitoring and intelligent management mechanisms. Accordingly, a systematic literature review was conducted using the PRISMA protocol to examine the role of IoT, cloud computing, sensor networks and data-centric management approaches in construction operations. Based on the insights derived from the literature, a multi-layered architectural framework—comprising data acquisition, middleware processing, network communication, cloud analytics, and decision-support components was developed. The proposed architecture enables uninterrupted collection, transmission and analysis of sensor-based data, yielding substantial benefits such as real-time monitoring, workflow optimization, error reduction and enhanced operational efficiency. The originality of this study lies in its conceptualisation of IoT not merely as a technical infrastructure but as an integrated digital management model capable of transforming construction processes. Future work will focus on validating the proposed architecture through expert evaluations and field-based testing, with the aim of evolving it into a practical implementation framework adaptable to various construction site typologies.

Keywords: Internet of Things (IoT), Digital Construction Site, Solution Architecture, Sensor Technologies, Construction Technologies

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Additive Manufacturing Solutions for Rapid, Inclusive, and Sustainable Housing

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Abstract

The growing demand for fast, affordable, and resilient housing solutions for vulnerable communities has intensified interest in advanced construction technologies such as 3D printing with cementitious materials. This study explores the development of rapidly deployable social housing units produced through 3D concrete printing, focusing on the use of circular, waste-based materials to reduce environmental impact while meeting structural and functional requirements. The proposed system enables the rapid fabrication of modular housing components that can be transported, assembled, and adapted to post-disaster or migration-affected contexts. Preliminary findings indicate that 3D printing offers significant advantages in construction speed, material efficiency, and design flexibility, allowing the creation of structurally robust units with reduced labor and logistics needs. By integrating recycled resources and digital manufacturing, the approach supports both sustainability and social resilience. Overall, this work demonstrates the potential of 3D-printed construction as a scalable solution for fast accommodation and inclusive social housing.

Keywords: 3D Concrete Printing, Rapid Social Housing, Circular Construction Materials, Sustainable Additive Manufacturing

Comparison of Static Strength Under Load and Natural Frequency Analysis of Different Side Panel Forms in Tumble Dryer

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Abstract

Vibration-induced noise problems, which directly affect customer perception in the white goods sector, are also observed in tumble dryer. In the past, studies have been conducted to reduce vibration intensity on specific components; however, vibration and static strength analysis on the elements that constitute a tumble dryer driven by a motor are quite limited in the literature.

In this study, the response of two different side panel forms used in a heat pump tumble dryer to deformation under load was investigated. Additionally, the natural frequencies of these two different side panel forms were calculated. Design studies were carried out during the transition from the boomerang side panel form to the newly designed box side panel form, and studies were conducted on the optimum form depth and form shape to increase its strength. During these studies, it was desired to observe the change in natural frequency.

During operation, components such as the motor and compressor in a tumble dryer act as a source of vibration on the machine. This study aims to compare the static behavior and strength resistance of two different side panels with boomerang and box form shapes mounted on the side of the tumble dryer under load, and to examine their natural frequencies using the modal analysis method. The ANSYS program was used to calculate the natural frequencies and displacements of the side panel shapes under load.

When comparing the displacements between the two side panel forms, it was determined that the displacement of the new design was reduced compared to the existing design. Six different mode shapes were created. As a result of the analyses, it was determined that the natural frequency of the Box Side panel form was higher than that of the Boomerang side panel form.

Keywords: Structural Analysis, Vibration, Natural Frequency, Side Panel, Clothes Dryer.

Analysis of GNSS-Based Referencing Techniques for Processing Unmanned Aerial Vehicle Derived Imagery and Producing 3D Data

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Abstract

Unmanned Aerial Vehicles (UAVs) are widely used as an alternative technology to traditional methods in various applications such as high spatial resolution orthophoto production, three dimensional (3D) point cloud generation, and 3D digital twin creation. UAV derived high accuracy datasets provide significant advantages, particularly for monitoring surface changes in regions where access is limited. The positional accuracy of the produced data may vary depending on the referencing techniques employed, such as Real Time Kinematic (RTK), Post Processed Kinematic (PPK), and ground control points (GCPs). Challenging conditions such as mountainous topography, lack of accessibility to reference points, and insufficient internet connectivity necessitate the use of alternative solution approaches.

In this study, in addition to examining standard RTK and PPK solution techniques, the processing of RINEX data obtained from distant TUSAGA-Aktif stations via the PPK method under challenging terrain conditions was evaluated. This approach aims to enable reference point establishment in mountainous areas where triangulation points are absent and internet based positioning is not feasible. The findings indicate that the proposed technique provides significant benefits for reference point establishment in UAV based photogrammetric projects conducted in mountainous regions.

Keywords: UAV, GNSS, 3D Point Cloud, RTK, PPK

Optimizing the Use of Varnish in Flexo-Printed Boxes

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Abstract

The project focuses on optimizing varnish use in corrugated cardboard boxes produced with flexographic printing. Varnish is widely used in the industry because it provides gloss and durability, improving both print quality and visual appeal. However, excessive use increases production costs and environmental impact.

In this project, different varnish types and application methods are tested, alternative eco-friendly options are explored, and production processes are refined through technological improvements. The main goal is to prevent unnecessary varnish consumption, helping reduce both costs and environmental effects.

In current flexo printing processes, varnish consumption can be unnecessarily high, which in turn increases production costs and waste generation. Typically, the flexographic plate (cliché, used to transfer ink) features a smooth and even surface. In this study, the varnish plate was modified by introducing a halftone (screened/dotted) structure. This transformation enables reduced ink transfer by distributing varnish only to screened areas instead of a fully surface, thereby achieving significant material savings. Additionally, operators working on the printing machines were informed about the project and trained, resulting in more efficient process execution. The project not only created economic benefits but also promoted a more environmentally responsible production process by reducing overall ink and varnish consumption. To meet one of its main goals—optimizing varnish use in flexo-printed box production—the varnish applied per square meter was reduced through the selection of suitable anilox cylinders, improved varnish formulations, and the standardization of key process parameters. These improvements led to a 15–30% decrease in varnish usage, which in turn lowered energy consumption and maintenance costs. Implemented through a coordinated approach that addressed both technical and operational aspects, the project successfully advanced its objectives of improving quality, increasing efficiency, and supporting sustainability.

Keywords: Corrugated Cardboard, Flexographic Printing, Varnish

An Adaptive Multi-Layer Attack Prevention Approach in a Reverse Proxy System: A Dynamic Decision Mechanism via Behavioral Scoring on Real Traffic Data

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Abstract

Reverse proxy architectures, which are fundamental components of modern web services, are directly exposed to high traffic volumes and variable attack vectors. Given that traditional threshold-based protection methods often prove insufficient under intense attack conditions, there is a critical need for a more dynamic and context-aware defense approach. In this study, an adaptive attack prevention algorithm based on behavioral patterns modeled from real traffic data is proposed.

The proposed architecture is built upon the Stochastic Traffic Anomaly Framework (STAF), which evaluates client behavior through a multi-layer analysis process. The system incorporates burst analysis for detecting short-term traffic spikes, model-drift metrics for identifying long-term behavioral shifts, and correlation-based analyses to calculate cross-flow contextual consistency. These data are processed by the Edge-Aware Adaptive Decision Layer (EA-ADL), operating near the network edge, and converted into a multi-dimensional decision vector. This decision vector is subsequently interpreted by Hierarchical Isolation Protocols (HIP) operating at the application and network layers, thereby containing potential malicious behaviors at varying levels of isolation.

Evaluations conducted on a large-scale real traffic dataset demonstrate that the proposed approach significantly reduces system load during intense attack periods, minimizes false positive rates, and successfully adapts to changing traffic dynamics. The results indicate that dynamic and highly context-aware defense models offer significant advantages in terms of security and performance in reverse proxy-based systems.

Keywords: Adaptive Security, Reverse Proxy, Traffic Anomaly Detection, Dynamic Defense Model, Behavioral Scoring

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Investigation of Residual Stress Effects on the Fatigue Life of a Sheet Metal Spring Seat

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Abstract

The spring seat is a critical component of the chassis system widely used in the automotive industry and serves as one of the main elements of the suspension system. Its primary functions are to maintain the correct position of the spring, ensure proper load transfer, and contribute to the shock absorption process. This component manufactured from sheet metal materials, requires high fatigue strength under both dynamic and static loading conditions. In this study, the fatigue behavior of the spring seat component was investigated using the finite element method (FEM), focusing on the significance of residual stresses generated at the end of the manufacturing process. In the first stage, linear-elastic analyses were performed in the Abaqus software to obtain the stress distribution and plastic deformation regions. The results from these analyses were then transferred to the fatigue analysis software Simcenter 3D. In Simcenter 3D, the Smith-Watson-Topper (SWT) method with Bergman was applied by considering the mean stress effect, and fatigue damage calculations were performed. Using the damage results, fatigue life estimations were carried out based on Miner's rule. In the second stage of the study, residual stresses occurring during the manufacturing process were determined through forming simulations performed in AutoForm software. These plastic strain values from simulation were converted into residual stress values using the Newton iteration method and were directly implemented as input in the fatigue analysis. The comparisons showed that tensile-type residual stresses induced by the manufacturing process increase local plastic deformation tendency and adversely affect fatigue life. According to the analysis results, when residual stresses were not considered, the average fatigue life of the spring seat component was approximately 6% higher. This outcome demonstrates that accounting for manufacturing-induced residual stresses is a crucial step in achieving more realistic and reliable fatigue life predictions for sheet metal chassis components.

Keywords: Spring Seat, Sheet Metal, Residual Stress, Fatigue Analysis

Mini Unmanned Aerial Vehicle Design and the Effect of Wing Profiles

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Abstract

An Unmanned Aerial Vehicle (UAV) is a type of aircraft that does not carry a pilot or passengers, but instead carries equipment designed for specific purposes such as video, cameras, GNSS, and laser scanning devices. UAVs can perform their tasks via remote control or automated systems. Originally developed for military purposes, this technology is now widely used in both civilian and military fields.

In the military field, UAVs undertake surveillance, detection, tracking, and attack missions; in the civilian field, they play critical roles in many applications such as large-scale map making, documenting archaeological sites, forest management, agricultural applications (spraying, monitoring), traffic control, and disaster management. UAV systems have many advantages, such as no loss of life in the event of an accident, lower operating costs compared to manned systems, and the ability to perform long-term missions. With the advancement of technology, the use of UAVs is expected to become even more widespread and to replace manned systems in the future. The airfoil profile is of vital importance for the aircraft. The airfoil profile affects many parameters such as cruise speed, takeoff and landing distance, stall speed, and aerodynamic efficiency. Therefore, determining an airfoil suitable for the chosen mission profile and flight envelope constitutes one of the most critical stages in mini UAV design.

Within the scope of this study, a preliminary design study was conducted in the mini UAV category by first researching similar systems. The study continued with the selection of the optimal configuration and sizing; finally, the accuracy of the design was examined through analysis and testing.

Keywords: Unmanned Aerial Vehicle, Design, Analysis, Mini UAV, Wing Profiles

Development of a Single-Fixture Integrated Welding System and Investigation of Its Impact on Production Efficiency

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Abstract

This study examines the impact of a newly developed Single-Fixture Welding System on production performance, aiming to eliminate inefficiencies observed in the existing welding process. In the conventional setup, using separate fixtures for each product leads to long setup times, operator dependency, and variability in placement accuracy. These conditions increase cycle time, reduce process stability, and generate frequent bottlenecks within the production line.

The proposed single-fixture system enables all product variants to be positioned on a universal, modular fixture, eliminating setup operations and standardizing the clamping process. Performance tests show a 45-55% reduction in total cycle time, significant elimination of operator-induced variability, and a notable increase in daily production capacity. The results demonstrate that the single-fixture approach offers a sustainable and effective solution for removing bottlenecks caused by clamping and preparation activities in welding operations

Keywords: Single-Fixture Welding System, Production Optimization, Performance Tests, Leakage Test, Cycle Time Improvement

Comparison of Stud Welding and Gas Shielded Welding in Terms of Penetration and Torque Resistance When Joining A2 Stainless Steel Studs to DD13 Plates

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Abstract

In this study, the joining performance of A2 stainless steel M10 studs welded onto 3 mm DD13 sheet steel was experimentally investigated using two different processes: gas metal arc welding (GMAW) and arc stud welding. The GMAW specimens were produced with a parameter set of 100 A welding current, 20 V voltage, 5 m/min wire feed speed, a shielding gas mixture of 80% Ar–17% CO_2–3% O_2, and a travel speed of 12 mm/s. The stud welding specimens were manufactured using 1200 A current, 120 ms welding time, and a 1.5 mm lift-off distance. Weld penetration was examined through metallographic cross-sections, and the torque strengths of the joints were comparatively measured. Results indicate that, under the applied parameter sets, stud welding achieved higher torque performance, whereas the lower heat input in GMAW resulted in comparatively reduced mechanical strength. Penetration evaluations showed that both methods produced acceptable weld profiles, although stud welding exhibited more consistent and repeatable penetration characteristics. These findings highlight the significance of process selection and parameter influence on torque strength and penetration stability in sheet–stud joining applications.

Keywords: Stud Welding, Gas Metal Arc Welding, A2 Stainless Steel Stud, Torque Strength, Weld Penetration

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Architectural Shell Integration without Interfering with the Existing Structure: The Case of Özel Kabuk Tasarımlı Arena

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Abstract

Sports complexes can be defined as facilities that holistically bring together multiple functions such as indoor and outdoor areas for various sports, spectator stands, athlete, service, and technical spaces, all according to specific standards. In this context, the Özel Kabuk Tasarımlı Arena, designed by Aslı Partners, is a multi-purpose sports complex located in Iran with a capacity of 12,000 people, hosting sports including volleyball, basketball, and handball. The research involved document analysis using primary sources. The project aimed to design a shell facade and roof system supported entirely by columns added later, without interfering with the existing structure of the stadium, whose rough construction had been completed. Within this scope, an independent load-bearing system has been created on these columns. Engineering details such as technically and mechanically challenging load transfer mechanisms, wind and dynamic load calculations have also been comprehensively evaluated. Additionally, during the design phase, digital modeling and simulations were used to ensure the functionality and aesthetic harmony of the system. A thin glass-fiber reinforced concrete panel facade system that highlights the texture of concrete was chosen for the facade applications, adding lightness and modernity to the structure. In the roof system, the support structure built on additional columns carrying the thin roof was designed to optimize both visual integrity and technical load transfer. In the design process of interior spaces, the thermal conductivity performance of the fabrics and flooring materials to be used is targeted to be improved by at least 20%; this will positively impact the thermal comfort of the space and reduce energy costs. In the furniture designs featured in the project, functionality, modularity, and durability have been prioritized, ensuring maximum efficiency in the space across different usage scenarios. As a result, designs that enhance the existing structure both aesthetically and functionally have been strategically integrated throughout the process.

Keywords: Architecture, Interior Architecture, Sports Complexes, Shell Design

Industry 4.0 Integration in Cold Storage: Smart Sensors, Remote Monitoring and Data Intelligence

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Abstract

The rise of Industry 4.0 has accelerated the digital transformation of industrial facilities, enabling more effective use of automation, data analytics, and connected systems. Cold storage facilities, which play a critical role in product quality and cold chain continuity, are highly vulnerable to temperature fluctuations, energy inefficiencies, and operational risks. For this reason, advanced control systems equipped with smart sensors, remote monitoring capabilities, and data-driven intelligence have become increasingly essential. This study aims to develop an Industry 4.0-based integrated architecture for cold storage operations. The proposed approach provides a digital framework that enables real-time monitoring, data-intelligent decision support, energy optimization, and enhanced operational reliability. The system consists of IoT-based smart sensors, wireless data transmission, a cloud-based remote monitoring platform, and AI-supported analytical modules. Variables such as temperature, humidity, door-opening frequency, and compressor operation parameters were captured in real time, and machine learning models were employed for anomaly detection, energy curve analysis, and performance forecasting. The architecture was evaluated through a pilot implementation in an industrial cold storage facility.

The results demonstrate that the system can reduce temperature fluctuations by 18%, achieve an average of 11% improvement in energy consumption, and detect potential failures at early stages, thereby preventing operational interruptions. The remote monitoring interface further enabled managers to make faster and more accurate decisions through real-time data visibility.

Overall, the study shows that integrating Industry 4.0 technologies into cold storage operations enhances operational efficiency, reduces energy consumption, and significantly contributes to the sustainable management of the cold chain. The combination of smart sensors, remote monitoring infrastructure, and data intelligence transforms cold storage facilities from traditional systems into digital, predictable, and highly reliable environments. Future work will focus on more advanced predictive models and scalability analyses across different types of cold storage applications.

Keywords: Cold Chain Management, IoT (Internet of Things), Smart Sensors, Energy Efficiency, Remote Monitoring

Modeling Natural Seashell Surfaces with Innovative Technologies: Geogebra, 3D Printing, and Augmented Reality Applications

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Abstract

The mathematical modeling of seashells represents a significant research area, both for revealing the underlying geometric order in natural forms and for transferring this order into digital design processes. Modeling such natural surfaces contributes to understanding the spontaneous structure of nature itself, while also facilitating the development of skills in mathematical modeling and computer-aided geometric design.
In this study, various seashell surfaces were modeled using mathematical expressions found in the relevant literature, and these models were digitally designed via the GeoGebra software. The resulting digital models were physically fabricated using 3D printers to enhance their usability as educational materials. Furthermore, these designed models were transformed into an interactive learning environment through Augmented Reality (AR) applications. The overall objective of this study is to develop a holistic perspective among the disciplines of nature, mathematics, and engineering by materializing the mathematical forms of seashells in digital and physical environments, and to raise awareness regarding the use of innovative technologies in education.

Keywords: Seashell Design, Geogebra, 3D Printing, Augmented Reality

Derivation of Representative Force–Displacement Relationships for Buildings Designed According to Simplified Design Rules

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Abstract

The Simplified Design Rules defined in Chapter 17 of the Turkish Building Earthquake Code (TBDY-2018) provide a streamlined seismic design method for regular reinforced concrete buildings that meet specific criteria. However, the code does not explicitly define capacity curves that characterize the nonlinear seismic behavior of such buildings. Reliable capacity curves are essential for applications such as the development of fragility functions and urban-scale seismic risk assessments. This study addresses this gap by deriving representative force–displacement capacity curves for buildings designed according to the Simplified Design Rules. A total of 24 reinforced concrete building models were developed, considering various numbers of stories, number of bays, and span lengths. The structures were modeled using an advanced nonlinear analysis framework, where beams and columns were represented through distributed plasticity elements. Displacement-controlled nonlinear static (pushover) analyses were conducted for all models, and capacity curves were obtained from the base shear–roof displacement relationships. The resulting curves were idealized into bilinear elastoplastic models following the FEMA-440 guidelines. Yield displacements, yield base shears, and ultimate roof displacements were identified for each building, enabling the definition of representative idealized capacity curves. Comparison between the original pushover curves and their bilinear idealizations demonstrates consistent elastic stiffness and yield points across all models. Although some buildings exhibited post-peak strength degradation, the overall similarity of the derived capacity curves indicates that the proposed idealized models are suitable for use in fragility and risk assessment studies.

Keywords: TBDY-2018**,** Simplified Design Rules, Nonlinear Static Analysis, Bilinear Capacity Curve

Development and Validation of a MATLAB Implementation of the ReaxFF Reactive Force Field for Carbon Systems

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Abstract

Classical molecular dynamics (MD) with reactive force fields is widely used to study structure, dynamics, and chemical reactivity in materials when fully quantum-mechanical methods are too costly. The Reactive Force Field (ReaxFF) formalism is particularly suitable for carbon-based systems, as its bond-order–dependent interactions and dynamic charge equilibration can in principle describe transitions among sp, sp^2, and sp^3 bonding environments. Carbon materials—from small clusters to two-dimensional (2D) networks such as graphene—provide demanding yet chemically simple test systems, where accurate and efficient potential energy descriptions are essential for exploring mechanical failure, functionalization, growth, and high-temperature transformations. While ReaxFF is available in production MD codes such as LAMMPS, there is a persistent need for transparent, easily modifiable implementations that integrate smoothly with custom analysis, method development, and teaching. We present and benchmark a MATLAB implementation of the ReaxFF potential energy framework for carbon-based systems. The code explicitly evaluates all five standard ReaxFF energy contributions: bond, valence, torsion, van der Waals, and Coulomb terms. Its performance is assessed against LAMMPS using identical force-field parameters for a hierarchy of systems: a carbon dimer, a carbon trimer (triangle), and extended 2D carbon structures. For the smaller systems, the MATLAB energies exhibit good quantitative agreement with LAMMPS, with deviations at the level of a few percent. Analysis of these differences indicates that the main source of the error is the current omission of charge equilibration (QEq) in the MATLAB implementation. The framework thus provides a validated and extensible platform for ReaxFF energy evaluation within MATLAB, well suited for coupling to optimization and machine learning tools, and offers a clear path toward full QEq integration and dynamical simulations.

Keywords: Reactive Force Field (ReaxFF), MATLAB Implementation, Carbon-Based Materials

Cable Box Design and Prototyping

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Abstract

This project addresses the design of an innovative box intended to provide practical solution to the clutter, disorganization, and transportation difficulties that arise during the use of cable reels. The designed box is made entirely of corrugated cardboard and features a window structure allows the user to pull the cable directly without removing reel from the box. This design approach significantly reduces common issues such as cable tangling, contamination, and damage during storage. Additionally, the lightweight structure of the corrugated cardboard box and the circular window opening detail contribute to easy handling and storage in various working environments, as the product can be comfortably carried by holding it through this opening. The main objective in design process was to develop a low-cost, lightweight, environmentally friendly, and easy-to-manufacture structure. Corrugated cardboard was chosen as the primary material due to its recyclability, formability, and economic advantages. The window on the front surface of the box allows the cable to be pulled out in the needed length only, while the internal placement and movement space of the reel were planned to support the overall functionality of the design. In this way, the structure aims to offer practicality both during storage and on-site use. The box was shaped to serve its intended purpose effectively and has taken its final form accordingly. By avoiding unnecessary material usage, a solution that is both economically and structurally balanced was achieved. In conclusion, cable reel box designed from corrugated cardboard provides functional solution with its light weight, low cost, eco-friendly material, and user-oriented windowed design. The study demonstrates an effective example of an innovative product development approach and contributes to improving order, accessibility, and efficiency in cable management processes. Furthermore, the adaptable structure of the design allows it to be easily modified for different cable types or usage scenarios.

Keywords: Cable Box, Corrugated Cardboard, Design, Cable Reel

A Pre Production Oriented Design Methodology for Minimizing Failure Risks in Automotive Crashbox Development Using Integrated Ishikawa, QFD, and DFMEA Approaches

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Abstract

Crashbox components are key elements of automotive safety systems, designed to absorb impact energy during low and medium speed collisions while reducing structural damage and repair costs. Achieving stable and repeatable energy absorption behavior at the early design stage remains challenging due to the combined effects of material properties, geometry, manufacturing tolerances, and assembly conditions.

This study presents a systematic and methodology driven design framework for automotive crashbox development based on the integrated application of Ishikawa cause effect analysis, Quality Function Deployment, and Design Failure Mode and Effects Analysis. The primary objective of the framework is to identify and mitigate potential design and manufacturing related failure risks before the production stage, thereby reducing late stage design changes and production induced errors. The approach emphasizes structured engineering reasoning and traceable decision making during the conceptual and preliminary design stages without relying on experimental testing or proprietary numerical data.

An Ishikawa diagram is used to identify potential sources of performance deviation in crashbox behavior, including material variability, geometric parameters, manufacturing induced imperfections, and assembly related misalignments. These factors are then translated into measurable engineering requirements through a QFD based House of Quality, linking customer and regulatory expectations to key technical characteristics.

Subsequently, Design Failure Mode and Effects Analysis is applied to evaluate critical crashbox failure modes such as unstable buckling, excessive peak force, insufficient energy absorption, and corrosion related degradation. This evaluation supports early stage risk prioritization and the definition of preventive design actions.

The results indicate that integrating classical quality and risk analysis tools provides a robust and transferable framework for early stage decision making in crashworthy automotive component design.

Keywords: Crashbox Design, Automotive Safety, Systematic Design Methodology, Quality Function Deployment, Design Failure Mode and Effects Analysis

Effect of Blanking Diameter and Punch Angle on G1/4 Thread Forming Performance: Post-Plating Performance Evaluation

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Abstract

In this study, the gauge pass performance of zinc-plated components subjected to a G1/4 thread forming process on 160 mm diameter plates was investigated. Within the manufacturing process, pre-punching operations were performed using eccentric presses, followed by flaring (extrusion) forming, thread tapping, and subsequent zinc coating. The reliability of gauge acceptance is highly dependent on both the flaring diameter and the punch geometry. Therefore, these process parameters were evaluated through a combination of QForm metal forming simulations and experimental trials conducted on the production line.

Different punch angle configurations were tested during the flaring operation, and the effects of each angle on the flaring geometry and thread tolerance stability were systematically analyzed. The experimental results demonstrated that the use of a flat punch with a 0° angle produced a more symmetrical and stable flaring profile, ensured measurement repeatability during the thread forming process, and enabled consistent and successful gauge acceptance of all parts after zinc plating using the G1/4 thread gauge.

These findings significantly enhance process reliability, optimize manufacturing efficiency, and prevent potential assembly incompatibilities during customer installation.

Keywords: Flaring Diameter, Punch Angle, G1/4 Thread, Thread Gauge Acceptance, QForm Simulation

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Development and Implementation of a Standard Card Barcode Reading System

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Abstract

In the corrugated cardboard box production process, corrugated cardboard sheets are produced in the corrugator machine and placed on a pallet with a forklift and stored in the stock area called semi-finished product stock area. Corrugated cardboard box production machines, which we call converting machines, turns corrugated cardboards to the boxes The sheets in the semi-finished product stock area have cards which we called labels on them so that the converting machines can find the sheets.The converting machines find the products on production list by looking at the labels in the semi-finished stock area divided into zones and put them into production. Forklift operator examines the labels in the areas and finds the corrugated cardboards of the product. During this period, time is lost. In some cases, these products cannot be found and converting machines are stopped and losses occur. With the developed system, a barcode containing product information was added to the labels and the semi-finished product stock area was divided into sections and identified with a barcode.Forklift operators scan the barcode on the label cards hanging on the semi-finished sheet, using a barcode scanner and a tablet, with the barcode scanner in their forklifts. and registers it to the system with the program on its forklift, and the product addressing is completed. The forklift operator who delivers the product to the converting machines enters the information about the product to be worked on into the system via the tablet system and the system tells the operator the exact location of the product. With this developed system, losses in searching and finding products have been eliminated. There has been an increase in productivity in production, forklift movements have become traceable, stock tracking has become possible by product addressing.

Keywords: Barcode, Corrugated Cardboard, Process Development, Addressing, Storage

Development of Functional Biopolymeric Nanocomposite Films and Investigation of Their Potential Use as Food Packaging Materials

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Abstract

This study aimed to develop functional biopolymeric nanocomposite films by reinforcing natural biopolymers, alginate and chitosan, with different combinations of plasticizers and nano-reinforcement materials.

Within the scope of the study, a total of 24 different formulations were investigated, using alginate and chitosan polymers as the base matrix, with increased mechanical flexibility using glycerin and PEG plasticizers, improved barrier properties using bentonite clay, and antimicrobial properties using ZnO nanoparticles. Following a preliminary evaluation, 8 formulations with the most suitable mechanical and physical properties were selected and subjected to detailed characterization studies.

The selected films were characterized by tensile strength, UV-Vis light transmittance, water solubility, water vapor permeability, antimicrobial efficacy tests, and FTIR and FE-SEM imaging. ZnO nanoparticles improved antimicrobial properties and durability, while bentonite clay enhanced barrier properties.

This study is expected to contribute to the development of sustainable food packaging materials and offer an environmentally friendly alternative to traditional plastics.

Keywords: Alginate, Chitosan, Nanoparticle, Biopolymer, Food Packaging

Design and Analysis of Detachable Bolt Head (Zinc-Cap) from Zinc-Aluminum Series Alloys

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Abstract

Bolted joints are essential components in many engineering applications, especially in power transmission lines where structures are exposed to severe vibrations and low-frequency galloping oscillations. These dynamic effects can cause bundle conductors to collide, leading to mechanical wear and reduced system stability. Spacer dampers are therefore installed to maintain conductor spacing and mitigate vibration. However, their clamps must be tightened with precise torque values to function correctly. Under-tightening can lead to clamp slippage, while over-tightening may damage the conductor strands in aluminum-to-aluminum interfaces. To address this challenge, a torque-limiting separable bolt head, called the Zinc-Cap, has been specifically designed. The product consists of two zamak alloy sections connected by a thin, intentionally weakened shear region. The upper section transfers torque during installation, while the lower section grips the bolt head with a tight-fit geometry. When the applied torque reaches the predetermined limit of 45 Nm, the shear zone undergoes controlled fracture, separating the upper part from the lower part. This mechanism prevents further tightening and ensures the bolt is consistently fastened to the correct torque value, independent of installer skill.

Keywords: Separable Bolt Head, Torque-Limiting Design, Controlled Fracture, Mechanical Safety

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Improving Energy Efficiency by Optimizing Compressed Air Usage in the Factory

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Abstract

In corrugated cardboard box production processes, compressed air, along with electricity and water, is used as a fundamental auxiliary energy source for the uninterrupted operation of the converting and corrugated lines. Compressed air production generally accounts for the highest percentage of energy costs. Therefore, efficiency improvements in compressed air systems have become critical requirement that directly contributes to operational economics and implementation of ISO 50001 Energy Management System applications. Furthermore, lower energy use reduces pollution and emissions, improving the project's sustainability.In this study, the existing compressed air process was analyzed in detail. Performance of the compressed air system was remote monitored. The device for detecting compressed air leaks was acquired to identify losses that reduce performance. Our maintenance personnel incorporated these losses into their planned machine maintenance actions to eliminate them. Additionally, program was developed to detect compressed air leaks twice a year for all equipment in the factory. The operating conditions of compressors are another important factor for performance. For this reason, the compressor room environmental conditions have been optimized to be cleaner and with less hot air. Air guns used for cleaning purposes have been replaced with pressure-limited models, thus reducing unnecessary pressure loss and energy waste. In addition, awareness training has been organized for maintenance personnel and machine operators. As a result of the project, a significant reduction in compressed air consumption has been achieved, operating costs have decreased in parallel with energy savings, and greenhouse gas emissions have also been reduced. Production continuity has been ensured through continuous monitoring, automation-supported monitoring, and regular maintenance practices.This comprehensive approach strengthened the facility's compliance with ISO 50001 targets and contributed to the overall performance of the factory at a strategic level by increasing operational efficiency.

Keywords: Energy, ISO50001, Compressed Air, Compressor

Smart Glasses Design with Integrated Sensor and Navigation Systems for The Visually Impaired

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Abstract

This paper focuses on designing and building smart glasses to assist visually impaired individuals or enhance spatial awareness by detecting nearby obstacles. The system is controlled by an Arduino Uno microcontroller and uses an ultrasonic sensor and navigation signal to measure distances to objects in the user's path. When an obstacle is detected within a predefined range, the device alerts the user through a buzzer and a vibration motor, providing both auditory and haptic feedback. The glasses are powered by a rechargeable battery, with a voltage regulator ensuring stable power delivery to all components. The ultrasonic sensor, buzzer, and motor are mounted onto a glasses frame, making the device portable and wearable. This project combines hardware integration, programming, and user-centric design to create a practical and accessible assistive technology solution. The main objective of this project is to increase the safety, mobility, and confidence of visually impaired persons by offering a low-weight, low-cost, and user-friendly solution. Testing and calibration proved that the device is reliable and accurate, hence promising for enhancing the quality of life for its intended users. The results highlight the potential of this innovative approach, which could inspire future advancements in assistive technologies for the visually impaired.

Keywords: Ultrasonic sensor, Arduino uno, smart glasses, obstacle detection.

The Importance of Using ATEX-Compliant Equipment in Electrical Installations in Explosive and Flammable Environments

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Abstract

Recent studies have demonstrated that a significant proportion of electrical industrial accidents in explosive and flammable environments are linked to the use of non-ATEX compliant equipment. The presence of explosive and flammable gases, vapors, or dusts is common in industrial facilities, particularly in environments such as the chemical industry, refineries, mines, and power generation plants. In such environments, explosive atmospheres may be formed as a result of the mixing of air and flammable substances in appropriate proportions. Electrical installations can pose serious hazards as they can be a potential ignition source in these atmospheres. Internationally, the ATEX Directive, along with IEC standards, has been widely adopted and regularly updated to reduce explosion hazards. Although significant progress has been made in occupational health and safety legislation in Turkey, challenges remain in the practical implementation of these regulations, related to limited awareness among technical personnel and inadequate supervision practices. Therefore, strengthening the effectiveness of ATEX management at national and international levels is critical. This study systematically investigates the role of ATEX management in improving occupational health and safety in the field of electrical engineering by encompassing academic publications from the past decade. The ATEX Directive serves as a fundamental element in establishing necessary safety protocols. Findings indicate that compliance with ATEX standards significantly reduces the frequency of electrical accidents in hazardous areas. However, a lack of regulatory knowledge among technical personnel and the misuse of explosion-proof equipment remains critical obstacles for accident prevention. Furthermore, inadequate routine inspections and limited employee training programs contribute to existing risks. Also, establishing a widespread occupational health and safety culture is essential for sustainable success. The study concludes that technical compliance is insufficient and that effective implementation of ATEX is necessary.

Keywords: Flammable and Explosive Atmosphere, ATEX, Safety, Electrical Installation

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Topographic Controls on Station-Satellite Temperature Bias in the Büyük Menderes Basin

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Abstract

Land Surface Temperature (LST) is an essential parameter in climate change research, drought monitoring, agricultural management and urban environmental studies. This research examines the period 1984–2024 by comparing long-term air temperature data from 15 meteorological stations in the Büyük Menderes Basin with LST values derived from Landsat 4, 5, 7, and 8 imageries. The main objective of this research is to evaluate the reliability of satellite-based LST data relative to ground-based meteorological measurements and to analyze the relationships between LST, elevation and distance from the sea. Results show that, the Pearson correlation coefficients range between 0.91 and 0.96, indicating a strong statistical relationship between satellite-derived and ground-based temperature data. However, RMSE values of 8.5 to 15 °C show that the error magnitude increases in high-elevation areas. Bias ratios predominantly greater than 1 indicate that the LST product systematically overestimates temperatures compared to ground measurements, a pattern that is also reflected in the mean error values. This warm bias is driven by several factors: LST represents surface temperature rather than 2-meter air temperature; Landsat's morning overpass captures a period of rapid surface heating; and the 30-m spatial resolution can mix multiple surface types (asphalt, soil, vegetation) within a single pixel, creating local discrepancies around station environments. When the results are analyzed in relation to elevation and distance from the sea, the errors are found to increase with both variables, which is contrary to the usual expectation of smaller errors farther inland. A plausible explanation is that distance from the sea, elevation and station siting are interrelated, such that inland stations tend to be located at higher elevations. Consequently, elevation exerts a more dominant control on the shaping the LST–air temperature bias than the direct effect of distance from the sea.

Keywords: Land Surface Temperature (LST), Landsat Satellite Imagery, Büyük Menderes Basin

The Use of AI-Powered Generative Design and Additive Manufacturing Technology in In-Mold Labeling Robots

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Abstract

In-Mold Labeling (IML) automation requires robotic grippers to place, guide, and retrieve thin polymer labels inside the injection mold; this process is performed in very short periods per cycle (production speeds of 6-10 seconds). Traditional label gripper units are CNC machined and assembled from multiple components, leading to high inertia, long production times, and costly redesigns when the label shape or mold geometry is changed. This study compares the design and production of additive manufacturing (AM) suitable with Generative Artificial Intelligence-based design with that of traditional CNC machining. Generative design enabled the design of topology-optimized geometries with integrated vacuum channels and label placement capabilities. The design process was lightened by selecting Polyamide 12 material suitable for additive manufacturing. Compared to traditional design, the innovative design resulted in a 46% weight reduction, a 50% time saving in the production process, and an 80% advantage in production costs.

Keywords: IML Robot, Generative Design, Additive Manufacturing

Effects of Different Backward-Curved Blade Numbers on the Performance of a Large-Scale 750 mm Centrifugal Fan

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Abstract

In this study, three impeller geometries with 11, 13, and 15 backward-curved blades were investigated for a large-scale centrifugal fan with an outer diameter of 750 mm, and the effects of blade number on aerodynamic performance and noise level were evaluated. While the existing literature primarily focuses on fan diameters in the range of 250–355 mm, this study addresses a significant gap by examining performance trends in large-scale centrifugal fans. Numerical and experimental analyses revealed that the blade number plays a decisive role in determining static pressure, volumetric flow rate, flow stability, and overall noise level.

The results show that the 13-blade configuration achieved the lowest noise level, providing an acoustic advantage, whereas the 11- and 15-blade configurations generated higher airflow rates. In particular, for the 15-blade configuration, the narrowing of inter-blade flow passages caused a deterioration in the flow pattern at the blade exit and intensified the interaction with the volute outlet edge, leading to an overall increase in noise level. These findings are consistent with previously reported relationships between blade-exit flow characteristics, flow stability, and blade number. Overall, the study demonstrates that blade number is a critical design parameter for optimizing the performance of large-scale centrifugal fans and that the noise–performance relationship should be jointly considered during the design process. The results are expected to contribute to ongoing optimization efforts related to energy efficiency, flow quality, and noise reduction in industrial fan applications.

Keywords: Centrifugal Fans, Backward Curved Blades, Blade Number Optimization, Aerodynamic Performance, Noise Reduction

Idealized Capacity Curve Characterization of RC Residential Buildings Before and After Retrofitting

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Abstract

Turkey is located in a seismically active region, and assessing the seismic performance of reinforced concrete (RC) structures, which constitute a major portion of the national building stock, is critical for reducing loss of life and property during future earthquakes. Low- to mid-rise residential buildings, particularly those with 3, 4, and 5 storeys, are especially vulnerable due to limited lateral stiffness and common structural deficiencies. This study aims to evaluate the seismic behavior of such typical RC buildings and to assess the effectiveness of retrofitting with reinforced concrete shear walls using idealized capacity curves. In this study, 150 structural models (50 for each storey category) were generated to represent 3-, 4-, and 5-storey residential buildings. The models incorporate statistically representative variations in geometric properties, material strengths, reinforcement details, and concrete classes based on data available in the literature. Nonlinear pushover analyses were conducted to obtain the global force–displacement behavior of each structure. The analyses were performed both for the original (as-built) buildings and for their retrofitted counterparts strengthened with shear walls. The resulting capacity curves were idealized into bilinear elastic–plastic representations, from which key parameters such as yield strength, ultimate displacement, and initial stiffness were extracted. Comparative evaluation of the idealized curves shows that adding shear walls substantially increases lateral stiffness and yield strength, while also influencing the ductility characteristics of the buildings. The findings provide valuable insight into the nonlinear behavior of typical RC residential buildings in Turkey and the effectiveness of shear-wall retrofitting strategies.

Keywords: Reinforced Concrete Buildings, Retrofitting, Pushover Analysis, Idealized Capacity Curve, Shear Wall

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Investigation of Corrosion Resistance and Durability of Coated and Powder-Coated Industrial Metal Components

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Abstract

Metal components used in industrial applications can gradually corrode over time, causing significant problems in both performance and service life. For this reason, it is important to accurately evaluate the effectiveness of different surface protection methods. In this study, two methods—coating and powder coating—applied to increase the corrosion resistance of piston and plate parts were compared. The surface structure, adhesion quality, and durability of both methods were examined. Additionally, it was considered that when powder coating or general paint layers are exposed to impact, the protective layer can be damaged, making corrosion inevitable on the exposed metal surface.

To assess corrosion performance, the samples were subjected to a standard salt spray test. The results showed that both coating and powder coating provide similar levels of protection. However, the coating method performed better in long-term exposure and maintained its protective barrier for a longer period under salt spray conditions.

These findings indicate that choosing the appropriate surface protection method depends on factors such as possible mechanical impacts, operating conditions, and the required level of corrosion resistance.

Keywords: Salt Spray Test, Coating, Powder Coating, Corrosion, Electro Galvanizing Coating

Side-Channel Analysis on ECC Implementations Using Deep Learning-Based Generalized Power Attack Models

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Abstract

Elliptic Curve Cryptography (ECC) is widely used in modern embedded systems and secure communication protocols due to its efficiency and strong mathematical foundations. However, the physical implementations of ECC remain vulnerable to side-channel attacks (SCAs), which exploit information leakage such as power consumption or electromagnetic emissions. This study focuses on the evaluation of ECC scalar multiplication leakage through power analysis and the application of deep learning-based models to recover private key information. Specifically, a Generalized Power Analysis Model (GPAM) is employed to perform hardware-independent key recovery using trace segments obtained from STM32 microcontrollers. The model is trained on a large dataset of power traces and evaluated for its accuracy and generalization performance across different devices and conditions. Experimental results demonstrate that GPAM can successfully identify key-dependent leakage patterns even in noisy measurement environments, achieving robust scalar byte prediction without prior hardware-specific tuning. These findings highlight both the practicality of deep learning-assisted SCAs and the continuing need for implementation-level countermeasures in ECC-based systems. The study also provides insights into preprocessing methods such as normalization, windowing, and alignment, which significantly influence model performance.

Keywords: Elliptic Curve Cryptography (ECC), Side-Channel Attack, Power Analysis, GPAM

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The Evolution of Public Open Spaces in the 20th Century

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Abstract

In our country, the formation of public spaces has been shaped by many different social, political, and technological factors since the Republic. In the early Republican period, the formation of new public spaces in cities, along with representational spaces for the nation-state and modernization, was observed; various public open spaces such as squares, parks, and monumental areas emerged. Changing social and political approaches to the formation of public space redefined both the form and function of urban spaces. In the mid-20th century, differentiations in the nature of public spaces were seen with urbanization movements, and after 1980 and 2000, public open spaces were reshaped by factors such as neoliberal policies and urban transformation. This study examines the formal and functional formation and change of public open spaces from the Republican period to the present day. The scope of the study focuses on the spatial formation of public open spaces such as square arrangements, city parks, and coastal areas planned or transformed after 1923. This study utilizes a combination of literature review, maps and photographs, field research, and spatial analysis; morphological characteristics of public open spaces and the factors influencing their formation are determined through selected examples. The importance of this study lies in examining the approach to the production of public space in the 20th century through various examples and providing a basis for contemporary urban design processes by comparing the changing approaches to the production of space. The study demonstrates the relationship between approaches to the production of space and its physical formation, and aims to offer a guiding perspective for current planning and design practice.

Keywords: Place Production, Public Space, Urban Morphology, Urban Design

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An Analysis of Continuing Airworthiness Management Costs in Aging Aircraft Fleet

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Abstract

The aim of this paper is to analyse in detail the direct and indirect effects of aircraft aging on continuing airworthiness management costs in civil aviation. It quantitatively assesses the relationship between aircraft age and maintenance costs, models this relationship using linear, polynomial, and robust regression techniques, attributes deviations to engineering factors such as structural damage, corrosion, or modifications, and demonstrates how the findings can inform maintenance planning, failure prevention, and fleet management strategies

In this analysis, maintenance records of specific aircraft types (Airbus A300-600 and A330) operated by a low-cost air cargo carrier are examined. The A300-600 is one of the earliest Airbus wide-body designs. Therefore, maintenance and cost data from aircraft that have been in operation for up to 35 years is used. In addition, the operator's fleet includes A330 aircraft that have been in service since production, as well as several A330s of varying ages. The use of data from this mixed-age fleet enables the identification of trends in maintenance cost increases associated with aircraft aging.

The study confirms that aircraft aging significantly influences continuing airworthiness management costs, primarily due to structural fatigue, corrosion, and required modifications. Regression analysis effectively captures cost trends, providing valuable insights for maintenance planning, failure prevention, and fleet management. These findings support informed decision-making to optimize operational efficiency and ensure the long-term airworthiness of aging aircraft.

Keywords: Aircraft Aging, Continuing Airworthiness Management, Maintenance Cost

Analysis of the Electrical Performance of EDLCs (Electric Double Layer Capacitors) at Various Temperatures

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Abstract

Electric Double Layer Capacitors (EDLCs), commonly known as supercapacitors, are widely used in energy storage systems due to their high power density, fast charge–discharge capability, and long cycle life. The performance of EDLCs, however, is highly dependent on operating temperature. At low temperatures (–40 °C to 0 °C), increased electrolyte viscosity reduces ion mobility, leading to higher equivalent series resistance (ESR) and a noticeable decrease in capacitance. At room temperature (20–25 °C), EDLCs operate near their rated performance with low ESR and high energy efficiency. Although ion mobility increases at higher temperatures (60–85 °C), electrolyte degradation becomes more significant, causing gas generation, increased leakage current, and accelerated aging. In this study, the electrical behavior of EDLCs under low-temperature and room-temperature conditions was investigated. The results highlight the importance of considering temperature effects in the design of energy storage systems, especially in military, automotive, and industrial applications.

Keywords: Supercapacitor, ESR (Equivalent Series Resistance), Temperature Effects, Energy Storage

Development and Characterization of Decellularized Avocado Tissue as a Sustainable Biomaterial

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Abstract

In the field of tissue engineering and regenerative medicine, there is growing interest in plant-derived biomaterials due to their inherent biocompatibility, sustainability, and unique structural properties. Decellularization serves as a critical technique in this domain, aiming to generate functional scaffolds by removing immunogenic cellular components while preserving the native extracellular matrix (ECM) architecture. This study investigates the potential of avocado (*Persea americana*) fruit tissue as a novel, natural biomaterial as a tissue engineering scaffold.

Avocado tissue was subjected to a sodium dodecyl sulfate (SDS)-based decellularization protocol. Macroscopic whitening of the tissue was observed following treatment, suggesting substantial removal of cellular constituents while preserving the overall porous morphology.

Comprehensive characterization analyses were conducted to validate the physicochemical and biological properties of the scaffold. Immunofluorescence staining with DAPI confirmed the complete absence of nuclear DNA, ensuring the removal of genetic material to minimize immunogenicity. Fourier Transform Infrared Spectroscopy (FTIR) analysis revealed the preservation of the structural integrity of cellulose and hemicellulose backbones, while characteristic peaks for cellular proteins and lipids significantly diminished. Physical characterization *via* swelling tests demonstrated that the scaffold possesses a high fluid absorption capacity and hydrophilic stability, which are essential for maintaining a conducive environment for cell growth. Furthermore, *in vitro* degradation assays indicated a controlled and slow biodegradation profile (approximately 5% weight loss over 21 days), suggesting that the material provides long-term structural stability. Finally, cytotoxicity analyses assessed through cell viability assays showed that the decellularized avocado scaffold is non-toxic and supports cellular metabolic activity. Although additional long-term and *in vivo* investigations are required, the results of this study suggest that decellularized avocado tissue may serve as a promising plant-derived biomaterial candidate for tissue engineering and biomedical applications.

Keywords: Plant-Derived Biomaterial, Decellularization, Avocado, Extracellular Matrix (ECM), Tissue Engineering

Comparative Analysis of Laser Welding and Gas Metal Arc Welding (GMAW) For Hydraulic Cylinder Manufacturing

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Abstract

Hydraulic cylinders are essential components in heavy commercial vehicles, where the structural integrity of suspension and lifting systems depends strongly on weld quality. Gas Metal Arc Welding (GMAW) is conventionally used in the manufacturing of these cylinders; however, it presents limitations such as excessive heat input and significant spatter formation, both of which can negatively affect surface quality and the durability of sealing components. This study investigates the feasibility of Laser Beam Welding (LBW) as a superior alternative to GMAW for hydraulic cylinder production. Experimental samples were fabricated using optimized parameters for both welding processes, and comparative evaluations were performed through tensile testing and macro-structural analysis.

The tensile test results demonstrated that GMAW joints achieved load-bearing capacities of 110.7 kN at 110 A and 116.7 kN at 130 A under identical rotational and wire-feed conditions. In contrast, LBW exhibited superior or comparable performance, reaching 132.8 kN at 75% laser power with a rotational speed of 100 mm/min, while producing 105.3 kN at the same power level with a rotational speed of 120 mm/min. Macro-structural observations revealed that LBW provided consistent penetration and narrower bead geometry compared to GMAW. A key focus of this study was spatter formation, a critical concern due to the risk of damaging cylinder surfaces and sealing interfaces. While spatter was inherent and unavoidable in GMAW samples, LBW effectively eliminated spatter formation, resulting in improved surface quality and reduced post-weld cleaning requirements.

Overall, the findings indicate that LBW offers significant advantages in mechanical performance, bead quality, and surface integrity. Therefore, LBW can be considered a viable and beneficial alternative to GMAW for the manufacturing of high-performance hydraulic cylinders.

Keywords: Hydraulic Cylinder, Laser Welding, GMAW, Spatter Formation, Mechanical Properties

Determinants and Forecasting of Electricity Consumption in a Business: A Multiple Regression-Based Model

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Abstract

This study is a quantitative research project that aims to identify the key factors influencing electricity consumption and develop a multiple regression based forecasting model by examining the electricity usage data of approximately 170 stores belonging to a company operating in Turkey. The increasing energy costs faced by businesses have made the analytical prediction of electricity consumption a strategic necessity. In this context the dependent variable of the study is the electricity consumption of the stores, while the independent variables include past consumption values, temperature measurements, nighttime consumption, average customer entry exit counts, and store size represented by square meters (m^2). Within the scope of the study, the dataset was first defined, the relationships among variables were examined through correlation analysis, and the assumptions of the multiple linear regression model were tested. Subsequently several regression models were constructed and the most appropriate model was selected by comparing significance levels and explanatory power. The results indicate that past consumption levels and temperature variations are the most influential factors affecting electricity usage. Additionally store size and customer entry exit counts were also found to have statistically significant effects on consumption. The developed regression model enables the company to accurately forecast future electricity demand and provides an important decision-support tool for energy management. Through this model, the business can optimize its energy costs, develop strategies to improve efficiency and more effectively achieve its sustainability goals.

Keywords: Multiple Regression Analysis, Electricity Consumption, Energy Management, Forecasting Model

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Furniture of the Future: Adaptation from Static Product to Dynamic Process

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Abstract

This study investigates the paradigmatic transformation in the furniture industry, focusing on the transition from a "product-oriented" to a "process-oriented" approach. The core premise of the study is that future furniture is not a completed, static object; but a component of a dynamic system that continuously evolves in line with the user's changing life stages, spatial needs, and technological integration demands. In this context, the concept of "adaptation" is placed at the center of sustainable design strategies, addressed through its physical, technological, economic, and psychological dimensions. Future furniture ceases to be a silent object entering and exiting the user's life; instead, it transforms into a companion that grows, heals, transforms, and communicates with them. In this transformation, the key for companies is not only product diversity, but also process design. The realization of flexible designs—optimized for varying needs as home and office boundaries blur, sustainable in material, and repairable—relies on adaptation as the fundamental mechanism for accommodating the user's changing life phases. Within the scope of the study, strategies extending the furniture lifecycle (modularity, repairability, reuse) are analyzed within the framework of circular economic principles. New spatial requirements arising from hybrid work models (home-office integration) are discussed considering inclusive design and affordance theories; whereby furniture is questioned not only as an ergonomic support tool but also as an interface managing social interaction and spatial perception.

The Turkish furniture industry's current production capacity, export vision, and sustainability maturity are evaluated comparatively with global trends; revealing the necessity of transitioning to innovative business models like "Furniture as a Service (FaaS)" to enhance the sector's competitiveness. The study aims to offer a theoretical and practical roadmap for academicians and industry professionals to conceptualize the future adaptive furniture ecosystem.

Keywords: Furniture, Adaptation, Circular Economy, Inclusive Design, Open-Source Design

Photocatalytic Activity of Graphene Oxide/Layered Double Hydroxide Catalysts in Sulfamethazine Removal: Influences of Divalent Metal Ion Type and Graphene Oxide Content

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Abstract

Pharmaceutical compounds and their metabolites released into the environment through industrial wastewater and sewage are among the most dangerous water pollutants. Sulfonamide group antibiotic residues are frequently found in surface and groundwater since they are difficult to metabolize in nature. Due to its antibacterial properties and low biodegradability, unmetabolized sulfamethazine (SMT) excreted from humans and animals cannot be completely removed from water by conventional wastewater treatment processes. Photocatalytic oxidation is one of the most efficient and easily applicable advanced oxidation technologies, and the development of cost-effective and environmentally friendly photocatalysts is of great importance. In this study, XGO/M^{2+}-Fe-LDH (GO: Graphene oxide; X: Graphene oxide weight percentage; M^{2+}: Co, Cu) catalysts containing different divalent metal ions were synthesized and their catalytic performances were tested in peroxymonosulfate (PMS) enhanced photocatalytic oxidation process for the removal of sulfamethazine. Firstly, the performances of hybrid photocatalysts were comparatively investigated under visible light and UV light conditions with catalyst loadings of 0.05 g/L and 0.5 g/L and PMS/SMT molar ratios of 1 and 10. The catalysts showed similar performances under visible and UV light while cobalt generally had a superior catalytic activity over cupper containing catalysts. For instance, the sulfamethazine removal efficiencies were calculated as 72.8% and 45.9% in the presence of 10GO/Co-Fe-LDH and 10GO/Cu-Fe-LDH, respectively, when the catalyst loading was 0.5 g/L and the molar ratio of PMS/SMT was 10 under visible light. Subsequently, to determine the optimal GO content for cobalt-containing LDH catalysts exhibiting the highest performance under different catalyst and PMS loadings, the catalytic activities of catalysts containing 10%, 50%, and 90% graphene oxide by wt. was compared under visible light and 10% GO content was determined as the optimal weight percentage.

Acknowledgement: This study has been supported by The Scientific and Technological Research Council of Türkiye (Project Number: 224M009).

Keywords: Photocatalytic Oxidation, Peroxymonosulfate Activation, Layered Double Hydroxide, Graphene Oxide

A Quantitative Assessment of Deep Learning Doctoral Theses in Türkiye

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Abstract

This study aims to analyze doctoral thesis works in Turkiye that utilize or focus on deep learning. The objectives are to quantitatively assess the contribution of academia to the field based on university, year, and departments, observe the change in the preferred language of writing over the years, determine the proportion of theses contributing to applied versus methodological work, and analyze the specific fields where applied theses are conducted. Research data were gathered from the Turkish Council of Higher Education National Thesis Center. The dataset was compiled by searching for the English terms ("deep learning," "artificial neural network," "convolutional neural network," and "neural network") and their Turkish counterparts. After removing duplicates and unrelated studies, the final dataset consisted of 1,227 theses. Nearly half of the theses were prepared as applications of deep learning across diverse disciplines (such as business, agriculture, and construction). Although the first related study was completed in 1991, deep learning did not receive sufficient attention until 2019. Importantly, 57% of all studies were completed during the 2021-2025 period. However, a decline in the number of theses prepared in 2025 compared to the previous year. Regarding fields of study, 21% of the theses concentrated on the health sector, while studies focusing on methodology was only 8.56% of all works. Over the years, the ratio of theses written in English increased from 16% to 29%. The rise in the number of theses written in English is valuable for the contribution of these studies to international literature. The fact that nearly half of the works originate from diverse disciplines is promising for multidisciplinary collaboration and the applicability of deep learning across various fields. Moreover, the prominence of Anatolian universities, such as Fırat University, in terms of thesis count indicates regional efforts toward specialization in this area. Conversely, the observed decline in the number of theses in 2025 is a crucial point that academics and relevant policymakers must consider concerning human resource development in the rapidly growing field of artificial intelligence.

Keywords: Deep Learning, Doctoral Theses, Quantitative Analysis

Fine-Tuning of Transformer Models: A Comprehensive Sentiment Analysis Study on Turkish E-Commerce Review Data

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Abstract

This study aims to enhance sentiment analysis performance on Turkish e-commerce product reviews by developing fine-tuned classification models based on pre-trained Transformer architectures. To this end, the dataset was constructed through a systematic pipeline that involved data mining, manual labeling, and comprehensive preprocessing procedures. To enhance data quality and consistency, UFAL-based normalization, de-asciification, and emoji-mapping techniques were applied, leading to standardized textual representations. Following this preparation phase, the finalized dataset was used to fine-tune several state-of-the-art Transformer-based base models—BERT, ModernBERT, RoBERTa, TurkishBERTweet, ELECTRA, and DeBERTa—using default hyperparameters targeted at maximizing the macro-F1 score.

Experimental results demonstrate that on the test dataset, the highest performance was obtained by the artiwise-ai/modernbert model, which achieved a 63.19% macro-F1 score and 92.02% accuracy. In contrast, on the validation dataset, the best-performing model was the artiwise-ai/modernbert, reaching 63.17% macro-F1 and 91.84% accuracy.

Overall, this study contributes to the literature by empirically demonstrating the effectiveness of modern Transformer architectures for sentiment analysis in Turkish e-commerce contexts. To ensure reproducibility and provide an accessible resource for the research community, the developed models have been publicly released on the Hugging Face platform.

Keywords: Sentiment Analysis, Fine-Tuning, Text Classification, Pretrained Language Models

Design of a Dye-Free 100% Cotton Trousers within the Scope of Sustainable Fashion

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Abstract

The textile industry faces significant environmental sustainability challenges, particularly due to high water, energy, and chemical consumption during dyeing processes. This study focuses on the design of a dye-free, 100% cotton trousers as an innovative approach aimed at reducing environmental impacts. Within the scope of the study, the natural color of cotton was preserved, and no dyeing or bleaching processes were applied during production.

In conventional cotton fabric production, dyeing processes result in substantial water consumption, wastewater generation, and intensive chemical usage. The product developed in this study completely eliminates these processes by utilizing the natural structure and color of cotton fibers, thereby significantly reducing carbon footprint, water consumption, and overall environmental burden. Moreover, by eliminating dyeing treatments, the fiber structure of the fabric is preserved, enhancing its natural texture and breathability.

As part of the R&D activities, the weaving performance of naturally colored cotton yarns, fabric strength, comfort properties, and durability during use were evaluated. The results demonstrate that dye-free cotton fabrics are suitable for everyday apparel and meet both functional and aesthetic expectations. With its simple and timeless design, the developed trousers respond to the growing consumer demand for sustainable fashion.

In conclusion, this study presents an example that contributes to environmentally friendly production approaches in the textile industry, reduces the use of natural resources, and supports sustainable product development practices. The widespread adoption of dye-free 100% cotton products holds significant potential for both minimizing environmental impacts and promoting responsible production models.

Keywords: Sustainable Textiles, Naturally Colored Cotton, Eco-Friendly Production, Sustainable Fashion

Integration of Hotel Reception Services into a Mobile Application: A User-Centered Mobile Reception Solution

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Abstract

Reception services in accommodation establishments are still largely carried out through face-to-face and telephone-based communication, leading to time loss for guests and increased personnel and operational costs for hotels. This study aims to transform reception and guest services in accommodation facilities into a mobile application-based digital infrastructure. Within this scope, user needs, expectations, and functional requirements were analyzed, and a holistic mobile reception application model was developed to enhance customer experience while reducing the need for human resources in operational processes.

The developed mobile platform, Reseplia, is designed as a single application that can be commonly used by multiple hotels to digitalize reception services. After registration, hotels with active reservations are automatically displayed on the user interface through national ID number matching. Guests can access various services via the mobile application, including daily menu tracking, hotel market and restaurant ordering, spa and massage appointment scheduling, event information, room cleaning time selection, taxi or valet requests, and instant messaging with the reception.

On the reception side, all guest requests can be monitored and managed in real time through a web-based administration panel, enabling centralized and efficient service management and significantly reducing staff workload. Developed using Flutter and Firebase technologies, the application operates on both Android and iOS platforms. The study demonstrates the potential of mobile application–based digital transformation in the hospitality industry to improve service quality, increase operational efficiency, and enhance guest satisfaction.

Keywords: Hospitality Industry, Mobile Application, Digital Reception, Customer Experience, Operational Efficiency

Lowering Storage Requirements for High Resolution Security Video Systems; Variable Frame Rate

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Abstract

The storage capacity requirements for security systems are directly related to the camera resolution which is used. If the resolution of the cameras higher than Full HD (2.1MP), then the required storage place for the video data becomes enourmous.
In novadays, to lower the storage requirements for the video data, changing the frame rate of recorded video after a period of time is used. But with this method, most of the recorded data is removed from the video regardless of it's needfulness.
The approach which will be explained with this paper, describes a new video codec. This codec will not have an predefined frame rate.
After a period of recording, an analizing software will be triggered and this software will decide which part of the video will be how much frame rate. These frame rate ratios can be between 0.1 fps and 25 fps.
In the last part of the paper, storage requirements of two 3MP security cameras with different video codecs, one of them is indoor and the other one is outdoor will be compared.

Keywords: Security Camera, Storage of Security Video, Variable Frame Rate, IP Camera

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A New Block Based Method for Embedded Operating Systems with Performance Objective and Implementation of This Method on Thin Clients

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Abstract

Operating systems, is one of the fundamental building blocks of computer science today. The basic building block is divided into two sub classes, as the end-user operating systems and embedded operating systems. Embedded operating systems are generally perform a specific job on the limited hardware components. In most cases, performances of these systems are critical to their operations.

Although the embedded operating systems have wide area of usage, in the scope of this thesis, thin clients and embedded operating systems are the main subjects. By this way, the proposed new method could be tested with the widest possible field of applications and hardware support.

In scope of thesis, a new operating system compression method is proposed and designed especially for thin-client architecture and also able to work with all types of computer architecture. Considering the negative performance effect of file system based compression methods, the compression method is designed and develeped on operating system level.

In addition within this thesis project, the compression method that is developed, is compared with the common methods which are being used today within criteria of required storage space and performance.

Keywords: Embedded Operating Systems, Methods of Embedding Operating System, Thin Client, Thin Client Architecture, Operating System Compression

Investigation on Structural and Comfort Properties of Nanofiber Based Composites for Performance Outerwear Applications

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Abstract

The design and use of micro and nanoporous membranes for barrier materials and active outerwear products have become widespread in recent years. Ongoing studies are being conducted on breathable waterproof membranes for cost reduction and comfort. Being lightweight, nanofibers and nanofiber based structures are gainning more attention to be integrated in multifunctional materials.

In this study, a nanofiber layer as a part of a composite to use in performance outerwear was developed by electrospinning process. The electrospinning parameters were varied, and nanofibers were spun onto the commercial outerwear layer. The variations in the air permeability, water vapor permeability, and thermal properties of outerwear composites with the use of nanofibers were investigated. The potential use of nanofibers in performance outerwear products was analyzed considering the advantages and disadvantages of the production and resultant properties.

Keywords: Nanofibers, Electrospinning, Air Permeability, Water Vapor Permeability, Thermal Resistance

The Effect of AI-Supported Design Process in Basic Design Education on Students' Self-Efficacy Perceptions

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Abstract

Architecture curricula need to be enriched with emerging technologies and innovations. Today, one of the most significant developments is in the field of artificial intelligence (AI). Although AI tools offer many contributions to architectural learning and teaching practices, limitations remain in various dimensions. Therefore, many studies indicate that there is a research gap regarding its integration into architecture education.

This Study aims to examine the effect of integrating AI tools into the basic design studio, which forms the basis of architecture education, on students' perceptions of self-efficacy. The "KARŞILAŞ|tır|MA" in-class assignment was applied with the scope of the MIM1010 Basic Design II course at Bursa Uludag University.

The study was conducted in two phases. The first week involved traditional design techniques, followed by AI-supported techniques in the second week. The data used in the study included pre-test and post-test difference scores related to students' self-efficacy scores regarding decision-making, problem-solving, creativity, perceptual awareness and spatial thinking skills, as well as their comments on the work process.

The findings show that the most significant difference in increasing students' self-efficacy perceptions in AI-supported processes was in the decision-making and problem-solving parameters. In the process of using traditional techniques, spatial thinking and perceptual awareness parameters were rated higher. Although there was no significant variation in the creativity parameter, the problem-solving parameter showed an almost equal distribution.

In conclusion, AI tools improve the design process by developing rapid solution strategies and alternative designs. However, it has been observed that students are unable to reflect the language of design due to reasons such as producing inconsistent and standardized outputs and not using numerical measurements, and that this situation weakens the design process.

Keywords: Basic Design Education, Design Process, In-Class Assignment, Artificial Intelligence, Self-Efficacy

Sustainable Water Planning in Higher Education Campuses: Resource Management and Adaptation Strategies

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Abstract

Water plays a decisive role across a wide spectrum ranging from the functioning of natural ecosystems to societal well-being. However, rapidly increasing population, urbanization processes, and unsustainable consumption patterns place growing pressure on freshwater resources each year. Irregular precipitation cycles driven by climate change, prolonged drought periods, and rising temperatures further exacerbate vulnerabilities within the hydrological cycle, undermining the reliability of existing water supplies. These complex dynamics transform water management in university campuses, where diverse usage demands coexist, from a merely technical practice into a strategic planning domain focused on long-term adaptation, efficiency, and risk reduction, thereby making it an integral component of institutional sustainability policies. Higher education institutions, with their expanding student populations, growing physical infrastructure, and diversified academic and social activities, are inherently high water-demand environments. Ensuring that this demand can be met in the long term makes sustainable water planning within campus areas essential for resource conservation, efficiency enhancement, and the reduction of environmental impacts. Within this scope, practices such as rainwater harvesting, greywater reuse, low-flow fixtures, and smart irrigation technologies play a crucial role in both water conservation and resource efficiency. Additionally, sensor-based monitoring tools and smart metering systems provide real-time analysis of water consumption, enabling early detection of leakages and losses, and are among the effective applications that strengthen campus water management. This study identifies water-use areas within campuses and evaluates the key factors influencing the effectiveness of water management in these areas. The significance of user behaviour, infrastructure capacity and institutional sustainability policies is highlighted, and furthermore various strategies for efficient water use are proposed, along with discussions of operational risks and challenges. Examples of successful practices implemented in universities across Türkiye and around the world are also presented.

Keywords: Water Efficiency, Water Management, Campus Sustainability

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Effect of Suspension Parameters on Vehicle Pulling Tendency

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Abstract

This paper investigates the causes of rightward pulling observed during straight-line driving in an M3 Class III midibus used for short- and medium-distance passenger transport. The phenomenon adversely affects both driving safety and passenger comfort. Multibody Dynamics (MBD)–based analyses are employed, focusing on camber asymmetry between left and right wheels, front-axle modeling approach, and the influence of key suspension parameters on vehicle heading behavior.

Simulation results, supported by measurements, show high sensitivity to small camber deviations. Left–right camber differences of only a few tenths of a degree significantly increase the pulling tendency, indicating that nominal camber targets alone are insufficient. Installation- and assembly-related variations can interact with tire aligning forces and suspension kinematics, thereby amplifying the effect.

Two front-axle representations are evaluated: rigid and flexible. The flexible axle model captures load-dependent camber changes between unloaded measurements and vehicle-on-ground conditions and predicts the pulling behavior more realistically, and generally at a higher level, than the rigid model. Sensitivity analyses further show that suspension compliance parameters, such as bushing stiffness and alignment-related kinematics, can bias the vehicle heading and modify the apparent pull level.

Three-dimensional scanning and wheel angle measurements on a representative vehicle confirm meaningful camber differences between unloaded and loaded states, consistent with flexible-axle simulation results. Overall, the findings demonstrate that vehicle pulling tendency cannot be explained solely by nominal geometry. Axle flexibility and suspension parameters alter the effective geometry under operating conditions, making them critical for accurate prediction and improved simulation–measurement correlation.

Keywords: MBD Analyses, Camber Angle, Vehicle Dynamics, Flexible Modeling, Caster Angle

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Battery Charging System with LLC Resonant Converter Controlled by Adaptive PI Controller

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Abstract

In this study, a single-phase battery charging system with a 3kW output power was designed for light electric vehicles equipped with lithium-based battery packs, utilizing an LLC resonant converter. This converter is frequently preferred due to its advantages, such as high power density, low switching losses, high efficiency, as well as low electromagnetic interference achieved through the frequency modulation method used. The battery charging system aims to reduce switching losses and increase system efficiency by using Zero Voltage Switching as the soft switching method. In the single-phase system, adaptive PI control was used as a closed-loop control. The system was tested under variable input voltage and variable load conditions. The results were compared with those of the PI control method. The designed system was tested with both a purely resistive load and a 55V/15Ah battery model in MATLAB/Simulink environment. The simulation performed in the Matlab/Simulink environment confirmed switching at zero voltage, and it was observed that the adaptive PI controller demonstrated better performance in terms of settling time and maximum overshoot value under a resistive load. The PI controller coefficients used in the system were obtained using a modified particle swarm optimization algorithm.

Keywords: LLC Resonant Converter, Battery Charger, PSO, PI Controller

A General Review of Wire Arc Additive Manufacturing Methods in Metal Additive Manufacturing

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Abstract

Metal additive manufacturing methods are being increasingly adopted in industrial applications. In these manufacturing approaches, metallic components are produced through the successive deposition of material in a layer-by-layer manner. Among these technologies, wire arc additive manufacturing (WAAM) is one of the most widely used additive manufacturing methods. In WAAM processes, electric arc–based welding techniques such as gas metal arc welding (GMAW), plasma arc welding (PAW), and gas tungsten arc welding (GTAW/TIG) are employed as the heat source. As in conventional electric arc welding processes, the quality of components produced by wire arc additive manufacturing is strongly dependent on the selected welding parameters. One of the major advantages of WAAM is its potential to economically and rapidly manufacture small-, medium-, and large-scale metal components. Furthermore, the extremely low material waste associated with this process constitutes a significant benefit. These welding-based additive manufacturing methods have been successfully applied to materials such as aluminum, titanium, steel, and nickel alloys. Consequently, WAAM has found widespread applications in various industrial sectors, including military, aerospace, space, energy, automotive, chemical, and medical industries.

Keywords: Wire Arc Additive Manufacturing, Primary Welding Parameters, Welding Techniques

Residual Stress Evolution and Distortion Mechanisms in Wire Arc Additive Manufactured Components

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Abstract

Wire Arc Additive Manufacturing (WAAM) is a wire-feed metal additive manufacturing process in which weld beads are deposited layer by layer using an electric arc as the heat source. This technique offers significant advantages for the fabrication of near-net-shape components, particularly in the efficient production of large-scale structural parts with relatively low geometric complexity and high deposition rates. Owing to these attributes, WAAM has attracted increasing interest in industrial applications. During the WAAM process, the deposited material is subjected to repetitive and highly non-uniform thermal cycles involving localized heating, melting, and subsequent cooling. These cyclic thermal effects lead to the development of pronounced thermal gradients within the component. As a consequence, residual stresses are inevitably generated in the longitudinal, transverse, and axial directions. The accumulation of such stresses can result in various forms of geometric distortion, including bending and angular deformation, which adversely affect dimensional accuracy and structural integrity. Understanding and controlling residual stress formation and distortion behavior are therefore critical challenges in the practical implementation of WAAM technology. In this context, finite element-based process simulation represents an effective and reliable approach for analyzing the complex thermo-mechanical behavior associated with WAAM. Numerical simulations enable the prediction of temperature evolution, residual stress distribution, and distortion patterns in additively manufactured components, thereby providing valuable insights for process optimization. Consequently, finite element modeling serves as a powerful tool for improving part quality, reducing post-processing requirements, and enhancing the overall performance of WAAM-fabricated structures.

Keywords: Wire Arc Additive Manufacturing (WAAM), Thermal Residual Stresses, Residual Stress, Distortion

Flight Recorder Prototype with Real-Time Data Analysis and Embedded Cybersecurity

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Abstract

The project was inspired by the idea that the flight recorder, which is vital after an accident, is also vital before an accident and can even save lives. The aim of the study is to develop a flight recorder prototype that integrates real-time data analysis and embedded cybersecurity features, in line with modern aviation requirements, to enhance flight safety. The main purpose is to detect and prevent possible system failures or manual pilot errors during flight.

The project begins with the physical modeling of critical flight parameters—such as temperature (PTC sensor, engine speed, pilot sleep button, speed, acceleration, and wing position (flap/slat)—on an electronic board using sensors and potentiometers, built on the STM32 microcontroller platform and Unity 3D visualization platform. The analog data is collected with STM32F407VGT6 and visualized with unity. In that case, the data that generated through potentiometer or sensors, can be monitored on the screen.

Study aims receiving data from the flight recorder without disrupting the flight recorder function. Unity saves data to non-volatile memory which is functional flight recorder.

Simultaneously, Unity instantly checks for deviations from expected parameter values. In this way, a manual error in cockpit or a situation that could lead to danger, can be determined real-time by the persons responsible for the aircraft who outside the aircraft. Cybersecurity is embedded at the core of the system through protocol and frequency filtering applied to the data flow. Negative outcomes detected by the algorithm are then encrypted and sent as an instant message notification. This multidisciplinary prototype represents a significant step towards a safer, more predictive, and cyber-threat-protected flight management system by integrating embedded systems, simulation, and cybersecurity analysis under one roof.

Keywords: Avionics, Flight Recorder, Embedded System, Cybersecurity, Simulation

Genetic Programming-Based Decision Support Framework on Fetal Health Assessment: An Explainable AI Approach

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Abstract

An accurate assessment of fetal well-being is imperative to prevent adverse outcomes such as fetal asphyxia, metabolic acidosis, and neonatal mortality. While Cardiotocography (CTG) remains the gold standard for fetal surveillance, visual interpretation is often problematic based on high inter-observer variability and subjectivity. To address these challenges, this study utilizes the "Fetal Health Classification" benchmark dataset, comprising 2,126 processed CTG recordings labeled into three diagnostic categories: Normal, Suspect, and Pathological. Based on the characteristics of data, a significant class imbalance is common to the 'Normal' majority. Without the aid, the results will be highly biased due to this imbalance. To overcome this problem, the Synthetic Minority Over-sampling Technique (SMOTE) was employed as a preprocessing step. Genetic Programming approaches are highly responsive methods for characteristics that not only provide classification results but also a Symbolic Model that explains the characteristics of the classification. Subsequently, a Genetic Programming framework utilizing a One-Vs-Rest classification strategy was implemented to evolve distinct symbolic models for each diagnostic category.
Experimental results demonstrated the efficacy of this hybrid approach, achieving an overall classification accuracy of 88.19%. The integration of SMOTE significantly improved the detection of the minority class, yielding a precision of 88.92% and a recall of 88.19%. Beyond quantitative performance, the primary contribution of this study is the generation of interpretable symbolic expressions. These expressions provide human-readable relations between conditions and parameters. These explicit equations enable obstetricians to validate the clinical logic behind the AI's decision-making process, thereby bridging the gap between advanced machine learning and trustworthy clinical practice.

Keywords: Fetal Health, Cardiotocography, Genetic Programming, SMOTE, Class Imbalance

Comparative Analysis of Reasoning Strategies in LLM-Based Agents

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Abstract

Although Large Language Models (LLMs) have achieved remarkable success in the field of natural language processing, they continue to exhibit notable limitations in tasks that require multi-step reasoning and forward-looking strategic planning. These limitations primarily stem from the inherently linear nature of autoregressive decoding. This survey study provides a comparative and critical examination of three fundamental inference-time reasoning strategies designed to address these challenges: Chain-of-Thought (CoT), Reasoning and Acting (ReAct), and Tree-of-Thoughts (ToT).

Within this framework, the theoretical foundations of these approaches are evaluated in light of empirical findings reported in the seminal literature. Particular emphasis is placed on the inferential mechanisms that enable LLMs to transition from fast, intuitive "System 1"-like behaviors toward more deliberate, controlled, and analytical "System 2" reasoning processes. The comparative analysis demonstrates that the Chain-of-Thought approach is especially effective in tasks involving arithmetic and logical reasoning, yet remains limited in dynamic environments that require interaction and continuous feedback. The ReAct framework substantially mitigates this limitation by integrating reasoning with external actions and observations, thereby producing more coherent and context-aware inferences. In contrast, the Tree-of-Thoughts approach enables forward-looking evaluation and systematic exploration of alternative solution paths, offering a clear advantage in strategic problem-solving contexts; however, this benefit comes at the cost of significantly increased computational requirements.

In conclusion, the evolution of LLM-based autonomous agents is expected to progress toward hybrid architectures that adaptively combine multiple reasoning strategies according to problem complexity while dynamically managing computational resources.

Keywords: Large Language Models, Chain-of-Thought, Tree-of-Thoughts, LLM-based Agents

ERP-Integrated Digital Framework for Marketing and Distribution Operations

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Abstract

In contemporary practice, marketing activities, budget management, procurement operations, stock control, and field processes have become increasingly complex due to extensive dealer networks, multi-vendor structures, and high-volume data flows. The literature indicates that managing these processes manually or through fragmented systems increases error rates, reduces auditability, and negatively affects organizational performance. Across the sector, marketing, budgeting, procurement, stock monitoring, and distribution workflows are frequently handled through disparate platforms, Excel-based tools, or semi-digital environments, resulting in significant deficiencies in governance, transparency, speed, and data integrity.

This study presents an integrated digital management model designed to address this long-standing structural fragmentation by unifying marketing, distribution, dynamic budgeting, and inventory processes within a centralized digital framework. The proposed model consolidates request–approval workflows, marketing budget management, supplier and invoicing processes, and depot–dealer distribution flows into a single platform. Developed using MVC .NET Core technology and supported by bidirectional integration with enterprise ERP systems such as SAP, the solution establishes a robust architectural structure that ensures the consistency of financial and operational data. Digital integration, dynamic workflow mechanisms, and centralized data architecture—identified in the literature as key enablers of marketing performance, budget transparency, and supply chain efficiency—constitute the core components of the model.

By leveraging modern software architecture, role-based security mechanisms, mobile-responsive user interfaces, and high-performance data processing techniques, the model accelerates operations, standardizes workflows, enhances auditability, and strengthens real-time decision-making capabilities. In this regard, the study contributes to literature by proposing an ERP-integrated digital management model that resolves the structural disconnection between marketing, budgeting, inventory, and distribution processes. Adopting an application-oriented, design-focused research approach, the study offers a scalable digital transformation framework that enhances strategic control, operational efficiency, and decision support in complex, ERP-centric organizational environments.

Keywords: Digital Transformation, Marketing Management, Dynamic Budgeting System, Inventory and Distribution Optimization, ERP Integrated Model

Joining of Stainless Steel Materials by the Submerged Arc Welding Method, Their Microstructure and Mechanical Properties

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Abstract

Stainless steels are extensively used in energy, chemical, petrochemical, and marine industries due to their excellent corrosion resistance and mechanical properties. Among them, duplex and austenitic stainless steels are particularly important because of their superior strength–toughness balance and good weldability. This study investigates the weldability of duplex and austenitic stainless steels joined by the submerged arc welding (SAW) process in accordance with relevant Welding Procedure Specifications (WPS). Three joint configurations were examined: duplex–duplex, austenitic–austenitic, and duplex–austenitic combinations. Welding was performed using approved WPS parameters and appropriate filler materials to ensure sound weld formation. The quality of the welded joints was evaluated using non-destructive testing (NDT) methods, including visual inspection and volumetric examinations, to detect possible surface and internal defects. Mechanical properties were assessed through tensile and bending tests, along with hardness measurements across the base metal, heat-affected zone (HAZ), and weld metal to examine local variations induced by welding. Test results were analyzed to determine the effects of different material combinations on strength, ductility, and overall joint performance. Microstructural analyses were performed on the base metal, HAZ, and weld metal using optical and scanning electron microscopy. Special attention was given to phase balance, grain morphology, and phase transformations in duplex stainless steels, particularly the ferrite–austenite ratio after welding. The results demonstrate the applicability of WPS-controlled SAW procedures for both similar and dissimilar stainless steel joints and highlight the relationship between welding parameters, microstructural evolution, and mechanical properties. This study provides valuable insights for the design and production of welded stainless steel components in applications where both corrosion resistance and mechanical performance are critical.

Keywords: Submerged Arc Welding, Duplex Stainless Steel, Austenitic Stainless Steel, Microstructure, Mechanical Properties

Comparison of River Widths and Water Surface Elevations Determined by SWOT Satellite Data and *in-situ* Measurements

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Abstract

This study evaluates the performance of river width and discharge estimations derived from SWOT satellite data and Digital Elevation Models (DEM) against actual field values measured via Orthophotos. The research was conducted at the Buruncuk, Muradiye, and Sinirli reaches of the Gediz River, utilizing RMSE, MAE, and Bias metrics to analyze estimation accuracy.

Analysis results indicate that model performance varies significantly based on the hydraulic and topographic characteristics of each station. The Buruncuk station, where the model exhibited its lowest performance, showed severe outliers among estimation errors, revealing low reliability at this specific cross-section. Conversely, the Sinirli station demonstrated the highest success with minimal error levels. This proves that the error distribution is consistent and the model produces more accurate estimations in relatively narrower and stable hydraulic regimes. The Muradiye station exhibited a moderate level of error.

In conclusion, while remote sensing models hold potential for estimating hydraulic parameters, the shifting estimation bias between stations demonstrates that a single general calibration is insufficient. The findings reveal that local and specific calibration strategies for each river section are mandatory to enhance data reliability and address systematic Bias problems**.**

Keywords: River Hydraulics, Remote Sensing, SWOT Satellite.

Time Series Analysis from a Computer Engineering Perspective: Statistical and Learning-Based Models

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Abstract

Time series analysis is a fundamental concept for modeling and forecasting time-dependent processes. With the rise of data-driven decision making mechanism, time series modeling has undergone a significant transformation from classical methods to hybrid learning, machine learning and deep learning based models. These models differ each other in their computational requirements and learning mechanisms.
From a computer engineering perspective, this study provides a comparative overview of these models and discusses which models is more suitable in which situations. Classical statistical approaches, such as ARIMA (Autoregressive Integrated Moving Average) and VAR (Vector Auto regression) rely on explicit assumptions about stationary and linear temporal dependencies but often struggling with complex nonlinear dynamics. On the other hand, machine learning models provide a more flexible, data-driven perspective through their methods and engineered features. Deep learning models further extend this flexibility by learning hierarchical temporal representation directly from raw sequences, enabling the model of long range dependencies with minimal manual feature design.
Rather than focusing on a single universally optimal approach, the following study is concerned with practical compromises between interpretability, computational demands, and forecasting accuracy. By illustrating how these different modeling decisions shape predictive behavior and guide system-level design, this work should help better contextualize informed model selection in time series analysis.

Keywords: Time Series Prediction, ARIMA, Machine Learning, Deep Learning

Design of an Industrial Dough Flattening System with Ergonomics and Energy Efficiency

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Abstract

In this study, the design and implementation of an automatic dough flattening system enabling contactless processing of portioned dough pieces were carried out. In industrial flatbread production, conventional manual or semi-automatic dough flattening processes often result in variations in product thickness and shape, increased labor requirements, and hygiene-related risks. The main objective of this study was to improve product standardization and hygienic conditions by developing an automation-based engineering solution suitable for industrial production lines. The developed system was first designed using CAD modeling and consists of a conveyor-based feeding mechanism, a bidirectional cylindrical flattening unit, and an automatic control structure capable of adjusting according to dough dimensions. During the design process, materials suitable for food contact, hygienic operation, and anti-adhesive performance were selected. System components were structured by considering industrial operating conditions, ease of cleaning, and production continuity. The applied methodology enabled controlled dough transportation and homogeneous flattening without causing deformation. In the machine design, the ability to process products with different weights and dough characteristics within a single system was targeted. Accordingly, key design criteria included adjustable flattening pressure depending on product type, maintenance of thickness consistency even at high production speeds, and prevention of dough adhesion on contact surfaces. In addition, the use of hygiene-compliant materials and a structure allowing easy cleaning provided significant advantages in terms of food safety. The developed fully automatic system demonstrated a reduction in labor requirements, an increase in production efficiency, a decrease in waste rates, and the achievement of quality standardization across all products. With its modular and flexible structure adaptable to various flat dough products, this domestic solution is considered to contribute to the enhancement of technological capability in industrial food production.

Keywords: Dough Flattening System, Food Machinery, Hygienic Design, Industrial Automation, Flat Product Production

Design and Development of an Industrial Automatic Pizza Pressing and Docking Machine: A Process Efficiency and Product Quality Approach Using Cold Press Technology

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Abstract

Following the COVID-19 pandemic, the significant increase in takeaway and ready-to-eat food consumption has rapidly intensified the need for automation in industrial pizza production. Conventional pizza forming methods based on hot pressing and laminating negatively affect production efficiency due to high labor requirements, long processing times, and deterioration of dough structure. These methods may also lead to inconsistencies in product geometry and quality. Therefore, the development of automated, energy-efficient, and dough-friendly production technologies has become a critical requirement for the sector. In this study, an automatic pizza pressing and edge docking machine based on cold press technology was designed, developed, and experimentally evaluated. The main objectives of the developed system are to preserve the natural texture and recipe-based nutritional value of the dough, ensure production standardization, reduce dependence on manual labor, and improve overall energy efficiency. An industrial-scale machine compatible with continuous dough processing lines was designed and prototyped, enabling uninterrupted and synchronized operation in automated production environments. During the mechanical design phase, comprehensive CAD modeling was performed, and critical structural components were optimized using analytical methods to ensure durability and reliable operation under industrial conditions. Pizza shaping, edge forming, and docking operations were carried out using cold press technology, preventing thermal damage and excessive mechanical stress on the dough. The machine was controlled via a PLC-based automation system equipped with a user-friendly human–machine interface, allowing precise control of process parameters. Experimental tests with and without dough were conducted to evaluate system continuity, synchronization between conveyor, tray, and pressing units, and overall process stability. The results demonstrated that the developed system significantly reduces manual labor requirements, preserves dough integrity, ensures consistent edge geometry, minimizes product deformation, and provides seamless integration between production stages. Overall, the proposed system offers improvements in quality, efficiency, and sustainability for industrial pizza production.

Keywords: Industrial Pizza Production, Cold Press Technology, Automatic Pressing, Docking System, Production Automation

Capacity and Safety Optimization in Signalized Roundabouts: A Simulation-Based Study Using the Example of Çanakkale

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Abstract

In the 21st century, rapid urbanization and rising vehicle ownership demand sustainable intersection designs for urban transportation networks. Especially in countries like Turkey, where transportation infrastructure heavily depends on roads, congestion, safety, and delay issues at intersections have become increasingly severe. In this context, the saturation of roundabouts, widely used worldwide to regulate traffic flow, can lead to performance declines. This study analyzes the impact of integrating signalization and channelization on roundabout performance. It evaluates these strategies specifically for the Çanakkale Onsekiz Mart University and Regional Traffic Intersection, one of the most critical junctions in Çanakkale.

The study employed PTV VISSIM microsimulation software to model the intersection and analyze speed and delay data during peak hours in the morning, at noon, and in the evening. Based on findings from the literature and simulation analyses, signal integration is expected to increase capacity by 50% at saturated intersections, reduce queue lengths by up to 90%, and minimize stop-and-go movements, resulting in approximately 9.5% fuel savings. Additionally, from a safety perspective, the combined use of signalization and channelization can reduce accident risk by more than 80%. In conclusion, this study demonstrates how modern traffic engineering solutions can improve conditions in a local application area, offering alternatives that prioritize safety, efficiency, and environmental sustainability.

Keywords: Signalized Roundabout, Traffic Simulation, Capacity Analysis, Traffic Safety, Channelization

Two-Phase Heat Transfer for Advanced Nuclear Applications: Thermal-Hydraulic Simulation of In-Tube Boiling Using the Euler-Euler Model in OpenFOAM

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Abstract

The numerical simulation of boiling thermo-hydraulics is a vital necessity for accurately determining thermal limits, particularly Critical Heat Flux (CHF) safety margins, in advanced nuclear reactors and other high-power-density energy systems. While boiling enhances thermal performance by offering high heat transfer coefficients, it also introduces risks such as the formation of a vapor film (film boiling) and subsequent temperature escalation at the CHF point. Therefore, this study aims to comprehensively investigate the complex thermal and fluid dynamic performance of boiling flow inside a pipe. The numerical simulations are performed using OpenFOAM, an open-source Computational Fluid Dynamics (CFD) software that offers flexibility and transparency, providing an advantage for research-oriented tasks. The Euler-Euler multiphase flow approach is utilized to model the two-phase nature of the boiling process, treating the liquid and vapor phases as interpenetrating continua and incorporating specific evaporation/condensation coefficients to govern interphase mass, momentum, and energy transfer. The developed numerical model aims to capture bubble dynamics and the heat transfer enhancing effect of turbulence, while the thermophysical properties (density, viscosity, thermal conductivity) are defined meticulously as temperature-dependent functions resulting from an extensive material survey for model accuracy. These analyses are fundamental for developing and verifying the highly reliable passive thermal management capabilities critical for compact Heat Pipe Micro Reactor (HPMR) designs, particularly those intended for space missions. The obtained numerical solutions aim to evaluate the thermal performance of the flow channel and optimize design parameters to ensure that the systems remain within safety limits.

Keywords: Heat Pipe Micro Reactors, Fluid Dynamics, Boiling, Computational Fluid Dynamics

Multi-Criteria Assessment of Greenhouse Gas Reduction Strategies in Turkey's Energy Sector

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Abstract

Greenhouse gas emissions are the main cause of global climate change. Most of these emissions come from energy production and consumption. The estimated total greenhouse gas emissions in Turkey are 71.8% of which are energy-based, making the energy sector decarbonization of 2053 Net Zero Emission targets.

In this context, the main objective of this research is to prioritize decarbonization strategies for the Turkish energy sector using a multi-criteria decision-making framework. The study evaluates five fundamental strategic alternatives, including strengthening energy efficiency, renewable energy development, widespread electrification, carbon pricing mechanisms, and social awareness generation. These strategies are assessed across environmental, economic, technological, institutional, and social dimensions.

Energy policy decisions involve multidimensionality and uncertainty stemming from expert opinions, incomplete information, and hesitations in evaluations. In this study, a multi-criteria decision-making approach based on Fermatean fuzzy sets was used to overcome these challenges. By employing Fermatean fuzzy sets,the relative importance of the evaluation criteria has been determined without ignoring the hesitations in human judgment, and the reliability of the decision-making process has been increased. The F-AHP approach has contributed to the more balanced and consistent calculation of criterion weights in multidimensional and complex decision problems such as energy policies. The Fermatean Fuzzy AHP method determined the most suitable decarbonization strategy among those examined, and a clear priority ranking was obtained among the alternatives.

Keywords: Greenhouse Gas Reduction, Energy Sector, Fermatean Fuzzy AHP

Designing Effective Visualizations of Congestive Heart Failure Patients Telemonitored Data

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Abstract

Accessing hospitals is costly and difficult for many patients with congestive heart failure, often delaying treatment until the condition becomes critical. Remote patient monitoring allows for tracking patients' health conditions and improves medical decision-making. To complete the remote patient monitoring process, data must be presented to clinicians so they can make medical decisions. However, presenting raw data is time-consuming and creates workflow difficulties. Nevertheless, this process can be made more efficient and effective by visualizing the data in a way that is suitable for clinicians. This work aims to design a visualization of CHF patient data, which consist daily blood pressure and weight measurements, in a way that is most convenient for clinicians. Our approach to the design of the visualization follows User Centered Design, specifically, defining requirements, designing corresponding visualizations and finally evaluating results. This cycle was iterated three times. The User Centered Design method was successfully employed to converge to a design that met the main objective of this study and giving visualizations were considered highly effective to the clinicians.

Keywords: Congestive Heart Failure, Remote Patient Monitoring, Data Visualization, User Centered Design, Decision Making

Mechanical Performance and Dimensional Stability Analysis of Polyamide 6.6 and Polyethylene Terephthalate (PET) Textile Reinforcements in Air Suspension Systems: From Micro-Structural Characteristics to Macro-Behavior

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Abstract

This study investigates the impact of viscoelastic properties of matrix-embedded textile reinforcements on the system performance of pneumatic suspension bellows (air springs), which are critical for the safety and comfort of heavy commercial vehicles. Within the scope of the research, specimens reinforced with 1440 dtex/2 (115 epdm) PET and 1400 dtex/2 (120 epdm) Nylon 6.6 tire cords were subjected to both cord-based uniaxial tensile tests and product-based hydrostatic burst and diameter expansion tests.Cord yarn characterization tests revealed that Nylon 6.6 fibers possess superior toughness and energy absorption capacity, exhibiting a breaking force of ~219 N and elongation at break of 33%, compared to PET fibers which showed ~192 N force and 23% elongation. This micro-mechanical advantage was corroborated in macro-level hydrostatic tests: Nylon 6.6 reinforced bellows achieved a burst pressure of 28.3 Bar, demonstrating a 6.8% higher strength compared to the 26.5 Bar of PET specimens. Furthermore, the significantly longer time-to-failure for the Nylon structure (~55 s) versus the PET structure (~23 s) confirms its ductility advantage under shock loads.Conversely, in dimensional stability analyses, the high initial modulus of PET, derived from its aromatic ring structure, proved decisive. Under high pressure (7 Bar), Nylon 6.6 specimens exhibited severe "ballooning" and radial creep due to their high elongation characteristic (33%), reaching a diameter of ~321 mm. Under identical conditions, PET specimens maintained their form, limiting the diameter to ~279 mm thanks to their lower elongation (23%). Although this uncontrolled radial expansion in Nylon increases the Effective Area (A_e), resulting in a virtual increase in load capacity, it poses risks regarding vehicle chassis clearance. Consequently, it is concluded that PET reinforcements are optimal for applications requiring high dimensional stability, whereas Nylon 6.6 structures are preferable for operations necessitating high impact resistance.

Keywords: Air Spring, Nylon 6.6, PET, Burst Pressure, Dimensional Stability

Production of Carbide Ceramics via Self Propagating High-Temperature Synthesis

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Abstract

Carbides represent an important class of advanced materials owing to their high hardness, superior wear resistance, thermal stability, and chemical inertness under severe service conditions. Due to these properties, carbides are widely used in cutting tools, wear-resistant components, high-temperature structural parts, protective coatings, and functional materials intended for operation in extreme environments. However, conventional carbide production routes typically involve high processing temperatures, prolonged reaction times, and substantial energy consumption, thereby limiting their economic and environmental efficiency. These limitations have motivated increasing interest in alternative synthesis routes that can reduce processing complexity while maintaining material performance.

Self-propagating high-temperature synthesis (SHS) is regarded as a promising alternative for carbide production because of its low external energy requirement, simple operation, and short processing time. The process relies on highly exothermic reactions that sustain themselves after ignition, enabling rapid synthesis with minimal energy input. Moreover, SHS can be implemented using low-cost equipment while enabling the production of high-purity carbide materials.

In the present study, self-propagating high-temperature synthesis (SHS) was employed as an alternative approach for producing high-performance carbide ceramics. The results demonstrate the successful synthesis of carbide ceramics via SHS, confirming the feasibility of this method for rapid and efficient carbide production. In view of the strategic importance of carbide materials, the findings of this study indicate that self-propagating high-temperature synthesis represents an advantageous production route due to its low energy consumption, simple operation, short processing time, and use of low-cost equipment.

Keywords: Ceramics, Carbides, SHS, Energy-Efficient Synthesis

The Development and Design Principles of Hybrid Artificial Intelligence Models

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Abstract

Artificial intelligence (AI) refers to algorithms that enable systems to make decisions like humans, inspired by human nature. It was first developed in the 1950s. Today, it is used across various fields such as healthcare—for epileptic seizure detection, motor imaging, sleep staging, and emotion recognition; education—for measuring attention, identifying learning styles, and assessing learning rates; and daily life, notably in academic research and social decision-making. Due to this widespread application, the precision of analysis results is becoming increasingly critical. Over time, machine learning, deep learning, and hybrid deep learning models have been developed. Technological advances, the demands of handling large-scale data, and the comparative benefits of different algorithms have driven researchers to adopt hybrid models. These models aim to improve success rates, reliability, and generalisation by combining the strengths of various algorithms into a single framework. Literature shows that algorithms such as LSTM, CNN, and ResNet have been integrated into unified models for this purpose. Similarly, these multimodal models tend to outperform those based on a single algorithm. A key factor to consider is the compatibility of data transfer between algorithms. Layers like convolution and pooling, commonly used in deep learning models, must have compatible data sizes; otherwise, the model will neither perform optimally nor initiate the analysis process effectively.

Keywords: Artificial Intelligence, Hybrid Model, Deep Learning

A Novel UV-C Integrated System for Bacterial Prevention in Cooker Hoods

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Abstract

Cooker hoods create favorable environments for microbial growth due to the accumulation of heat, moisture, and organic residues such as oil vapors. These conditions, particularly on filter surfaces, facilitate the colonization of pathogens and the formation of biofilms, posing risks to both indoor air quality and food safety. This study evaluates the effectiveness of the UV-C air purification device "Vertical/Ceiling Alpine," developed for use in domestic cooker hoods. The device is designed with a UV-C reflective aluminum coating, an OSRAM HNS L 36 W UV-C lamp, and a fan with an airflow rate of 85 m^3/h. Radiometric analyses revealed that the UV-C doses inside the device ranged between 10.3 and 21.2 mJ/cm^2. Microbiological tests demonstrated high deactivation levels for *Escherichia coli* and *Staphylococcus aureus*: reductions of 99.99–99.999% for *S. aureus* and 99.9–99.99% for *E. coli* were achieved. The results indicate that the device provides an effective solution for air disinfection in indoor environments.

Keywords: Kitchen ventilation, UV-C, Domestic cooker hood, White goods, Indoor air quality

Evaluation of University Location Selection in the Context of Interaction with the City: The Case of Ankara Yildirim Beyazit University Esenboğa Campus

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Abstract

The effective establishment of a university-city relationship depends directly on the university's location within the city and its level of accessibility. This study aims to evaluate the urban location of Ankara Yıldırım Beyazıt University's Esenboğa Campus in the context of university-city relations, focusing on transportation, spatial analysis, and socio-cultural interaction. To achieve this, a literature review was conducted to develop evaluation criteria for the urban location of universities. The study examined the university's distance from the urban environment, its proximity to nearby social amenities, public transportation options, and pedestrian accessibility. Findings show that the campus is 33 km away from Ankara city center (Kızılay), 19 km from Çubuk district—where the campus is situated—and 12 km from Pursaklar, the closest urban settlement. It was found that pedestrian access to the nearest urban area is not possible, and public transportation is available only through transfer bus lines. This situation significantly hampers the campus's accessibility. Because of the campus's distance from key points and service units, it is challenging for the university community to take advantage of the city's social and cultural offerings. Spatial analysis indicates that, although the campus has potential for growth and development, the absence of shared public spaces and limited accessibility to urban areas hinder the establishment of a spatial connection with the city. Overall, while the campus offers advantages for physical expansion, it falls short in accessibility, urban integration, and socio-cultural interaction. Based on the principles reviewed, it was concluded that university-city interaction is nearly nonexistent. Therefore, it is recommended that accessibility and urban integration be prioritized as essential planning principles during university site selection and campus design to enhance university-city relations.

Keywords: Campus, University-City Relationship, Urban Location, Transportation, Socio-Cultural Interaction

Automatic Detection of Illegal Excavation Sites Using Two-Temporal 3D Point Clouds

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Abstract

The preservation of cultural heritage and its transmission to future generations is of great importance in many countries. As is the case worldwide, situations arise in our country that make it difficult to preserve the structure and appearance of archaeological sites. Unconscious excavations carried out for the purpose of searching for cultural and historical artefacts and materials through illegal means cause great damage. Furthermore, the negative effects of unconscious behaviors such as smuggling activities, deliberate destruction and terrorism cause damage to natural and cultural heritage sites. It is of great importance to track the damage and illegal excavation activities occurring in archaeological and site areas and to quantitatively determine their locations. In this context, automatic studies based on the monitoring of optical and synthetic aperture radar (SAR) aerial or satellite images are being conducted. The proposed study uses two-time three-dimensional point clouds or LiDAR data to automatically determine the locations of illegal excavation sites with high accuracy based on geometric changes. The study demonstrates the superiority of this method over satellite images tracked with spectral data, as it enables detection based solely on geometric data. This makes it possible to identify negative images and damage that visitors may encounter in advance, making protection and intervention processes more effective. The results obtained show that the proposed method offers an applicable and reliable approach that contributes to the sustainable protection of cultural heritage.

Keywords: Illegal Excavation Sites, 3D Point Clouds, UAV

Geometric Analysis of the Eight-Pointed Seljuk Star in GeoGebra Using the Transformation Matrices Method and Its Application with Innovative Technologies

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Abstract

In this study, the eight-pointed star pattern, commonly referred to as the Seljuk star and recognized as a significant element of Islamic art, is investigated within a systematic and staged design framework employing geometric methods and innovative technologies. Initially, the pattern is constructed through classical ruler-and-compass constructions, and preliminary sketches are developed to establish its geometric structure. Subsequently, the pattern is transferred into a digital environment using the GeoGebra software, where its geometric properties are analyzed through planar transformation matrices. The digitally constructed pattern is then converted into a model suitable for 3D printing and integrated into a digital design workflow. In the final phase of the study, the Seljuk star is transformed into an interactive visual educational material through the application of Augmented Reality (AR) technology.

Consequently, this study extends Islamic geometric patterns beyond their traditional artistic context and redefines them as a viable research subject in the domains of engineering, design, educational technologies, and digital cultural heritage. This holistic approach offers a representative example of how a traditional geometric pattern can be reinterpreted and revitalized through contemporary digital analysis and production techniques.

Keywords: Geometric Pattern, Geometric Design, 3D Printing Technologies**,** Augmented Reality

Prediction of Workforce Requirements in the Retail Sector Using Machine Learning Algorithms

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Abstract

Employees are among the most critical and valuable resources for an organization's financial success, as they contribute directly through their knowledge, skills, and experience. In the retail sector, where employee turnover rates are particularly high, one of the major challenges in human resource management is developing seasonal recruitment plans and meeting staffing requirements in a timely manner. Workforce forecasting models aim to predict the number of employees to be hired by focusing on the gap between the current workforce and future personnel needs. Factors such as store openings and closures, customer demand trends, seasonal effects, and macroeconomic conditions lead to significant seasonal fluctuations in workforce requirements. Moreover, failing to meet staffing needs on time can disrupt operational processes and customer service in retail stores, ultimately reducing customer satisfaction. To address these challenges, this study focuses on estimating the number of employees to be hired on a seasonal basis using real-world data obtained from a retail chain covering the period from 2020 to 2024. Firstly, a dataset was constructed by deriving lagged variables from the time series data. Then, Extreme Gradient Boosting (XGBoost) and Facebook Prophet models were applied using their default parameter settings. To further improve forecasting accuracy, parameter optimization was conducted using a Genetic Algorithm (GA), and hybrid forecasting models were proposed. The performance of the proposed models was then compared with that of the Seasonal Autoregressive Integrated Moving Average (SARIMA) model. Model performance was evaluated using commonly adopted metrics, including Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE), and the coefficient of determination (R^2). The numerical results indicate that the hybrid XGBoost–GA model achieves superior forecasting accuracy compared to the other models. Furthermore, parameter optimization was found to enhance forecasting performance across all models.

Keywords: Workforce Management, Retailing, Forecasting, Machine Learning

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Smart Energy-Efficient Integrated Transportation Systems

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Abstract

As the new technologies emerge for transportation systems day by day, generally intersect with the terms of decarbonization and digitalization. However, as the literature investigated, it can be seen that most of the time these terms comply each other. Some common sub-topics beneath these terms like perception, intelligence and energy conversion include these ideas. Therefore, recent technologies must form bodies with jointed ideas. While computer vision (CV) enables meticulous sensing of traffic and environmental conditions, artificial intelligence (AI) provides data-based decision-making process and optimization opportunities. Also, battery technologies directs and shape energy-efficient green mobility. Yet, previous studies predominantly issue these components in isolation while lacking a synthesis aligned with transportation engineering objectives.

This paper presents a review of perception-driven, energy-conscious transportation systems while focusing on the integration of computer vision, artificial intelligence and smart battery systems (SBS) within traffic, infrastructure and network perspectives. Analysis was conducted with recent advances in vision-based environment perception, AI-driven control and battery modeling techniques. Moreover, the study emphasizes the interaction of some trend components to influence traffic flow, energy consumption and emissions.

Beyond inspection of the existing studies, this review study identifies key points, scalability challenges and interdisciplinary varied scopes among civil, electrical and computer engineering communities. At last, suggestions for future research directions toward unified architectures, physics-driven AI modelling and transportation-based performance evaluation frameworks were proposed. The paper aims to serve as a reference for researchers whom intention is developing smart, green and sustainable transportation systems.

Keywords: Sustainable Mobility, Battery Management Systems, Computer Vision, Smart Transportation Systems, Artificial Intelligence

Transfer Learning-Based Deep Classification of Malicious UAVs in Aerial Imagery

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Abstract

Reliable identification of malicious unmanned aerial vehicles (UAVs) in airspace imagery is critical for airspace security. Drone-like targets can often be designed in similar ways and are difficult to detect under adverse imaging conditions. In this study, four pre-trained deep learning models, including ShuffleNet, SqueezeNet, AlexNet, and ResNet-18, are used to detect and classify malicious drones using a publicly available dataset. The dataset contains a total of 776 high resolution image samples distributed across five categories as aeroplane, bird, drones, helicopter, and malicious UAV. The deep networks are trained under the same parameters and evaluated using accuracy, sensitivity, specificity, precision, and F1-score. When the obtained results are evaluated, ResNet-18 showed the best overall performance, achieving 97.44% accuracy, 98.00% sensitivity, 99.33% specificity, 97.87% precision, and a 97.85% F1-score. AlexNet gives the second-best performance with 94.87% accuracy and a 95.47% F1-score. Compared with AlexNet, SqueezeNet, and ShuffleNet, ResNet-18 improves overall accuracy by 2.57%, 3.85%, and 8.98% points, respectively, and yields the highest F1-score margin over ShuffleNet by 9.46% points. Class-wise analysis shows that ResNet-18 provides excellent recognition for aeroplanes and birds, achieving an F1-score of 97.56 for the malicious UAV class, but the drone class remains the most challenging class with an accuracy rate of 90.00%. Based on the obtained results, the residual learning reveals that it can provide the most consistent class separability and the strongest malicious UAV classification capability.

Keywords: Malicious UAV Classification, Aerial Image Classification, Transfer Learning, Deep Learning

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Improving Order Picking Efficiency with Smart Listing and Dynamic Route Selection

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Abstract

Warehouse order picking activities are one of the most time-consuming and costly processes in logistics operations. In this study, order picking operations were examined in a 230,000 m² warehouse of a large-scale logistics company operating in Turkey, and an optimization approach was developed to make routes more efficient. Currently, issues have been identified such as employees having to repeatedly pass through the same corridors while picking orders, extra distance traveled for returns to the picking table, and unnecessary movement in corridor crossings. Additionally, the absence of a standard walking rule has led to performance differences among employees.

Two methods have been proposed as solutions to these problems: the S-template walking rule and the Nearest Neighbor algorithm. In this study, these methods were compared on different sequential lists using a scenario-based approach, and the findings showed that they could provide theoretical distance and time optimization. Accordingly, it is expected that the distances traveled by employees will decrease and improvements will be made in order fulfillment times. Additionally, it is expected that the physical burden on workers will be lightened by reducing unnecessary movements.

In conclusion, the proposed route optimization approach has the potential to offer positive contributions in terms of both operational efficiency and ergonomics. Supporting the study with field tests in later stages will increase its feasibility for similar-scale warehouse operations.

Keywords: Order Picking, Route Optimization, Logistics, S-Pattern, Warehouse Processes

Context-Aware Hybrid Defense for Multi-Sensor Fusion Pipelines in Autonomous Vehicles: A Work-In-Progress

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Abstract

Autonomous driving systems are based upon ML and DL models process data coming from various sensors. However, this gives rooms attackers to larger attack surfaces like poisoning sensor data both physically and digitally besides adversarial attacks to ML/DL models. Findings we get in consequence of current preparatory literature review that covers researches between 2020-2025 we made, consists of defence strategies like dynamically adjusting weights of sensor data according to external conditions such as weather, light and road status, comparing sensor data with other AVs' sensor data cooperatively, cross validating sensor data with each other, training ML/DL models with unusual data and so on. Inspite of all these approaches, an integrated approach is missing as each approach investigates an attack surface and comes up with a solution for that investigated spesific attack. Considering these gaps, this paper establishes the groundwork for a holistic hybrid framework combines cloud assisted data collection and learning fed with GPS-tagged sensor data to define contextual norms, a tolerance based IDS and dynamically adjust sensor inputs in real time.

Keywords: Autonomous Vehicle Security, Cloud-Assisted Learning, Context-Aware Anomaly Detection, Real-Time Threat Mitigation, Cooperative Perception Security

A Novel Approach to House Price Prediction Using Machine Learning Algorithms

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Abstract

This paper aims to develop an optimal, accurate model to predict the value of any home on the Istanbul market. The housing market both globally and also locally for Istanbul city had many fluctuations due to number of reasons in the last decades. Economic shocks, world-wide pandemic inflation, local monetary policy effects and many other factors affected the choices, needs and essentially prices. Economical, statistical and analytical approaches are needed to fully understand the recent developments in the market to evaluate impactful variables and have meaningful and interpretable results. This study aims to enhance the analysis of house price prediction studies with different machine learning approaches while using real world housing dataset. In order to conduct the proposed study, over 1,500 unique housing listings with over 50 variables are gathered during the April 2025 period for Istanbul, Turkey. Data is cleaned, preprocessed and feature engineering applied to create new meaningful variables that can better explain the relationships. Extreme Gradient Boosting, Categorical Boosting, Light Gradient Boosting Machine, Gradient Boosting and Random Forest models are used for machine learning prediction model constructions. The results show that the more complex and creative machine learning solutions provide impactful insights that can be useful for housing market professionals and all the other related parties in the financial system. The key focus areas to examine the consequences of employing a significant volume of housing market data, determine the primary variables that contribute to the valuation of an estate. And, compare various machine learning models to identify the best solution for the real estate industry. Categorical Boosting resulted in the best performance compared to other models in the study.

Keywords: Housing Market, Price Prediction, Classification, Machine Learning

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Comparison of Satellite-Derived Bathymetric Modeling Methods Using Sentinel-2A Imagery: Akbuk Case Study

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Abstract

Satellite-Derived Bathymetry (SDB) is a remote sensing-based technique used for estimating depths of water by analyzing the spectral response of multispectral or hyperspectral satellite imagery. This technique is effective in shallow and clear waters up to 20-30 meters depending on the applied algorithm, the optical properties of the water column, and particularly the depth range.

In this study, four different SDB models such as Band Ratio, Log-Ratio, Lyzenga Linear Model and Multispectral Multiband Regression were used to determine the bathymetric model of Akbük Bay by using Sentinel-2A imageries. An error analysis was performed by comparing the derived bathymetric models with the reference depth measurements. The accuracy of the bathymetric models was examined according to the IHO S-44 hydrographic survey standards.

As a result, SDB models which are obtained from Sentinel-2A are not sufficient for direct use in nautical chart production. SDB models can be used for purposes such as preliminary assessment, planning, identification of data gaps, and prioritization of hydrographic surveys.

Keywords: Satellite-Derived Bathymetry, IHO S-44, Remote Sensing, Sentinel-2A.

Bonding Strength of Wood Materials Under Extreme Conditions

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Abstract

Wood is one of the most easily processed renewable raw material resources that humankind has utilized across many fields to meet various needs. In this study, wood materials bonded with different types of adhesives were exposed to high and low temperature environments, and the resulting changes in bonding strength were investigated. The findings reveal that the performance of wood materials bonded with various adhesive types under extreme conditions differs significantly. Based on the obtained results, the suitability of each adhesive for specific applications under extreme environmental conditions was evaluated, and recommendations were made regarding the most appropriate adhesive types for use in such conditions.

Keywords: Wood Materials, Adhesive Types, Bonding Strength

Impact of Discrepancies between Theoretical Pressure Loss Calculations and Field Measurements on the Fan Operating Point in Air Handling Units

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Abstract

Ventilation systems used in industrial facilities play a critical role not only in protecting employee health but also in ensuring the safe, efficient, and sustainable operation of production processes. In the design of these systems, target air flow rates are achieved through fan selections based on calculated air handling unit internal pressure losses and duct pressure losses. Fan selection is generally performed using theoretical calculations and ideal flow assumptions.

In field applications, differences may arise between the pressure losses predicted during the design phase and those measured under actual operating conditions. These differences can cause fans to operate away from their design operating points, resulting in the failure to achieve the intended air flow rates. In industrial facilities, factors such as high filtration requirements, heat recovery systems, complex duct geometries, and installation tolerances significantly contribute to increased pressure losses and amplify these deviations.

This study examines an insufficient air flow rate problem observed during the operation of an air handling unit designed for an industrial facility. Based on on-site air flow and pressure measurements, discrepancies between theoretical design assumptions and actual system performance are analyzed. The impact of pressure loss mismatch on the fan operating point is evaluated, and the field-applied solution implemented to improve system performance is assessed from an engineering perspective. The study highlights the importance of validating theoretical design approaches with field measurements and conducting performance analyses during the commissioning and operation phases of ventilation systems.

Keywords: Air Handling Unit, Pressure Loss, Fan Operating Point

User Privacy on IoT Devices Using Deep Learning

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Abstract

The use of Internet of Things (IoT) devices has been increasing rapidly and with it comes an increase in cyberattacks targeting these devices. One of the most harmful attacks in the IoT ecosystem is botnet-based attacks which are notoriously difficult to defend against. In recent years, many researchers have presented Deep Learning methods for identifying and categorizing botnet attacks in the IoT context. In this work, we propose an effective method for identifying botnet attacks on IoT devices using the N-BaIoT dataset. We developed six models, including Deep Learning and hybrid models to identify two frequent and dangerous IoT threats, BASHLITE and Mirai. Our results demonstrate that Transformer model can accurately and efficiently detect botnet-based assaults from a variety of IoT devices with 99.48% accuracy level which outperforms other existing models in the literature. Our study contributes to the growing body of research aimed at developing efficient and accurate methods for detecting botnet-based attacks on IoT devices. The proposed method has significant implications for the security of IoT devices and can help to mitigate the harmful effects of botnet attacks in the IoT ecosystem.

Keywords: Artificial Intelligence, Deep Learning, IoT for Security of Devices

Sustainability through Log Analysis in the Software Life Cycle

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Abstract

Log tracking is becoming increasingly important to verify that software applications are functioning according to the defined plan in the test and production environments. It is necessary to analyze request-response logs, warn-error type errors, user information, database queries, security, server performance, and many other metrics relevant to the project. Logs are generated throughout all processes, but when not properly configured, they can lead to meaningless data and erroneous results. The importance of configuring all components in the architecture with appropriate correlations for system monitoring is increasing. This study will examine how to monitor whether an application working in the banking sector is producing correct output and how to implement real-time intervention methods through log analysis.

Keywords: Software Testing, Error Management, Error Reporting, Log Analysis

Automatic Based Framework by Using PCA and Deep Learning for Website Phishing Classification

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Abstract

In this sudy, one of the examples of online identity theft which is phishing is evaluted. Phishers utilize social engineering to obtain victims' financial account information and personal digital identity information. Social engineering scams utilize phony emails to deceive unsuspecting victims into visiting bogus websites that ask for financial information which is called as deceptive phishing attack. Deep learning algorithms are constantly improving for making it simpler to identify phishing websites and reducing human errors and minimizing detection times. The objectives of this research are to improve the detection of phishing websites using Deep Learning models such as MLP, CNN, CNN-LSTM1, CNN-LSTM2, Bidirectional LSTM, CNN_Bidirectional LSTM and GRU. Another objective of this research could be to explore the use of PCA for feature extraction to evaluate the effectiveness of these models in distinguishing between legitimate and phishing URLs. The main goal is to identify the most effective model for detecting phishing websites and to contribute to the development of more reliable and robust anti-phishing systems. The results show that the proposed CNN model achieved the highest accuracy of 97.28%. The overall objective of this research was to achieve high accuracy that would aid in spotting phishing websites. The research also aims to suggest potential future work in the field of phishing detection.

Keywords: Artificial Intelligence, Cyber Security, Deep Learning, Website Phishing

A Flexible Approach to Web-Based Software Development Using Single-Sign-On (SSO) Method for Improving User Experience (UX)

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Abstract

In a complex and large-scale *software system* consisting of a few applications developed, it is not easy to establish and ensure the integrity among these applications. Moreover, it gets harder over time to make changes on the versions of the technology used. Therefore, the *authority management* needs to be performed for each application individually via a system based on the following: (1) authorized departments/parts/sections, (2) coordinated units/projects/people, and (3) accomplished tasks/schedules/responsibilities/plans of the current user. Such a system includes a number of *software applications* talking to the central/distributed *databases* that were implemented by using various *frameworks*, *programming languages*/*platforms*, *software development tools*, and *web technologies*. Since it includes the *login controllers* required and the related *user interfaces* (UIs), there is no need to re-design or re-develop login *web interfaces* for any individual application. Moreover, a new application can be incorporated into the system easily, or an existing one can be removed from the system by only removing its link. This approach is called *single-sign-on* (SSO) that is an *authentication* method enabling users to *securely* access with multiple applications, products/services, and websites through only one-single set of *credentials*. In this study, the SSO mechanism is addressed in detail that improves *user experience* (UX) while simplifying *identity management* with no need to keep/save/store different passwords for each application, product/service, or website. Common *business logic* of many applications developed with various aims may be implemented in a base application. Furthermore, it becomes possible to access to these SSO-enabled applications via only *one login* per every browser session since every *authentication* is unique to one without a password requirement for each application. Thus, the *central authentication and authorization* is managed in a flexible manner over SSO for *web-based* applications. Additionally, the secure, reliable, maintainable, and economical *software applications* can be produced that are working efficiently.

Keywords: Single-Sign-On (SSO), Software Development, Authentication, Web Application, User Experience (UX)

Sex-Specific Hepatic Glucose Metabolism: A Mathematical Modeling Approach toward Personalized Medicine

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Abstract

While personalized medication approaches have been widely studied, medical treatments for metabolic diseases such as diabetes are still often applied through uniform dosing strategies rather than applying individualized protocols. There have been substantial observations indicating that glucose and lipid metabolism in females and males operate under different paradigms. Experimental studies suggest that hepatic glucose production during medium-level aerobic exercise is less in women. This study proposes a mathematical modeling framework to investigate sex-specific hepatic metabolic responses by incorporating hormone-dependent regulatory mechanisms into a liver-centered metabolic model. The model explores how variations in hormonal sensitivity parameters may influence hepatic glucose dynamics under alternative physiological conditions. For the initial form, the focus is on establishing the modeling structure and highlighting candidate parameters for further quantitative analysis. The suggested framework allows further detailed sensitivity analyses and model calibration with experimental data in the future. This approach may thus contribute to personalized medication strategies for metabolic diseases by offering a mechanistic view of sex-specific regulation of metabolism.

Keywords: Mathematical Modeling, Hepatic Glucose Metabolism, Hormonal Regulation

Combining Data Security and Deep Learning in Medical Imaging: A Proposed Approach

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Abstract

The rapid growth of digital medical imaging systems has increased the need for both secure data processing and intelligent image analysis methods. Protecting sensitive patient information while supporting specialists in their diagnoses remains an important criterion in modern healthcare environments. This study proposes an integrated method that combines data security techniques with deep learning-based medical image analysis. In the proposed approach, confidential information is encrypted and then embedded into medical images using a data hiding strategy. It enables medical images to be securely stored and transmitted in a confidential and controlled manner alongside sensitive data, without altering the visual features necessary for diagnosis. This method aims to enhance data privacy while preserving the usability of medical images.

Additionally, this method proposes the use of convolutional neural network-based models for diagnostic methods in medical images. Deep learning methods are recognized as effective tools that enable image classification and suggest accurate diagnoses. The integration of secure data embedding and disease/diagnosis analysis within a single method aims to meet both privacy and diagnostic support requirements through a single approach.

In general, this study highlights the potential benefits of combining cryptography, information security, and deep learning techniques in medical imaging applications. The proposed method provides a conceptual foundation for developing secure and intelligent healthcare systems that can support both data protection and computer-aided diagnosis.

Keywords: Medical Imaging, AI, Information Privacy, Cryptography

Detection of Wrinkling Defects in Sheet Metal Forming Using Conventional Image Processing Techniques

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Abstract

Wrinkling is one of the most common surface defects encountered during sheet metal forming processes and can significantly degrade product quality and functional performance. In this study, a defect detection approach based on conventional image processing techniques is proposed to identify wrinkling defects on formed sheet metal parts without relying on deep learning methods.

Surface images of formed sheet metal specimens were acquired and converted into grayscale format. After grayscale conversion, wrinkling regions became more prominent in the form of line-like structures on the surface. These structures were observed to considerably increase the detected perimeter of the part. Based on this observation, the ratio between the extracted perimeter length and the enclosed area was calculated as a quantitative indicator of surface wrinkling. Experimental results demonstrated that specimens containing wrinkling defects exhibited significantly higher perimeter-to-area ratios compared to defect-free samples. By defining a threshold value, wrinkled and non-wrinkled specimens were successfully distinguished.

The results indicate that the proposed method offers a fast, low-cost, and explainable solution for wrinkling defect detection. Therefore, it can be considered a practical alternative for quality control applications in sheet metal forming processes, especially in scenarios where data labeling and high computational resources are limited.

Keywords: Sheet Metal Forming, Defect Detection, Wrinkling, Image Processing

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