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Proceedings of

International Conference on Recent Trends in Mechanical Engineering

(ICRTME -2025)

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Edited by

Dr. M. Chandrasekaran

Dr. C. Dhanasekaran

Dr. R. Sridhar

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International Conference on Recent Trends in Mechanical Engineering

(ICRTME -2025)

24th and 25th September 2025

Organized by

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Dr. Siva Selvaraju

QA/QC Manager, Department of Rubber and Plastic Technology, HKB Boiler Solutions Netherlands.

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Senior Mechatronics Engineer, National Oilwell Varco, Melbourne, Australia.

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DEPARTMENT OF MECHANICAL ENGINEERING

The Department of Mechanical Engineering at VISTAS was established in 2009, following the university's Deemed status in 2008. Since then, it has grown into a center of academic excellence and multidisciplinary research, combining traditional mechanical principles with emerging technologies. Functioning under the School of Engineering, the department emphasizes a balance of theory, practice, and research that prepares students for global professional challenges. The department's expertise spans thermal engineering, fluid mechanics, materials science, robotics, sustainable manufacturing, and design engineering, with active work in nanotechnology, additive manufacturing, energy systems, and smart manufacturing. Students and researchers benefit from state-of-the-art laboratories, simulation facilities, and advanced testing equipment, ensuring practice-oriented learning aligned with industry standards. Accredited by the National Board of Accreditation (NBA), the department maintains rigorous quality standards in education and research, assuring stakeholders of its curriculum relevance and the career readiness of its graduates. With a strong research culture, the department has published over 492 international research articles in reputed Scopus and Web of Science–indexed journals. It has also secured major externally funded projects worth a cumulative ₹3.77 crore, supported by agencies such as the Department of Science and Technology (DST) and CVRDE, reflecting its strength in defence, energy, and sustainable technology research. In line with national priorities for innovation, the department has contributed significantly to intellectual property, with 41 patents filed/published and 21 patents granted across areas like composites, energy systems, and automation.

The Department of Mechanical Engineering at VISTAS continues to blend academic rigor with industrial relevance and social responsibility, fostering a culture of innovation, entrepreneurship, and global collaboration. Its vision is to create engineers who can lead transformative changes in manufacturing, energy, and sustainable technologies, reinforcing its role as a hub of academic and research excellence.

Message from the Chancellor's Desk

Dr. Ishari K. Ganesh

Founder-Chancellor

VISTAS

In an era defined by innovation, technological advancement, and global collaboration, the role of engineering has never been more vital. Among its many branches, Mechanical Engineering continues to serve as the backbone of industrial progress, seamlessly bridging scientific knowledge with real-world applications that enhance productivity, sustainability, and human welfare.

The **International Conference on Recent Trends in Mechanical Engineering (ICRTME 2025)**, organized by the Department of Mechanical Engineering at VISTAS on **24th& 25thSeptember 2025**, provides a significant platform to showcase the latest developments in the field. This conference will bring together leading academicians, researchers, industry professionals, and students from across the world to share pioneering ideas, exchange knowledge, and explore emerging trends in Mechanical Engineering.

I firmly believe that the intellectual discussions and collaborative spirit fostered during this conference will lead to meaningful innovations and inspire future directions in engineering research. Such initiatives not only enrich academic excellence but also contribute to the nation's growth and global competitiveness.

I extend my warmest congratulations to the faculty members, organizing committee, and students of the Department of Mechanical Engineering for their dedicated efforts in hosting this prestigious event. My best wishes for the grand success of **ICRTME 2025**, and may it serve as a beacon of knowledge, innovation, and collaboration.

With Best Wishes,

Dr. Ishari K. Ganesh

Founder & Chancellor, VISTAS

Message from the Pro-Chancellor's desk

Dr. A. Jothi Murugan

Pro-Chancellor (P&D)

VISTAS

I am pleased to note that the Department of Mechanical Engineering, VISTAS, is organizing the **International Conference on Recent Trends in Mechanical Engineering (ICRTME 2025)on 24th& 25thSeptember 2025**. This conference reflects the institution's unwavering commitment to fostering innovation, research, and collaboration in engineering and technology. Mechanical Engineering has always been central to industrial and societal progress. Today, with rapid developments in automation, advanced materials, renewable energy systems, and digital technologies, the discipline is expanding its impact on every aspect of modern life. Conferences such as **ICRTME 2025** provide an invaluable platform for researchers, industry professionals, and students to present their findings, exchange ideas, and build meaningful collaborations.

I am confident that the deliberations of this conference will generate new insights, encourage interdisciplinary perspectives, and inspire impactful research outcomes that contribute to both academic enrichment and industrial advancement.

I commend the Department of Mechanical Engineering on its dedicated efforts in organizing this prestigious event and extend my best wishes to all participants, sponsors, and organizers for a highly successful conference.

With Best Wishes,

Dr. A. Jothi Murugan

Pro-Chancellor (P&D), VISTAS

Message from the Vice President desk

Dr. Preethaa Ganesh

Vice President

Vels Group of Institutions

I am pleased to note that the *Department of Mechanical Engineering*, *VISTAS*, is organizing the **International Conference on Recent Trends in Mechanical Engineering (ICRTME 2025)** on **24th& 25thSeptember 2025** at our Pallavaram campus. This conference will provide an excellent platform for bringing together academics, researchers, industry professionals, and students to share their knowledge, innovations, and experiences.

Mechanical Engineering continues to be the foundation of industrial and technological progress. With the growing emphasis on sustainability, digital transformation, and advanced automation, conferences such as **ICRTME 2025** play a vital role in fostering collaboration and shaping future directions. I am confident that the deliberations, technical sessions, and keynote addresses will inspire new insights and open pathways for impactful research and industry–academia partnerships.

I extend my sincere appreciation to the organizing committee, faculty members, and students of the Department of Mechanical Engineering for their dedicated efforts.

My best wishes to all participants for a rewarding and enriching conference experience!!

Best Regards,

Dr. Preethaa Ganesh

Vice President

Vels Group of Institutions

Message from the Vice Chancellor's Desk

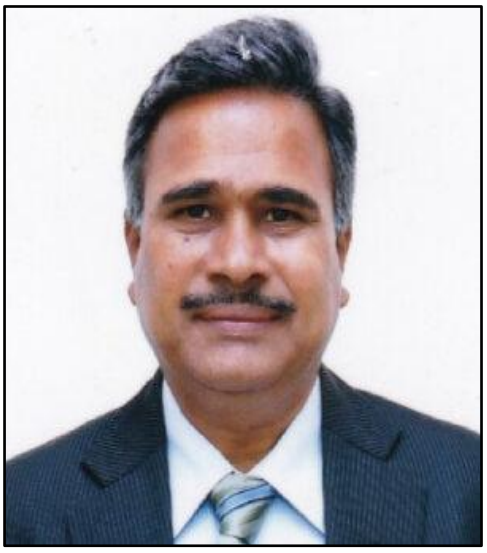
Dr. M. Bhaskaran
Vice Chancellor (FAC)
VISTAS.

It gives me immense pleasure to note that the Department of Mechanical Engineering, School of Engineering, Vels Institute of Science, Technology & Advanced Studies (VISTAS) is organizing the **International Conference on Recent Trends in Mechanical Engineering (ICRTME 2025)** on **24th& 25thSeptember 2025**. The themes and sessions planned for this conference are timely and highly relevant, showcasing the latest innovations and research directions in Mechanical Engineering and allied domains. With the growing emphasis on smart manufacturing, advanced materials, automation, energy-efficient systems, and sustainability, this event will provide a vibrant platform for academicians, researchers, industry professionals, and students to share their expertise and ideas.

I am pleased that eminent scholars and experts will deliver keynote addresses and that delegates from across the world will present numerous technical papers. Such engagements will not only enrich participants' knowledge but also inspire collaborations that address the challenges of modern engineering and technological development. I encourage all participants to actively engage in the sessions, keynote lectures, and poster presentations to maximize the academic and professional benefits of this gathering.I am confident that ICRTME 2025 will be a resounding success and will make a significant contribution to advancing knowledge and innovation in the field of Mechanical Engineering. I sincerely congratulate the organizing committee, faculty members, and students of the Department of Mechanical Engineering for their dedication and effort in hosting this prestigious event. My best wishes for the success of the conference and for it to become a benchmark for future academic and research endeavours.

Best Regards,
Dr. M. Bhaskaran
Vice Chancellor (FAC)
VISTAS.

Message from The Registrar



Dr. P. Saravanan

Registrar

VISTAS

I am delighted to know that the Department of Mechanical Engineering, School of Engineering, VISTAS, is organizing the **International Conference on Recent Trends in Mechanical Engineering (ICRTME 2025)** on **24th & 25th September 2025.**

Academic conferences play a crucial role in fostering knowledge exchange, research collaborations, and innovative thinking. **ICRTME 2025** will bring together renowned academicians, industry professionals, researchers, and students to share their expertise, present innovations, and discuss emerging challenges and opportunities in Mechanical Engineering. Such platforms not only advance academic and research culture but also inspire the younger generation to pursue excellence in engineering and technology.

I sincerely appreciate the efforts of the Department of Mechanical Engineering in planning and executing this prestigious event. I extend my warm wishes to the organizing committee, sponsors, and participants for making the conference a memorable and enriching experience.

With Best Wishes,

Dr. P. Saravanan

Registrar, VISTAS.

PREFACE

Welcome to the proceedings of the International Conference on Recent Trends in Mechanical Engineering (ICRTME – 2025), hosted in collaboration between the Department of Mechanical Engineering, VISTAS, and INTI International University, Malaysia. This publication brings together a collection of innovative research papers, insightful discussions, and pioneering developments presented at the conference, held on 24thand 25thSeptember 2025 at VISTAS, Chennai.

This year's conference theme, "Exploring Mechanical Engineering Trends for a Sustainable Future," emphasizes our dedication to advancing the field of mechanical engineering while addressing global challenges in sustainability, energy efficiency, and technological integration. The thematic tracks span across advanced manufacturing processes, materials innovation, robotics and automation, energy systems, and smart engineering solutions, reflecting the diversity and interdisciplinary nature of modern mechanical engineering research.

Each paper published in these proceedings has undergone a rigorous peer-review process by an international panel of experts, ensuring the quality, originality, and impact of the work presented. Together, these contributions showcase cutting-edge advancements that not only enrich academic knowledge but also provide practical insights into industrial applications and societal needs.

We are proud to feature contributions from a global community of scholars, researchers, and professionals, whose participation underscores the growing importance of international collaboration in solving engineering challenges. ICRTME 2025 stands as a bridge between academia and industry, fostering partnerships that transcend borders and disciplines.

We extend our heartfelt gratitude to all authors, reviewers, keynote speakers, and organizers whose dedication has made this conference a success. Your commitment to excellence, innovation, and knowledge-sharing has shaped ICRTME into a premier platform for advancing mechanical engineering.

It is our hope that these proceedings will serve as a valuable resource and inspire continued research, collaboration, and innovation. May the ideas presented here guide us toward a future that is sustainable, technologically advanced, and impactful for society at large.

Dr. M. Chandrasekaran

Dr. C. Dhanasekaran

Dr. R. Sridhar

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Friction Drilling: An Investigation of Anti-Corrosion Behavior in Galvanized Steel

GedionHabtay Gebremicheal[1], N. Rajesh Jesudoss Hynes[2], R.Kumar[3*], VijayAnanthSuyamburajan[4]

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ABSTRACT

The corrosion behaviour of the friction drilled hole of galvanized steel was conducted with3.5 wt. % of NaCl solution through the electrochemical impedance test. The maximum peak workpiece temperature during friction drilling process at 3600 rpm rotational speed, 37.5° tool angle and 2 mm workpiece thickness was detected through infrared thermometer at 798 °C. Therefore, it is observed that the friction drilling temperature exceeded the melting temperature (420 °C) of the zinc coating. This result exposed that the zinc coating on galvanized steel was melted during the process. Hence, the corrosion products can easily react with the surface of inner bushing length during immersion test with 3.5 wt. % NaCl solution. The surface morphology was investigated on the corroded sample of the drilled hole through scanning electron microscope (SEM). The result shows the increased corrosion resistance behaviour of the base metal than the material in the region of bush formed during friction drilling and confirmed by Tafel spectrum.

Keywords: Friction drilling, galvanized steel, NaCl solution, Corrosion study, Microstructure

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ICRTME25-102

Process Optimization for Enhanced Mechanical Properties of AA7075 & AA6101 Dissimilar Joints

Mohankumar Kalimuthu

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ABSTRACT

This work presents the study of FSW (friction stir welding) and the mechanical properties of AA7075 welds with 6101. The mechanical properties of FSW joints, such as tensile strength and hardness, are compared with different welding parameters. The development of friction stir welding has resulted in a variety of approaches for producing high-quality welds with 6mm dissimilar plates of AA7075 and AA6101. To create the experimental trails, an L9 orthogonal array was used, and the joints were created using a V-thread tool pin with different tool rotating speeds, axial forces, and welding speeds. This study analyzed mechanical properties such as ultimate tensile strength (UTS) and hardness to evaluate the performance and optimize the process parameters for enhanced material behavior under specified conditions. Using Taguchi methods and Multi-Object Optimization based on Ration Analysis (MOORA) technique, the optimum amounts of process control variables were determined according to experimental values. The parametric combination of tool rotation speed in the experiment at 1250 rpm, axial force of 4 N/m, and welding speed of 1.5 mm/min is optimal for multi-objective optimization using the MOORA entropy method.

Keywords: FSW, L9 orthogonal array, AA7075, AA6101, Thread tool pin,ANOVA

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ICRTME25-103

Study the characteristics of Surface Roughness during WEDM machining of Nano Cr_2C_3 – MoS_2 BasedHybrid Metal Matrix Composites

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ABSTRACT

This study focuses on identifying optimal machining parameters for Wire Cut Electrical Discharge Machining (WEDM) of Duralumin reinforced with varying proportions of particulates. Nano-chromium carbide (Cr_2C_3) at 3%, 4%, and 5% and molybdenum disulphide (MoS_2) at 2%, 3%, and 4% were used as reinforcements. Key WEDM parameters—pulse on time, pulse off time, and wire feed rate—were examined, with surface roughness taken as the response variable. The Taguchi design of experiments was applied to optimize machining conditions, and analysis of variance (ANOVA) along with regression modeling was employed to assess the influence of process parameters. Results revealed that the Cr_2C_3 weight fraction exerted the greatest effect on machining performance of the hybrid metal matrix composites. The optimal conditions for achieving improved surface finish were identified as 3% Cr_2C_3, 2% MoS_2, a pulse on time of 100 µs, a pulse off time of 100 µs, and a wire feed rate of 65 mm/sec.

Keywords: Duralumin, Nano Cr_2C_3, MoS_2, WEDM, ANOVA

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ICRTME25-104

Friction Stir Processing: Principles, Mechanisms, and Nanocomposite Applications

GedionHabtay Gebremicheal[1], R.Kumar[1*], VijayAnanthSuyamburajan[2]

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ABSTRACT

Friction Stir Processing (FSP) is a relatively new technique which has been developed for microstructural modification of metallic materials through intense and localized plastic deformation. This technique can be used to manufacture nano composites by the dispersion of reinforcement materials into the metal matrix. It can also significantly increase the wear resistance, hardness, ductility, etc. and preventing defects caused by material melting. It is an ideal material processing technology which has more prospects in the superplastic materials field and for the fabrication of metal matrix composites. The current chapter reviews the principle, process, applications and research progresses associated with friction stir processing and found to be a novel technique for manufacturing of nano composite. The nano composites fabricated by FSP provide higher surface hardness, improved wear and corrosion resistance properties which are highly beneficial in various industrial applications. Hybrid nano composites contain soft and hard reinforcement particles which are successfully fabricated by FSP with superior properties. Also, it offers defect free and uniform dispersed nano composites.

Keywords: Friction stir processing; Plastic deformation; Microstructures; Stir Zone; Recrystallization; Nano composites

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ICRTME25-105

Performance Evaluation of Cryogenic LN2 Coolant on Surface finish and Chip morphology in Machining 7075 Aluminium alloy

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ABSTRACT

This paper presents experimental investigations on surface finish and chip morphology during the machining of a 7075 aluminium alloy bar, comparing the use of Cryogenic Liquid Nitrogen (LN2) against a conventional coolant in turning operations. The analysis of chip thickness, form, and morphology, alongside surface roughness measurements, revealed that employing cryogenic coolant significantly improved the process outcomes. Specifically, the thickness of the metal chips was reduced by 6 to 20%, and the surface finish was enhanced by 15 to 23% under cryogenic machining conditions compared to those using a conventional coolant.

Keywords: 7075 aluminium alloy; LN2 cooling; chip thickness; surface roughness

978-81-992034-1-9

ICRTME25-106 The Role of Blockchain in Advancing Sustainable Development Goals: Ensuring Transparency Through Emerging Technologies

Mohamed Cassim Abdul Nazar[1*], M.S.M. Imthiyas.[2], R. Rajesh kanna[3], K.Karunakaran[4], V.Muthuraman[4], S.Arunkumar[4]

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ABSTRACT

In the evolving landscape of corporate governance, employee welfare has emerged as a critical pillar for sustainable business practices, directly aligning with the United Nations' Sustainable Development Goal 3 (SDG 3) on Good Health and Well-being. This conceptual paper explores the transformative potential of blockchain technology to design secure, transparent, and efficient employee welfare systems within Indian corporate settings. Leveraging blockchain's inherent features of decentralization, immutability, and smart contracts, organizations can revolutionize the delivery and monitoring of welfare initiatives from healthcare and insurance to mental well-being and work-life balance. The study proposes a novel blockchain-based framework that integrates HR functions with welfare programs to ensure ethical data management, real-time access, and equitable benefit distribution. This framework aims to bridge existing gaps in corporate welfare mechanisms while reinforcing compliance with both national labour standards and global sustainability objectives. The findings offer valuable insights for HR policymakers, technologists, and corporate leaders seeking to innovate their welfare strategies in a digitally-driven and socially responsible manner.

Keywords: Blockchain Technology; Employee Welfare; Corporate Governance; Sustainable Development Goals (SDG 3); Human Resource Management.

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ICRTME25-107

Effect of Process parameters on the Characteristics of Wire Arc AdditiveManufactured Stainless steel parts

P.S. Gowthaman[1], J. Manoj Kumar[2], V. Nandha Kumar[3]& R. Naveen Kumar[4]

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ABSTRACT

Wire Arc additive Manufacturing (WAAM) is a highly promising techniques due to its higher deposition rate, significant raw material savings, the ability to manufacture large components. 304 stainless steel is a commonly used material and has vast applications in the marine, heat exchangers, refrigerator and nuclear industry due to its high toughness and corrosion resistance. In this work, the effect of various process parameters on the material characterization and mechanical performance of WAAM 304 stainless steels using tungsten inert gas (TIG) welding are evaluated. Process parameters play a major influence and affecting the resultant material properties. The microstructure of 304L stainless steel consists of mixture of columnar dendrites and equiaxed grains. Micro-hardness of the deposits shows the periodic variation in hardness value from 180-210HV at various process parameters. Tensile specimen exhibits the increase in UTS, YS and EL values 510 MPa, 346 MPa and 45% as increase of weld current from 180- 200A. Moreover, the fabricated WAAM 304 stainless steel exhibits the finer solidification structure and higher mechanical properties than the parts manufactured via casting and wrought material.

Keywords: WAAM, Tungsten inert gas welding, 304 stainless steel, process parameters, microstructure and mechanical properties.

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ICRTME25-108

Design and Implementation of a Buoyancy-Controlled Autonomous Underwater Vehicle with Optical and Sensor-Based Navigation

Dr. VBN Jyothi[1], Dr. Sheeja V Francis[2], Akalya J[3],Sowmiya P[4], Soundar Palanibharathi K[5]

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ABSTRACT

Deep-sea exploration demands advanced Autonomous Underwater Vehicles (AUVs) equipped for precise navigation, environmental monitoring, object detection, underwater surveying, and real time data collection. This project develops a bio-inspired AUV with a hybrid propulsion system combining BLDC thrusters for extended-duration forward movement and buoyancy system for efficient, eco-friendly depth control.Inspired by marine life, the design minimizes harm to aquatic ecosystems while maintaining stable positioning in challenging conditions. Integrated object detection and surveying capabilities enable autonomous obstacle avoidance and detailed areamapping. A 32-bit embedded controller manages multiple sensors, actuators, and real-time processing for fully autonomous operation. The innovative design ensures reliable performance with low energy consumption and minimal maintenance requirements. This sustainable solution supports safer, longer, and more efficient underwater missions for ocean research, environmental monitoring, resource surveying, and maritime defense.

Keywords*:* Autonomous Underwater Vehicle (AUV), Bio-inspired design, Hybridpropulsion, Obstacle avoidance, Underwater surveying, Environmental monitoring

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ICRTME25-109

Artificial Intelligence in Additive Manufacturing using 3D Metal Printing

E. Bhaskaran[1], S.Baskara Sethupathy[2]

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ABSTRACT

The Precision Engineering and Technology Centre (PETC) in Thirumudivakkam, Chennai, hosts a shared EOS M 290 Direct Metal Laser Sintering (DMLS) facility that serves 40 automotive component manufacturers (ACMs). The objective of the study aims to compare the operational efficiency of traditional DMLS with Artificial Intelligence (AI) and Robotics-integrated DMLS by considering a broad set of technical and economic indicators. The methodology adopted is collection of Ten input variables like material powder (kg), machine time (hrs), energy consumption (kWh), labor hours, training cost (INR), maintenance downtime (hrs), consumables cost (INR), cooling/heat treatment time (hrs), support material usage (kg), and AI/software integration cost (INR) were evaluated against eight output variables: part accuracy (μm), surface finish (Ra μm), productivity (parts/hr), defect-free rate (%), iteration time reduction (%), material utilization efficiency (%), dimensional consistency (%), and lead time reduction (%). An output-oriented multi-stage Data Envelopment Analysis (DEA) was employed to estimate constant returns to scale efficiency (CRTSE), variable returns to scale efficiency (VRTSE), and scale efficiency, while stochastic frontier analysis was applied to measure productivity improvements. The findings demonstrate that AI and Robotics-enhanced DMLS significantly surpasses traditional approaches, delivering superior product quality, reduced defects, greater material efficiency, and shorter lead times. To conclude AI-driven adoption fosters cost minimisation and profit maximisation for individual ACMs, thereby enhancing the overall competitiveness of precision engineering clusters in the automotive value chain.

Keywords: Direct Metal Laser Sintering, Precision Engineering Cluster, Technical Efficiency, Data Envelopment Analysis, AI and Robotics, Productivity.

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ICRTME25-110

Design and Analysis of Tipper Chassis Frame with Internal Flitch

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ABSTRACT

Finite Element Analysis (FEA) was conducted to evaluate the structural integrity and failure possibilities of a 40-ton double-steered axle tipper chassis. The initial analysis revealed that the main chassis frame could not adequately withstand the applied loading conditions, leading to the introduction of an internal flitch for structural reinforcement. With the incorporation of the internal flitch, the tipper chassis demonstrated sufficient strength and rigidity to bear the load without failure. The flitch beam, used as reinforcement, is a composite structure consisting of a steel plate sandwiched between timber sections, joined using shot-fired nails. This system enhances performance consistency by eliminating variability in timber strength and enables the design to span larger openings while maintaining minimal depth. A detailed finite element model of the chassis was developed and analyzed using ANSYS software to validate the improved design. In terms of logistics, storage and handling procedures for flitch beams are similar to those for standard trusses. However, extra care must be taken to protect them from moisture; ensuring beams remain dry and structurally sound. Beams are clearly marked to indicate correct orientation and any special load-bearing points.

Keywords: Finite Element Analysis (FEA), Tipper Chassis, Structural Reinforcement, Flitch Beam, Composite Beam, ANSYS Simulation.

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ICRTME25-111

Tar mitigation studies using NiO/SiO_2 nano structured composites in Biomass Gasification systems

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ABSTRACT

Adoption of biomass gasification based power generating systems for meeting the power requirements of decentralized habitations on kW scale is not only a proven option but is also regarded as an environmentally benign approach. Of late numerous studies have been undertaken towards tar mitigation in producer gas espousing physical, thermal and catalytic techniques. Among these methods, catalytic tar cracking method is considered as the most effective method. Majority of catalytic tar cracking studies have been carried out using bulk catalysts which suffers from inherent disadvantages like limited reusability, large formation of organic waste and associated disposal problems. To overcome these disadvantages, research has been embarked upon nano catalysts to effectively mitigate tar. The NiO/SiO_2 nano structured catalysts were synthesized by Deposition-Precipitation(DP)Method. The synthesized catalyst was characterized using techniques like X-Ray Diffraction (XRD), High Resolution Scanning Electron Microscope (HR-SEM), High Resolution Transmission Electron Microscope (HR-TEM), Brunauer - Emmett -Teller (BET) - surface area method and Thermo Gravimetric Analysis (TGA). The characterization studies confirmed that the synthesized nano catalysts were <100nm and exhibited spherical morphology. The, NiO/SiO_2 catalyst seemed to yield the highest tar cracking efficiency of 97.5% at the optimal operating conditions.

Keywords: Biomass, Gasifier, Tar, cracking, Nano, SiO_2 and NiO

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Development of Sustainable PLA–CNF Polymer Composites for Packaging Applications

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ABSTRACT

Biodegradable polymer composites were synthesized using polylactic acid (PLA) reinforced with 10–30 wt% cellulose nanofibers (CNF) through melt extrusion, and their mechanical and thermal properties were evaluated. Tensile strength improved from 52.3 MPa (pure PLA) to 71.8 MPa at 20 wt% CNF loading, while elongation at break decreased from 6.4% to 3.1%, indicating enhanced stiffness. Differential scanning calorimetry (DSC) showed a 14.2% increase in crystallinity, and thermogravimetric analysis (TGA) confirmed improve thermal stability with a degradation onset temperature of 298 °C compared to 265 °C for neat PLA. Water absorption tests revealed a maximum uptake of 3.6% after 48 hours, which remained within acceptable limits for packaging applications. These findings suggest that PLA/CNF composites can provide a sustainable alternative to petroleum-based plastics with improved strength and durability.

Keywords: Biodegradable Polymers, PLA Composites, Cellulose Nanofibers, Mechanical Properties, Thermal Stability.

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ICRTME25-113 Experimental Investigation & Process Parameter Optimization in CNC Turning on EN8 Steel By Using Taguchi Technique

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ABSTRACT

Modern manufacturing industries aim to deliver low-cost, high-quality products within short lead times to remain competitive. Achieving this requires optimizing machining parameters to balance productivity and quality. This project focuses on single-response optimization of CNC turning parameters for EN8 steel, a material widely used in rollers, bolts, screws, connecting rods, axles, shafts, gears, and fasteners due to its superior tensile strength. Turning, a fundamental metal removal process, generates heat that influences surface finish and machining efficiency. In this study, spindle speed, feed rate, and depth of cut were varied to investigate their effects on surface roughness and material removal rate (MRR). The Taguchi method and Analysis of Variance (ANOVA) were employed to identify optimal cutting conditions. Results demonstrate that CNC turning of EN8 steel not only reduces cost but also improves component quality, supporting its growing use in modern manufacturing.

Keywords: CNC Turning, EN8 Steel, Surface Roughness, Material Removal Rate (MRR), Taguchi Method, ANOVA, Machining Optimization

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ICRTME25-114

Safe Nest Band: Wearable Emergency Detection and Alert System for Pregnant Women

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ABSTRACT

Pregnancy is a delicate phase that demands continuous health monitoring and rapid response to emergencies. During pregnancy, women are more likely to experience falls, fainting, high blood pressure, and other complications that could affect both the mother and the baby.Existing monitoring solutions often rely on either hospital-based systems or manual checkups, which are inadequate for real-time emergency detection. Wearable devices offer a promising solution but many currently available models focus on general fitness tracking rather than specialized maternal health needs. This paper proposes the Safe Nest Band, a smart wearable designed specifically for pregnant women. The device integrates multiple sensors to monitor vital parameters such as heart rate, blood pressure, oxygen saturation, and motion patterns. Abnormalities including sudden falls, sharp variations in vital signs, or prolonged inactivity trigger automatic alerts to caregivers and hospitals via a mobile application. Unlike traditional wearables, the Safe Nest Band is optimized for maternal comfort, low power consumption, and direct healthcare integration. The system architecture combines IoT-based sensing, Bluetooth/Wi-Fi data transmission, and cloud-enabled emergency response. By bridging the gap between fitness wearables and maternal healthcare monitoring, the Safe Nest Band aims to reduce delays in emergency response and provide pregnant women with safer, more independent lifestyles.

Keywords: Pregnancy Safety, Wearable Devices, Emergency Alert System, Maternal Health, IoT Healthcare

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ICRTME25-115

Investigation of Mechanical and Wear Properties of Al7055- Nano Silicon NitrideReinforced Composites

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ABSTRACT

In this paper an attempt has been made to find out the mechanical properties of developed composites. Al7055 were chosen as matrix material due to High hardness, high strength and better wear resistant properties. Hard ceramic Silicon nitride reinforcement in different weight fractions (1 wt.%, 3 wt.% and 5 wt.%) and particle size of 30 nm were incorporated into the matrix material through bottom pouring stir casting method.Microstructure of composites were characterized by optical microscope (OM) and SEM technique. OM and SEM images shown fair distribution of reinforcement for 3 wt.% composites. Hardness test results shown significant improvement for 3 wt.% composites and about 60 HRB value is obtained. This is due to proper bonding between the matrix and reinforcement. Tensile test exhibited higher ultimate tensile strength and yield strength for composites upto 3 wt.%. Wear test results reveals the load and sliding speed is the dominating factor.

Keywords: AA 7055, Nano Si_3N_4, SEM, Hardness, UTS, Wear

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ICRTME25-116

Impact of Variable Parameters and Dielectric Fluid Upon the Machining of Nano-sized Si_3N_4 fortified with AA7055 Alloy Metal Composites

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ABSTRACT

This paper examines the effect of a wide variety of input parameters on the electrical discharge current, flushing pressure, machining pulse off time, and pulse on time of AA 7055 alloy and nano silicon nitride (Si_3N_4) using electric discharge machining. The response parameters, including material removal rate (MRR), surface roughness (SR), and electrode wear rate (EWR), are also examined. Al 7055 of 9 wt. % silicon nitride particulate and 60 nm particle size were chosen for experimentation. In order to identify the multi-objective input parameters, Taguchi-assisted grey relational analysis (GRA) was employed. The Taguchi result reveals that the variables exhibiting a significant detrimental effect on SR, EWR, and MRR are input current and pulse timing. According to the GRA results, 10 discharge current inputs, 50 on-time pulses, 30 off-time pulses, and 0.50 f lushing pressure exhibit noteworthy results.

Keywords: Electric discharge machining,AA7055,Nano silicon nitride,MRR,SR.

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ICRTME25-117

AI-Based Low-Cost Battery Thermal Management System (BTMS) for Electric Vehicles

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ABSTRACT

The rapid adoption of electric vehicles (EVs) has intensified the need for efficient, reliable, and cost-effective Battery Thermal Management Systems (BTMS) to ensure safety, performance, and extended battery life. Conventional BTMS solutions often rely on expensive hardware and energy-intensive cooling mechanisms, which increase overall vehicle cost and reduce energy efficiency. This research proposes an AI-based low-cost BTMS that integrates machine learning algorithms with simplified thermal control hardware to achieve optimal temperature regulation. The system leverages real-time battery data—such as temperature, charge/discharge rates, and ambient conditions—to predict thermal behavior and dynamically adjust cooling or heating strategies. By using predictive analytics and intelligent control, the proposed BTMS minimizes energy consumption, reduces reliance on high-cost components, and prevents thermal runaway. Simulation and experimental results demonstrate that the AI-based system maintains battery temperature within the safe operating range while reducing operational costs, thereby enhancing the overall affordability and sustainability of EVs. This approach highlights the potential of artificial intelligence to revolutionize EV battery management, making electric mobility more accessible and energy-efficient.

Keywords: AI-Based, Low-cost Battery,Thermal Management,Electric Vehicles.

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High-Performance Energy Storage Solutions for Battery-Powered Mining Equipment

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ABSTRACT

The mining industry is undergoing a technological transition toward electrification to reduce emissions, enhance safety, and improve operational efficiency in underground and surface operations. Traditional diesel-powered mining machines contribute to high fuel costs, ventilation requirements, and environmental concerns. As a result, advanced battery technologies are being adopted to power load-haul-dump (LHD) vehicles, haul trucks, and drilling machines. This study investigates the application of high-capacity lithium-ion, solid-state, and hybrid battery systems in mining equipment, focusing on performance, durability, and safety under extreme operating conditions. Key considerations include thermal management, rapid charging capability, vibration resistance, and long cycle life to ensure reliability in continuous heavy-duty operations. The integration of AI-driven battery management systems (BMS) is also explored to enable predictive maintenance, optimize charging schedules, and prevent failures in harsh mining environments. Findings demonstrate that advanced battery technology not only reduces greenhouse gas emissions and energy costs but also enhances worker safety by eliminating diesel exhaust and lowering ventilation requirements. The adoption of robust, intelligent battery systems positions electrified mining machines as a sustainable and high-performance solution for the future of the mining industry.

Keywords: High Performance,Energy storage,Battery-Powered Mining Equipment.

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ICRTME25-119

Economical Blade Battery Manufacturing for Scalable EV Production

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ABSTRACT

The rapid growth of electric vehicles (EVs) has created a pressing demand for battery technologies that are not only safe and high-performing but also cost-effective to manufacture. Blade battery technology, known for its elongated cell structure, enhanced safety against thermal runaway, and high energy density, has emerged as a promising solution. However, large-scale adoption is often hindered by high production costs and complex manufacturing processes. This study explores low-cost blade battery making technology, focusing on material optimization, simplified cell assembly, and scalable production techniques. By incorporating cost-efficient electrode materials, advanced manufacturing automation, and AI-driven quality control systems, the proposed approach reduces fabrication complexity while maintaining high safety and performance standards. The research also emphasizes recycling strategies and second-life applications to further lower lifecycle costs. Results highlight that optimized blade battery manufacturing can achieve significant reductions in cost per kilowatt-hour, enabling affordable electric mobility without compromising safety or durability. This advancement provides a pathway toward mass adoption of EVs by making high-performance blade battery technology more economically viable and sustainable

Keywords: Blade, Battery Manufacturing, EV production.

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ICRTME25-120

Artificial Intelligence Integration in Blade Battery Systems for EV Performance Optimization

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ABSTRACT

The advancement of electric vehicles (EVs) demands battery technologies that combine high performance, safety, and cost efficiency. Blade battery technology, characterized by its long, thin cell design, enhances structural stability, thermal safety, and energy density, making it a promising solution for next-generation EVs. However, challenges remain in optimizing performance, extending lifespan, and ensuring efficient thermal management under diverse driving conditions. This study introduces an AI-based optimization framework for blade battery technology, leveraging machine learning algorithms and real-time data analytics to enhance performance and safety. The system predicts battery degradation patterns, monitors thermal distribution, and dynamically regulates charging/discharging processes to maximize efficiency. By integrating artificial intelligence with blade battery architecture, the proposed approach improves cycle life, reduces the risk of thermal runaway, and ensures stable high-power output. Experimental validation and simulation results indicate significant improvements in energy utilization, thermal stability, and overall battery longevity. This work demonstrates that AI-driven blade battery technology can accelerate the deployment of high-performance EVs, supporting sustainable and reliable electric mobility.

Keywords: Artificial Intelligence Integration, Blade Battery systems,EV performance optimization.

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High-Performance and Sustainable Battery Solutions for Heavy-Duty Electric Vehicles

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ABSTRACT

The electrification of commercial vehicles (CVs) is crucial to reducing greenhouse gas emissions, lowering operating costs, and achieving sustainable transportation goals. Unlike passenger EVs, commercial vehicles require battery technologies that deliver high energydensity, fast charging capability, long cycle life, and robust safety features to withstand heavy-duty operations. This research explores emerging battery technologies forcommercial vehicles, including lithium-ion, solid-state, and blade battery systems, while analyzing their performance, cost-effectiveness, and scalability. Emphasis is placed on optimizing thermal management, enhancing charging infrastructure compatibility, and improving durability under high-load conditions. Advanced solutions such asAI-driven battery managementsystems are discussed to enable predictive maintenance, extend lifespan, and optimize performance. The study concludes that integrating next-generation battery technology with intelligent energy management can accelerate the adoption of commercial EVs, reduce total cost of ownership, and ensure reliability for large-scale transportation and logistics applications.

Keywords: High-Performance, Sustainable Battery,Heavy DutyElectric vehicles.

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ICRTME25-122

The Mechanical Aluminium Graphite Stir Cast Composite's Ability to Improve Stirrer Speed

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ABSTRACT

Adjusting the stirrer speed and testing their mechanical qualities, a metal matrix composite with lubricating qualities can be created using a stir casting process. The casting machine has been activated. The temperature of the furnace is set to 750°C. The temperature is preheated to 150°C. The temperature of the pathway is fixed at 550°C. They let the furnace heat up. The aluminum silicon alloy is thrown into the furnace after it has reached 650°C. The melting point of the alloy is between 700 and 750°C. After being preheated, the finely ground graphite powder is allowed to thoroughly combine with the molten metal. To improve the wettability, graphite is preheated and used as reinforcement. To combine the alloy, a stainless-steel stirrer is utilized.First the stirrer is rotated at 250 rpm once both the alloy and reinforcement gets mixed up into a single red hot molt which is poured. The molt now leaves from the bottom of the furnace through the pathway from the machine. Pathway is maintained at 550°C to avoid the solidification of molt in the path. The pathway carries the molt to a die where the die is split up and the mould is taken out from the die. The die, furnace and pathway is coated with the non-stick paste to avoid the sticking of alloy in the walls. The same process is repeated for the stirrer speed of 450rpm, 650rpm, 850rpm and their mechanical properties are compared with each other to find the optimal stirrer speed

Keywords: Alminium Graphite, Metal Matrix Composite, Stir Casting, Properties and Behaviour, Stirrer speed.

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ICRTME25-123

Fabrication and Testing of Eco-Friendly Bio-composites Using Coconut Coir Fiber

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ABSTRACT

The increasing concern over environmental pollution and depletion of non-renewable resources has led to growing interest in the development of sustainable bio-composites. This project focuses on the fabrication and testing of eco-friendly composites reinforced with coconut coir fiber, a widely available natural fiber with excellent toughness and resilience. Epoxy resin is used as the matrix material due to its superior bonding and mechanical properties.The composites are fabricated through the hand lay-up method with varying weight percentages of coir fiber reinforcement. The prepared specimens are subjected to mechanical characterization tests, including tensile, flexural, impact, and hardness evaluations, in accordance with ASTM standards. In addition, water absorption and thermal stability tests are performed to assess durability under environmental conditions.Experimental results indicate that the addition of coconut coir fiber significantly enhances the toughness, impact resistance, and sustainability of the composites, while maintaining adequate strength and stiffness. The findings suggest that coconut coir-based bio-composites can serve as lightweight, cost-effective, and eco-friendly alternatives to conventional synthetic composites, particularly in automotive interiors, packaging, and low-load structural applications.This study demonstrates the potential of agricultural waste fibers in the development of green engineering materials, contributing to waste valorization and environmental conservation.

Keywords: Fabrication, Testing, Eco-Friendly, Bio-composites, Coconut coir Fiber.

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ICRTME25-124

Development of Hybrid Composites Using Jute and Glass Fibers for Structural Applications

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ABSTRACT

The growing demand for lightweight, sustainable, and high-performance materials has accelerated research in natural fiber reinforced polymer composites. In this study, a hybrid composite is developed by combining jute fibers (a renewable natural fiber) with glass fibers (a synthetic reinforcement) in an epoxy resin matrix. The objective is to harness the eco-friendliness and low cost of jute while enhancing mechanical strength and durability through glass reinforcement.The composites are fabricated using the hand lay-up method with varying weight fractions of jute and glass fibers. Mechanical properties such as **t**ensile strength, flexural strength, and impact resistance are evaluated in accordance with ASTM standards. In addition, tests for water absorption and thermal stability are conducted to assess suitability for structural applications.The results indicate that hybridization significantly improves the mechanical and durability properties of pure jute composites while reducing the brittleness and density compared to pure glass composites. The optimized jute–glass hybrid composite demonstrates a balance of strength, stiffness, and environmental sustainability, making it a promising alternative material for structural and semi-structural applications in automotive, construction, and aerospace sectors**.**This work highlights the potential of hybrid natural–synthetic composites as an effective strategy to develop eco-friendly engineering materials with improved performance.

Keywords: Hybrid composites, Jute, Glass fibre, Structural Applications.

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ICRTME25-125

Impact Strength Analysis of Hybrid Natural Fiber Composites for Automotive Applications

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ABSTRACT

The automotive industry is increasingly exploring lightweight and eco-friendly materials to reduce fuel consumption and environmental impact without compromising safety and performance. In this study, hybrid natural fiber composites are developed and evaluated for their potential use in automotive applications, with a particular focus on impact strength analysis.Hybrid composites are fabricated by combining two different natural fibers—such as jute and hemp, or banana and sisal in an epoxy resin matrix using the hand lay-up technique. The specimens are prepared with varying fiber weight ratios to investigate the influence of fiber hybridization on mechanical performance. Impact strength is evaluated using the Charpy/Izod impact test, following ASTM standards, to determine energy absorption capacity under sudden loading conditions. Complementary tests such as tensile and flexural strength are also conducted for a comprehensive evaluation.The results reveal that hybridization significantly enhances impact resistance compared to single-fiber composites, owing to improved fiber–matrix bonding and better stress distribution. Among the tested combinations, certain fiber ratios demonstrate optimal energy absorption and toughness, making them suitable for components subjected to sudden impacts, such as automotive panels, bumpers, and interior fittings.This work highlights the potential of hybrid natural fiber composites as sustainable alternatives to conventional synthetic composites, offering a balance of mechanical strength, impact resistance, and environmental benefits for next-generation automotive materials.

Keywords: Hybrid natural fiber composites, impact strength, automotive applications, epoxy resin matrix, hand lay-up technique, mechanical properties, sustainable materials, energy absorption.

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ICRTME25-126

Estimation of Mechanical Properties of Areca Palm Leaf Stalk Fiber and Mulberry Fiber Reinforced with Polyester Resin

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ABSTRACT

In this work, the combinations of Areca palm leaf stalk fiber (APLSF) and mulberry fiber were used as reinforcement in polyester matrix. The composites were fabricated using different laying pattern and continuous oriented of A-A-A, M-M-M, A-M-A and M-A-M is reinforced in polyester resin by compression molding technique. The scanning electron microscopic analysis, tensile, flexural and impact testing were performed in order to evaluate surface morphology and mechanical properties respectively. The results showed that the M-M-M composite has considerable increase in tensile properties; A-M-A composite has considerable increase in flexural properties and M-M-M, A-M-A has considerable increase in impact properties.The fractured surface morphology of composite samples was examined by Scanning Electron Microscopy (SEM). The results showed that the M-M-M and A-A-A surface morphology provides the less fiber breakage and fiber pullout was observed in the composite and it adhesion between fiber and matrix.

Keywords:Areca palm leaf stalk fiber, Polyester matrix, Compression molding, SEM Analysis, Surface morphology, Adhesion.

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ICRTME25-127

Fabrication of Compressed Nitrogen RC Car

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ABSTRACT

This project focuses on the fabrication of a radio-controlled (RC) car powered by compressed nitrogen as an alternative propulsion source to conventional battery or fuel-driven systems. The design employs a high-pressure storage cylinder to hold compressed nitrogen, a pressure regulator to control the release, and a pneumatic motor/turbine connected to the drivetrain for propulsion. The chassis of the RC car is fabricated using lightweight materials such as aluminum and composite sheets to ensure strength while minimizing overall mass. Standard RC components, including a transmitter, receiver, servo motors, and steering mechanism, are integrated for manoeuvrability and remote operation. Special emphasis is given to the assembly process, which involves secure mounting of the pressure vessel, leak-proof connections, alignment of the pneumatic motor with the transmission, and housing of control electronics. Safety measures such as pressure relief valves and reinforced joints are incorporated during fabrication to prevent accidental failures. The completed prototype demonstrates quick refuelling capability, reduced environmental impact due to zero combustion emissions, and the potential for high-speed performance in short-range applications. The fabrication process highlights practical challenges such as component alignment, flow optimization, and weight distribution, while offering insights into scaling pneumatic propulsion for micro-mobility solutions.

Keywords: Compressed nitrogen, RC car, pneumatic propulsion, fabrication, prototype development, sustainable mobility.

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ICRTME25-128 **Smart Fertilizer Dispensing Robot Using Nutrient Map Data FUSIO**

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ABSTRACT

In modern precision agriculture, automation plays a vital role in optimizing resource utilization and enhancing crop productivity. This paper presents an autonomous nutrient-monitoring and dispensing bot designed to assess soil health and regulate fertilizer application based on real-time data. The system continuously measures soil moisture, humidity, and NPK (Nitrogen, Phosphorus, and Potassium) concentrations, with data transmitted to a central controller for analysis through IoT-enabled modules. Water levels within the unit are automatically adjusted to ensure accurate nutrient detection. Once the operator sets the location, the bot autonomously navigates across the field to evaluate nutrient levels at different plant zones and applies fertilizers precisely where required. In addition, the bot can be operated and monitored remotely from anywhere in the world, ensuring seamless supervision and control.The proposed system addresses a critical gap in conventional farming practices, where uniform fertilizer application often leads to resource wastage, soil degradation, and reduced efficiency. By providing site-specific nutrient delivery, the bot minimizes manual intervention, enhances precision in nutrient management, and supports sustainable agriculture. Key advantages include reduced fertilizer wastage, improved soil fertility, enhanced crop yield, and the ability to remotely manage agricultural resources with minimal labor requirements.

Keywords: Precision agriculture, nutrient map data fusion, IoT modular monitoring andcontrol, NPK (Nitrogen, Phosphorus, Potassium) sensors, soil health and moisture analysis.

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ICRTME25-129 **Smart Irrigation System for Urban Green Spaces Using Soil and Climate Sensors**

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ABSTRACT

Urban green spaces play a crucial role in enhancing the liveability of cities by improving air quality, reducing urban heat, promoting biodiversity, and providing recreational areas for residents. However, maintaining these green spaces requires efficient irrigation management, especially in the context of growing water scarcity and climate change. Traditional irrigation practices are often based on fixed schedules, which do not account for real-time environmental conditions, leading to overwatering or underwatering, and significant wastage of water resources.This project presents the design and implementation of a Smart Irrigation System specifically tailored for urban green spaces. The system uses a network of soil moisture sensors and climate sensors (such as temperature, humidity, and rainfall sensors) to monitor environmental conditions in real-time. The collected data is processed through a microcontroller or IoT-based platform, which then controls the irrigation system based on actual soil water needs and weather conditions. For example, irrigation is delayed if rainfall is detected or if soil moisture is within optimal limits, ensuring water is used only when necessary.Sensor-based control, the system can be connected to cloud platforms for data logging, remote monitoring, and advanced analytics. This allows for predictive irrigation using weather forecasts and trend analysis, further optimizing water usage. A mobile or web-based user interface can also be incorporated to allow manual override, system status updates, and maintenance alerts.

Keywords: Smart Irrigation, Urban Green Spaces, Soil Moisture Sensor, Climate Sensor, IoT, Water Conservation, Automated Irrigation, Environmental Monitoring, Smart City

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Microstructural Evolution and Mechanical Performance of AA2024–AA4043 Dissimilar Alloys Joined by Vibration-Assisted Friction Stir Welding

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ABSTRACT

This study investigates the microstructural evolution and mechanical performance of dissimilar aluminum alloys AA2024 and AA4043 joined using vibration-assisted friction stir welding (VA-FSW). The welding experiments were conducted using 6 mm thick plates (150 × 150 mm) with an HSS tool featuring an 18 mm shoulder diameter, 6 mm pin diameter, and 2° tilt angle. A cylindrical threaded profile with shoulder flute design was employed to enhance material flow. Process parameters included rotational speeds of 800, 1000, and 1200 rpm, translational speeds of 40, 80, and 120 mm/min, and axial forces of 4, 8, and 12 kN. Microstructural characterization revealed significant grain refinement in the weld nugget zone due to dynamic recrystallization enhanced by vibration assistance. The heat-affected zone showed dissolution of precipitates in AA2024, while the AA4043 side exhibited modified eutectic silicon distribution. Mechanical testing demonstrated that optimal welding conditions achieved maximum tensile strength of 298 MPa (85% of the base AA2024 material) at 1000 rpm rotational speed, 80 mm/min translational speed, and 8 kN axial force. Microhardness measurements revealed a characteristic W-shaped profile across the weld cross-section, with peak hardness of 142 HV in the heat-affected zone of AA2024 side and minimum hardness of 78 HV in the weld nugget zone due to dissolution of strengthening precipitates. The vibration assistance effectively reduced welding defects and improved intermixing of dissimilar alloys, resulting in superior joint quality compared to conventional friction sir welding.

Keywords: Vibration-assisted friction stir welding, dissimilar aluminum alloys, AA2024, AA4043, Microstructural evolution, tensile strength, microhardness

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Optimization of Process Parameters in Vibration-Assisted Friction Stir Welding of Dissimilar Aluminium Alloys AA2024 and AA4043

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ABSTRACT

This research focuses on optimizing process parameters for vibration-assisted friction stir welding (VA-FSW) of dissimilar aluminum alloys AA2024 and AA4043 to achieve superior weld quality. Welding trials were performed on 6 mm thick plates (150 × 150 mm) using an HSS tool with 18 mm shoulder diameter, 6 mm pin diameter, and 2° tilt angle. A systematic experimental approach was employed varying rotational speed (800-1200 rpm), translational speed (40-120 mm/min), and axial force (4-12 kN). Response surface methodology (RSM) was utilized to develop mathematical models correlating process parameters with weld quality metrics including tensile strength, hardness, and defect formation. The optimization study revealed that intermediate rotational speed (1000 rpm), moderate translational speed (80 mm/min), and medium axial force (8 kN) produced optimal results. Under these conditions, the joints achieved maximum tensile strength of 312 MPa with minimal porosity and tunnel defects. The developed optimization model provides valuable guidelines for industrial implementation of VA-FSW for dissimilar aluminum alloy joining, demonstrating the technique's potential for aerospace and automotive applications.

Keywords: Vibration-assisted friction stir welding, process parameter optimization, response surface methodology, dissimilar aluminum alloys, AA2024, AA4043, tensile strength, welding defects

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Multi-Response Optimization of Process Parameters in Vibration-Assisted Friction Stir Welding of AA2024–AA4043 Dissimilar Alloys Using Grey Relation Analysis

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ABSTRACT

This study presents a comprehensive multi-response optimization approach for vibration-assisted friction stir welding (VA-FSW) of dissimilar aluminum alloys AA2024 and AA4043 using Grey Relation Analysis (GRA). Experiments were conducted on 6 mm thick plates (150 × 150 mm) with an HSS tool featuring 18 mm shoulder diameter, 6 mm pin diameter, and 2° tilt angle. The investigation systematically varied rotational speed (800, 1000, 1200 rpm), translational speed (40, 80, 120 mm/min), and axial force (4, 8, 12 kN). Multiple response characteristics including tensile strength, microhardness, elongation, and surface roughness were simultaneously optimized using GRA methodology. The grey relational grades were calculated to identify optimal parameter combinations that satisfy conflicting objectives. Results indicated that the optimal parameter combination (1000 rpm rotational speed, 80 mm/min translational speed, and 8 kN axial force) achieved the highest grey relational grade of 0.847. Confirmation experiments validated the optimization results, showing 18% improvement in overall weld quality compared to initial parameter settings. The GRA approach proved effective for multi-objective optimization in dissimilar aluminum alloy welding, providing a robust framework for industrial parameter selection.

Keywords: Grey relation analysis, multi-response optimization, vibration-assisted friction stir welding, dissimilar aluminum alloys, AA2024, AA4043, tensile strength, microhardness, surface roughness

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A Comprehensive Study on Tool Design and Its Influence on Vibration-Assisted Friction Stir Welding of Dissimilar Aluminium Alloys AA 2024 and AA 4043

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ABSTRACT

This comprehensive investigation examines the influence of tool design variations on vibration-assisted friction stir welding (VA-FSW) performance for dissimilar aluminum alloys AA2024 and AA4043. The study employed 6 mm thick plates (150 × 150 mm) with HSS tools featuring consistent 18 mm shoulder diameter and 6 mm pin diameter, while systematically comparing three distinct pin geometries: cylindrical, hexagonal, and pentagonal profiles. Welding experiments were conducted across rotational speeds of 800-1200 rpm, translational speeds of 40-120 mm/min, and axial forces of 4-12 kN with 2° tool tilt angle. Comparative analysis revealed that the hexagonal pin profile demonstrated superior material mixing efficiency due to enhanced plastic deformation and stirring action at the flat surfaces. The pentagonal geometry showed intermediate performance with improved material flow compared to cylindrical but slightly less effective than hexagonal design. Microstructural examination indicated that polygonal profiles promoted finer grain structure and more uniform distribution of intermetallic compounds. The hexagonal tool achieved maximum tensile strength of 305 MPa, while pentagonal and cylindrical profiles yielded 289 MPa and 272 MPa respectively. Microhardness analysis showed more uniform hardness distribution across the weld zone with polygonal geometries. The study establishes that pin geometry significantly influences material flow dynamics, with hexagonal profiles offering optimal performance for dissimilar aluminum alloy VA-FSW applications.

Keywords: Tool design, pin geometry, hexagonal tool, pentagonal tool, cylindrical tool, dissimilar aluminum alloys, AA2024, AA4043, material flow

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Effect of Tool Geometry on the Weld Quality of AA2024–AA4043 Dissimilar Aluminium Alloys Using Vibration-Assisted Friction Stir Welding

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ABSTRACT

This study investigates the effect of different tool geometries on weld quality in vibration-assisted friction stir welding (VA-FSW) of dissimilar aluminum alloys AA2024 and AA4043. Three distinct pin geometries were evaluated: cylindrical, cylindrical threaded, and taper cylindrical, all fabricated from HSS with 18 mm shoulder diameter, 6 mm pin diameter, and 2° tilt angle. Welding experiments were performed on 6 mm thick plates (150 × 150 mm) using systematic parameter variations of rotational speed (800, 1000, 1200 rpm), translational speed (40, 80, 120 mm/min), and axial force (4, 8, 12 kN). Comparative analysis revealed distinct performance characteristics for each geometry. The cylindrical threaded profile demonstrated superior material mixing and heat generation, achieving maximum tensile strength of 318 MPa and minimal defect formation. The taper cylindrical design showed improved material flow at the root region but exhibited higher heat input leading to grain coarsening. The straight cylindrical profile provided baseline performance with moderate mixing efficiency. Microstructural analysis confirmed that threaded geometry promoted better intermetallic compound distribution and reduced segregation zones. The study concludes that pin geometry significantly influences heat generation, material flow, and final weld quality, with threaded profiles offering optimal performance for dissimilar aluminum alloy VA-FSW applications.

Keywords: Tool geometry, pin profile, cylindrical threaded, taper cylindrical, dissimilar aluminum alloys, AA2024, AA4043, weld quality, intermetallic compounds.

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Advances in Additive Manufacturing of Nanomaterial- and Fibre-Reinforced Polymer Composites: A Comprehensive Review

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ABSTRACT

Additive manufacturing (AM), particularly fused deposition modeling (FDM), has revolutionized modern manufacturing by enabling the production of lightweight, customized, and geometrically complex structures with unprecedented design freedom. However, conventional polymer-based AM components frequently exhibit inadequate mechanical strength, poor wear resistance, and limited multifunctional properties, thereby constraining their applications in high-performance sectors including aerospace, automotive, and biomedical engineering. To overcome these inherent limitations, extensive research has focused on incorporating nanomaterials and fibres as reinforcements within polymer matrices. Nanomaterial reinforcements, including carbon nanotubes, graphene, nanoclays, metallic nanoparticles, and metal oxides, demonstrate remarkable capability in enhancing thermal conductivity, electrical properties, and multifunctional characteristics of polymer composites. Simultaneously, fibre reinforcementsencompassing both discontinuous short fibres and continuous fibre architecturesprovide substantial improvements in structural performance, stiffness, and load-bearing capacity. This comprehensive review systematically examines recent advances in nanomaterial- and fibre-reinforced polymer composites specifically tailored for additive manufacturing processes. The review critically analyzes processing methodologies, tribologicalbehavior, mechanical characterization, practical applications, and current technological challenges. Key findings reveal that hybrid reinforcement strategies combining nanomaterials and fibres offer synergistic effects, achieving superior performance compared to individual reinforcement approaches. The paper concludes by identifying future research directions, including the development of hybrid reinforcement systems, process parameter optimization strategies, sustainability considerations, and pathways for large-scale industrial adoption of these advanced composite materials in additive manufacturing

Keywords: Additive manufacturing, fused deposition modeling, nanomaterial reinforcement, fibre reinforcement, polymer composites, carbon nanotubes, graphene, mechanical properties.

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Design and Fabrication of Pneumatic Powertrain and Front-End Layout of RCCAR

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ABSTRACT

This project presents the design and fabrication of a pneumatic powertrain and optimized front-end layout for a Radio-Controlled (RC) car. The proposed system replaces conventional electric actuation with a pneumatic drive mechanism to enhance efficiency, responsiveness, and torque delivery in small-scale vehicle applications. The pneumatic powertrain includes an air compressor, pressure regulator, storage tank, and actuators integrated with the drivetrain to enable controlled propulsion. In parallel, the front-end layout was designed and fabricated to improve steering geometry, stability, and load distribution, ensuring effective handling and maneuverability. Prototypes were tested and validated through performance analysis considering speed, turning radius, response time, and energy efficiency. The results demonstrated that the pneumatic powertrain, combined with an optimized front-end layout, can provide reliable performance while serving as a cost-effective experimental platform for sustainable mobility solutions, robotics, and educational demonstrations.

Keywords: Pneumatic powertrain, RC car, front-end layout, design and fabrication, steering geometry, testing, validation, sustainable mobility.

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Design and Development Model of Spiral Bevel Gear with Minimized Weight

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ABSTRACT

Gears are used in most types of machinery and vehicles for the transmission of power. Bevel gears are widely used because of their sustainability towards transferring power between non-parallel shaft at almost any angle or speed. Drilling machines are used to cut woodwork pieces for the purpose of making furniture, Casting patterns, wooden seat designs, and wood prototyping, among other applications. In that machine, a set of spiral bevel gears is used for power transmission from the motor to the tool. The handheld tool's weight and continuous vibrations make it difficult to operate the machine for extended periods. Additionally, the power consumption per unit cut is very high, and vibrations lead to inaccuracy in cutting and errors in profile shape. Thus, the methodology used in the study involves carrying out tests on three sets of bevel plain gears: (i) no weight reduction, (ii) weight reduction achieved by providing recesses on the gear face, and (iii) weight reduction achieved by providing equi-spaced holes on the face—comparative performance analysis of the gears by load to derive the optimal performance of the gears. The optimization of spiral bevel gears can reduce weight, material usage, process time, and production costs.

Keywords: Weight reduction, Face recess, Face holes, and Vibration analysis

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Design and Development of SpotWelding Pneumatic Clamping Fixture

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ABSTRACT

In modern manufacturing industries, productivity, precision, and repeatability are crucial factors for ensuring high-quality welded assemblies. Conventional manual clamping during spot welding is often time-consuming, inconsistent, and ergonomically demanding for operators. To overcome these limitations, a pneumatic clamping fixture has been designed and developed for spot welding applications. The proposed fixture employs multiple pneumatic cylinders to achieve rapid, reliable, and uniform clamping of work pieces, thereby enhancing welding accuracy and reducing cycle time. Copper alloy elements are incorporated to withstand high temperatures and provide effective current conduction during the welding process. The fixture is designed to accommodate varying component geometries while maintaining rigidity and ease of operation. The system minimizes human effort, ensures operator safety, and improves productivity by enabling semi-automatic operation. Experimental validation demonstrates that the developed pneumatic clamping fixture significantly improves welding consistency, reduces setup time, and enhances overall process efficiency, making it suitable for mass production environments in the automotive and fabrication industries.

Keywords: Pneumatic Clamping Fixture, Spot Welding, Design and Development, Productivity Improvement, Welding Automation

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Design and Analysis of Expansion Joints and Bellows

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ABSTRACT

An Expansion Joints is an assembly designed to absorb the expansion and contraction of various construction materials, to absorb vibration, or to allow movement due to ground settlement or earthquakes. AnExpansion joint refers to a metal bellows expansion joint designed to absorb axial, lateral and angular motions in piping system.The bellows is the flexible element of the expansion joint. It must be strong enough circumferentially to withstand the pressure and flexible enough longitudinally to accept the deflections for which it was designed, and as repetitively as necessary with a minimum resistance. This strength with flexibility is a unique design problem that is not often found in other components in industrial equipment. Since the bellows must accept deflections repetitively, and deflections result in stresses, these stresses must be kept as low as possible so that the repeated deflections will not result in premature fatigue failures. In this project a metal expansion joint along with the bellows and the entire pipe cross over and the pressure parts in the cross over is designed by considering above words while designing. In the cross over “In line Pressure Balanced Expansion Joint” is replaced instead of Single Expansion Joints and Elbow Pressure Balanced Expansion Joints is also present in the cross over. Pressure is applied in the cross over.

Keywords: Design,Joint,Pipe, Elbow Pressure, Pressure Balanced Expansion Joint

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Experimental Investigation on a Mixed Biodiesel Fuelled by Direct Injection Diesel Engine

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ABSTRACT

There has been a worldwide interest in searching for alternatives to petroleum derived fuels due to their depletion as well as due to the concern for the environment.Biodiesel developed from non-edible oils promise to be a very important prospective alternative fuel for diesel engines in India. But, the availability of non-edible based biodiesel in the market is very low.In the present of high energy consumption in every sphere of life, renewable energy sources are emerging as alternative to conventional fuels for energy security, mitigating greenhouse gas emission and climate change. Producing and using renewable fuels for transportation Vegetable oil derivatives, namely, biodiesel, are being used in smaller volumes in some of the present-day diesel engines.Biodiesel developed from non-edible oils promise to be a very important prospective alternative fuel for diesel engines in India is one approach to a sustainable energy future for the world.In this work, an attempt has been made to study the application of mixed biodiesel (Methyl Ester of ThevetiaPeruviana, Jatropha, Pongamia, Mahua and Neem Seed Oil) in CI Engines, by comparing its performance and emissions characteristics with Petro-diesel. It was observed that results revealed that comparable performance and emission characteristics with that of pure diesel operation.

Keywords: Mixed Biodiesel, Fuelled, Injection, Diesel Engine.

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AI-Driven Design and Optimization of Natural Fibre Composites for Sustainable Engineering Applications

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ABSTRACT

Natural fibre composites (NFCs) are increasingly recognized as sustainable alternatives to conventional synthetic composites due to their biodegradability, renewability, and cost-effectiveness. Fibres such as jute, flax, hemp, and sisal, when embedded in polymer matrices, offer desirable strength-to-weight ratios, making them suitable for automotive, aerospace, civil, and consumer applications. Despite these advantages, widespread industrial adoption remains challenging because of fibre variability, moisture sensitivity, poor interfacial bonding, and inconsistent mechanical performance. Traditional trial-and-error methods for addressing these limitations are slow and resource-intensive, creating a need for more efficient design approaches.Artificial intelligence (AI) has recently emerged as a transformative tool for the design and optimization of NFCs. Machine learning (ML) and deep learning (DL) algorithms can predict critical mechanical properties such as tensile strength, modulus, and impact resistance by analyzing fibre morphology, chemical composition, fibre–matrix interactions, and environmental conditions. These predictive models not only reduce experimental workload but also identify optimal fibre–matrix combinations for targeted applications. Moreover, AI-driven optimization techniques enable balancing of mechanical performance with sustainability metrics, including biodegradability, recyclability, and carbon footprint.

Keywords: Design, Fibre, Renewability, Machine learning, Deep learning

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Image-Based Stress Prediction from Visual Cues Using Deep Learning Models

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ABSTRACT

Stress is a critical factor affecting human health and performance, and early detection through non-invasive methods is increasingly vital in modern healthcare and workplace environments. This study presents a deep learning-based approach for predicting stress levels from facial images using Wavelet Transform architectures.Detecting stress through visual cues has become an increasingly important area of research in affective computing and mental health assessment. This study proposes a deep learning-based framework for stress detection from facial images by leveraging subtle visual cues such as facial expressions, muscle tension, and micro-expressions. We evaluate severaldeep learning models—including Wavelet Transformtoanalyze their effectiveness in capturing both spatial and temporal patterns associated with stress. A publicly available dataset of labeled facial images is used to train and validate the models, with preprocessing steps including face detection, normalization, and data augmentation. Experimental results demonstrate that CNN-based models can effectively learn stress-related features from facial imagery, achieving high classification accuracy and strong generalization across individuals. This work underscores the potential of visual deep learning models as a non-invasive, real-time solution for automated stress monitoring in health, education, and workplace applications.

Keywords: Stress Prediction, Facial Images, Visual cues, Wavelet Transform,Deep Learning

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Enhancing IOT Network security Through CNN-Based Intrusion Detection

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ABSTRACT

Detecting IOT network intrusions using machine learning techniques has become a essential component of modern cybersecurity. This process begins with the collection of raw data from IOT network traffic, including packet data, logs, and other activity records. In preprocessing phase, the data is performed cleaning operations like normalize data, handle missing values, remove noise, ensuring that the data is ready for input model training. The Convolutional Neural Network (CNN) model is used to extracting spatial features from traffic data. By learning distinctive patterns within the network connections, the CNN-based model can differentiate between normal and malicious activities. Through Particle Swarm Optimization (PSO) hyperparameter optimization and fine-tuning, the model is adapted for improved accuracy and efficiency. Once trained, the model is fitted to the dataset and evaluated using performance metrics such as Accuracy, Precision, Recall, F1-score, and ROC-AUC to measure its effectiveness in correctly identifying intrusion. The final output is a robust system capable of classifying network traffic as either normal or attack, providing real-time intrusion detection and enhancing cyber security measures. This project, implemented using Python.

Keywords: Intrusion Detection System (IDS); Convolutional Neural Network (CNN); IOT Security; Deep Learning; Network Traffic Analysis; Anomaly Detection

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Predictive Optimization of Electro Less Coating Parameters for AH36 Steel in Defence Marine Applications

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ABSTRACT

Electroless nickel–phosphorus (EN–P) coatings are widely used to enhance corrosion and wear resistance of marine steels, yet their performance depends sensitively on bath chemistry and process conditions. This work develops a predictive, multi-objective optimization framework for EN–P deposition on AH36 steel targeted at defence marine environments. Key factors— bath temperature, pH, nickel source and hypophosphite concentrations, complexing agent level, stabilizer dosage (lead-free), agitation, and immersion time—are screened and modeled via a sequential design of experiments using Taguchi L27 followed by response-surface refinement. Responses include deposition rate, thickness uniformity, phosphorus content, microhardness (as-deposited and post-heat-treatment), wear rate, and corrosion metrics (icorr, Rp, |Z|0.01Hz) in 3.5% NaCl. Predictive models (Gaussian Process/ANN) are coupled with desirability-based optimization and a meta-heuristic (NSGA-II) to balance corrosion resistance, hardness, and deposition efficiency. Validation on AH36 coupons employs potentiodynamic polarization/EIS, pin-on-disk wear, ASTM D3359 adhesion, and cross-sectional SEM/EDS; reliability is assessed via k-fold cross-validation and lack-of-fit tests. The proposed framework identifies robust parameter windows and provides interpretable sensitivity (SHAP) rankings, delivering a tunable recipe for high-performance EN–P coatings on AH36 suitable for naval service.

Keywords: Steel, Disk, Temperature, NSGA-II, ANN

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Prenatal Autism Risk Assessment Using Machine Learning Algorithms on Ultrasound-Derived Measurements

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ABSTRACT

Autism Spectrum Disorder (ASD) is a complex neurodevelopment condition that affects social, behavioral, and cognitive development. Early identification of ASD risk before birth could enable timely monitoring and interventions to improve developmental outcomes. A machine learning approach to predict ASD risk using routine prenatal ultrasound measurements.The dataset underwent gestational age–based normalization, missing data imputation, andfeature extraction to capture growth patterns and proportional indices. Adataset comprising prenatal records and confirmed childhood ASD diagnoses was analyzed. Machine learning models, including logistic regression, random forest, and gradient boosting classifiers, were trained and evaluated using stratified cross-validation.Logistic regression demonstrated interpretability and baseline performance, while ensemble methods improved sensitivity and area under the ROC curve (AUC). This approach demonstrates the potentialof integrating machine learning with routine prenatal screening for early ASD risk stratification and paves the way for multi-center validation and clinical implementation.

Keywords: Mixed Biodiesel, Fuelled, Injection, Diesel Engine.

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Experimental Investigation of Solar PV Panel with Varying Anti-Reflective Coating Thickness

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ABSTRACT

This study presents a comprehensive evaluation of the performance enhancement in solar photovoltaic (PV) panels through the application of anti-reflective coatings (ARCs) with varying thicknesses. Two types of dielectric materials—Silicon Dioxide (SiO_2) and Magnesium Oxide (MgO)—were applied using a spray coating technique, nd their outcomes were contrasted with an uncoated reference panel. Three PV panels of the same type were used in the experiment. The first panel had a coating of SiO_2, and its performance metrics—voltage, current, and efficiency—were recorded under varying solar irradiance conditions. Similarly, The second panel was applied with MgO and analyzed under the same conditions. The third panel, left uncoated, served as the control group.To investigate the influence of coating thickness, a secondary level of the same material was coated on the SiO_2- and MgO-coated panels, resulting in varied coating thicknesses. Performance assessments were carried out after taken after each coating stage over a one-week observational period to account for environmental fluctuations and to ensure data consistency.Advanced surface analysis techniques, including Scanning Electron Microscopy (SEM) and Energy Dispersive X ray Spectroscopy (EDAX), were employed to analyze the microscopic structure and elemental composition of the coatings. These assessments contributed to understanding of the morphological quality and purity of the deposited layers, relating their structural attributes to the observed electrical performance. The data reveal that PV panel coated with SiO_2 exhibited the highest energy conversion efficiency, outperforming the MgO-coated panel by approximately 1.20% and the uncoated panel by 3.29%. The superior performance of the SiO_2-coated panel is attributed to its lower refractive index and higher transparency in the solar spectrum range, leading to enhanced light trapping and reduced surface reflection. Experimental study investigated that SiO_2 was a more effective anti-reflective coating material for solar PV applications in comparison with MgO. The findings supported the integration of optimized ARC layers, particularly SiO_2 with controlled thickness, to significantly improve the performance of solar photovoltaic systems.

Keywords: Anti-reflective Coating, SiO_2, MgO, SEM, EDAX.

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Engineered Microbes for the Conversation of CO2 into Valuable Biobased Products: A Review

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ABSTRACT

The rapid increase in atmospheric carbon dioxide and the depletion of fossil fuel reserves have necessitated the development of sustainable solutions for both carbon mitigation and renewable energy. Microorganisms such as algae, bacteria, and fungi present an eco-efficient alternative for dual-function applications: carbon capture and biofuel production. This project focuses on evaluating specific species Scenedesmusdimorphus, Rhodobactersphaeroides, Yarrowialipolytica, and Phanerochaetechrysosporium—based on their individual and combined potential in capturing CO_2 and producing lipid-based biofuels. Scenedesmusdimorphus, a microalga, is known for its rapid growth, high carbon fixation rate, and lipid accumulation capabilities, making it ideal for biodiesel production. Rhodobactersphaeroides, a photosynthetic bacterium, contributes to biohydrogen generation and supports carbon cycling. Yarrowialipolytica, oleaginous yeast, efficiently converts organic waste into lipids under nitrogen-limited conditions. Additionally, Phanerochaetechrysosporium, a white rot fungus, enhances the biodegradation of lignin-rich biomass, enabling better access to fermentable sugars for co-culture systems. The project aims to develop a hybrid, synergistic microbial culture that maximizes biofuel yield while minimizing environmental impact. Species selection is guided by lipid yield, carbon sequestration ability, growth conditions, and novelty. Future prospects include AI-driven metabolic pathway optimization and strain engineering to further enhance biofuel production.

Keywords: Carbon capture, Biofuel production, Microbial synergy, Sustainable biotechnology

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Microbial Biotechnology for Environmental Sustainability: Recent Advances and Future Prospects

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ABSTRACT

Environmental sustainability has become one of the most pressing global challenges, driven by rapid industrialization, climate change, and excessive reliance on chemical-based practices. Microbial biotechnology has emerged as a promising and eco-friendly approach to mitigate these issues by harnessing the metabolic potential of microorganisms for environmental restoration and resource management. This review highlights recent advances in microbial applications for sustainability, with a focus on four key areas: bioremediation, agriculture, waste management, and mycelium-based biomaterials. In bioremediation, diverse microbial species play a crucial role in degrading pollutants such as oil, plastics, and heavy metals, offering safer and more cost-effective solutions than conventional methods. In agriculture, biofertilizers and biopesticides improve soil fertility and crop productivity while reducing dependence on harmful chemical inputs. Microbial processes in waste management contribute to biogas production, sewage treatment, and composting, while microbial fuel cells provide novel opportunities for renewable energy generation. Furthermore, fungal mycelium is being explored as a sustainable alternative to plastics and synthetic materials, with significant industrial applications. Despite challenges such as large-scale implementation and variability in microbial efficiency, microbial biotechnology offers immense potential to support a circular economy and achieve long-term environmental sustainability. Future integration with synthetic biology and nanotechnology may further enhance its effectiveness.

Keywords: Microbial biotechnology, Environmental sustainability, Bioremediation, Biofertilizers, Waste management, Mycelium-based biomaterials.

ICRTME25-149

Statistical Evaluation of Drilling Performance in GFRP Particulate Composites Using the Taguchi Method

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ABSTRACT

This study investigates the drilling performance of glass fiber reinforced polymer (GFRP) particulate composites with cerium oxide filler, which are extensively used in aerospace and electronics applications. Drilling experiments were carried out on a radial drilling machine by varying feed rate, spindle speed, drill diameter, and filler content. Thrust and torque forces were measured using a drill tool dynamometer. The experimental design was based on an L9 orthogonal array of the Taguchi method, and the results were analyzed using signal-to-noise (S/N) ratios and analysis of variance (ANOVA). Regression models were developed to establish correlations between process parameters and drilling responses, with deviations between predicted and experimental values within 10%. The findings highlight that feed rate is the most significant factor influencing thrust and torque, followed by spindle speed, while filler content and drill diameter contribute comparatively less. The results provide a reliable framework for optimizing drilling parameters in particulate GFRP composites to minimize defects and improve hole quality

Keywords: GFRP composites; Drilling; Taguchi method; ANOVA; Thrust force; Torque

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Dynamic Analysis of a Suspension System for an Electric Vehicle using SolidWorks and ANSYS

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ABSTRACT

The suspension system is a vital element in vehicle engineering, directly influencing ride comfort, handling, and safety. As electric vehicles gain popularity, optimizing suspension design becomes increasingly important to enhance driving performance and encourage broader adoption. Finite Element Analysis (FEA) with ANSYS offers a robust framework for evaluating and improving suspension systems tailored to electric vehicles.This paper provides a detailed overview of suspension analysis and optimization using FEA in ANSYS. The introduction underlines the importance of suspension design in EVs, drawing attention to challenges such as lower centers of gravity and unique load distribution patterns. Through FEA, critical aspects like stress distribution, deformation, natural frequencies, and mode shapes can be thoroughly investigated.In addition, the advantages of suspension optimization are highlighted, including improved performance, reduced weight, efficient resource use, accelerated development, and cost-effectiveness. The paper also addresses challenges encountered during optimization, such as balancing multiple objectives, computational demands, model complexity, and real-world variability. Finally, it explores the broader implications of advanced suspension design for the future of electric vehicles, stressing the role of optimized suspensions in delivering superior driving experiences and supporting EVs as sustainable transportation solutions.

Keywords: Suspension system, Electric vehicle, Finite Element Analysis (FEA), ANSYS, Optimization, Ride comfort, Handling performance, Stress distribution, Deformation, Natural frequencies, Mode shapes.

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Real-Time Ransomware Detection using API Temporal Interval Patterns with SMOTE Balancing and LightGBM Classifier

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ABSTRACT

This project presents a real-time ransomware detection system based on analyzing API temporal interval patterns. The system simulates both ransomware and benign activities using safe dummy API sequences, enabling continuous monitoring of system behavior in a controlled environment. A Tkinter-based graphical interface provides user-friendly access with login authentication, behavior simulation, and real-time classification capabilities.The detection model is trained on real API behavior logs obtained from a known dataset. To address class imbalance, SMOTE (Synthetic Minority Oversampling Technique) is applied during preprocessing, ensuring balanced training data and improving model generalization. For classification, LightGBM (Light Gradient Boosting Machine) is employed due to its efficiency and high predictive performance in handling large-scale feature sets.By combining preprocessing, simulation, and advanced machine learning, the system effectively mimics the behavior of active ransomware in a safe environment while achieving improved detection accuracy compared to existing approaches. This design demonstrates the feasibility of robust, real-time ransomware detection and provides a practical framework for enhancing endpoint cybersecurity defenses.

Keywords: Ransomware Detection; API Temporal Interval Patterns; SMOTE; LightGBM; Real-Time Monitoring; Cybersecurity

ICRTME25-152

Design and Implementation of a GSM-Based Siren and Light Alert System for Agriculture and Disaster-Prone Regions

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ABSTRACT

The proposed GSM-based remote control and alert system is designed with a dual purpose: to protect agricultural crops from animal intrusion and to provide timely warnings in hill station regions that are prone to animal crossings, heavy rainfall, floods, and landslides. The methodology begins with the integration of a GSM SIM800L module with a microcontroller such as Arduino or ESP32, which serves as the core processing unit. The system is further connected to external devices like siren speakers, buzzers, and high-intensity flashing lights, which act as deterrents for animals and as warning signals for people in vulnerable regions. When a farmer or a local resident initiates a phone call or missed call to the SIM card inserted into the GSM module, the incoming signal is processed by the microcontroller, which then activates the siren and warning lights. This ensures that intruding animals such as wild boars, pigs, and cattle are immediately scared away from farmlands, thereby reducing crop losses. Similarly, in hill station regions, the same mechanism can be used to warn travellers and residents about the presence of animals in crossing zones or about potential disaster risks during heavy rain and landslides.To enhance flexibility and reduce dependence on manual operation, the system can be extended with automatic sensing components. Sensors such as Passive Infrared (PIR) sensors can detect animal movement near fields or roadways, while rain sensors and soil Moisture sensors can be employed to monitor conditions that may trigger floods or landslides. Once activated, these sensors can send real-time input to the microcontroller, which then automatically initiates the siren, lights, and even sends SMS alerts to registered users. This dual capability ensures that the system functions both as a manually controlled system through GSM communication and as an automated safety system through sensor integration.

Keywords: GSM Module, SIM800L, Arduino/ESP32, Remote Control System, Crop Protection, IoT in Agriculture, Embedded Systems, Disaster Management

ICRTME25-153

Comparative Study Of Mortarless Interlocking Block Masonry In An Energy-Efficient Structure

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ABSTRACT

This research investigates the structural and economic viability of mortar less interlocking block masonry systems as sustainable alternatives to conventional construction materials. The study comprehensively examines the mechanical properties, cost-effectiveness, and environmental impact of interlocking concrete blocks through experimental testing and comparative analysis. Laboratory investigations were conducted to determine fundamental material properties including compressive strength, water absorption, density, and dimensional characteristics, according to established Indian Standards. Masonry prism tests revealed an average compressive strength of 1.698 MPa with a modulus of elasticity reaching 3842.1 MPa, indicating superior stiffness compared to traditional masonry systems. Economic analysis demonstrated significant cost reductions when employing interlocking blocks, while embodied energy calculations showed environmental benefits with 4.92 MJ per block. The masonry efficiency achieved was 20.96%, comparable to conventional brick construction but with enhanced ease of assembly. Results indicate that interlocking block systems offer promising solutions for sustainable construction, particularly in applications requiring rapid assembly, reduced skilled labour, and improved thermal performance.

Keywords: Interlocking blocks, sustainable construction, masonry efficiency, embodied energy, mortar less construction.

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IoT-based Digital Twin for Battery Ageing and Reuse Optimization

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ABSTRACT

The increasing use of batteries in electric vehicles, renewable energy systems, and consumer electronics has created challenges related to ageing, performance degradation, and disposal. To address these issues, this project proposes an IoT-based digital twin framework for monitoring battery health and optimizing reuse strategies. The system integrates a Battery Management System (BMS) with sensors to measure key parameters, including voltage, current, and temperature, which are processed locally using a Raspberry Pi. A digital twin of the battery is developed to estimate the State of Charge (SOC), State of Health (SOH), and Remaining Useful Life (RUL), enabling predictive analysis of battery ageing. A local dashboard is designed for real-time visualization and decision-making, eliminating reliance on cloud infrastructure to ensure faster processing, lower costs, and enhanced data security. The outcomes of this project promote sustainable battery usage, reduce waste, and support reuse in applications such as solar storage, backup power, and consumer electronics

Keywords: Digital, Electronics, Battery Data, State of Charge, Battery Management System

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ICRTME25-155

A Review of Block chain's Potential in Contemporary Construction: Addressing Security, Sustainability, Obstacles, and Future Directions

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ABSTRACT

The integration and effects of blockchain technology in the construction sector are examined in this paper, with an emphasis on how it may be used to solve enduring issues like fraud, inefficiencies, payment delays, and transparency. The decentralized ledger system of blockchain technology is recognized as a crucial facilitator of trust and accountability, which may enhance supply chain management, contract administration, and construction procedures. Promising solutions for real-time data sharing, logistics optimization, and payment automation are provided by applications like smart contracts and the Blockchain of Things (BCoT). This paper highlights advantages, such as improved security, traceability, and transparency, as well as the drawbacks, such as scaling problems, and resistance to new technology. In order to effectively utilize blockchain's potential, this paper also highlights the necessity of a cooperative change in industrial culture, promoting standardization and improved stakeholder participation. The use of blockchain in risk management, the circular economy, and property title management, as well as its integration with the Internet of Things (IoT) and Building Information Modelling (BIM), are important topics for more learning. To fully comprehend blockchain's influence, this paper outlines adoption frameworks, points out research gaps, and provide a path for future research

Keywords: Blockchain, Smart Contract, Sustainability, IoT, Supply Chain, Embedded Systems, Disaster Management

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The Effects of Process Variables on the Laser-Assisted Development Strategy are Examined Using Finite Element Simulations

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ABSTRACT

Laser forming is a novel approach for shaping sheet metal by producing thermal stresses rather than using external forces. Finite Element (FE) simulation has become a potent tool forstudying and refining laser shaping because it provides information about the dynamics of the process without requiring a lot of experimentation. This study focuses on how important process variables, including beam diameter, laser intensity, traverse rate, and material properties, affect the final shape accuracy and deformation behaviour in laser forming. The process's thermal-mechanical interactions are modelled by FE simulations, which allow for a thorough examination of the deformation mechanisms, temperature distribution, and stress-strain history. The results demonstrate how variations in process parameters affect bending angles, thermal gradients, and residual stresses. This research provides a deeper knowledge of the laser-forming process. And serves as a foundation for optimizing parameters to achieve desired geometries and enhance efficiency in industrial applications.

Keywords: Elements, Variables, Temperature, Laser.

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Investigation on Mechanical Properties of Hemp Fiber Reinforced Epoxy Composites Using Filler as E-waste for Interior Parts for Vehicles

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ABSTRACT

The increasing demand for sustainable and lightweight materials in the automobile industry has encouraged the development of natural fiber composites. This study investigates the mechanical properties of hemp fiber reinforced epoxy composites incorporated with e-waste filler for potential application in vehicle interior parts. Hemp fibers, owing to their biodegradability and high specific strength, were combined with epoxy resin, while e-waste particles were used as a secondary filler to enhance strength and reduce environmental hazards caused by electronic waste disposal. The fabricated composites were tested for tensile, flexural, and impact properties. Results indicated that the addition of e-waste filler improved stiffness and impact resistance while maintaining lightweight characteristics. The study highlights the dual benefit of recycling e-waste and utilizing natural fibers, making the developed composite a promising eco-friendly alternative for automobile interior applications.

Keywords: Mechanical, Fiber, Composites, Fillers.

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Hybrid Deep Learning Approach for Cyber-Attack Detection in Cloud CPS

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ABSTRACT

Cloud computing has become a cornerstone for enabling scalability and efficient resource management in cyber-physical systems (CPS). However, the integration of CPS with cloud infrastructure also introduces new security challenges due to the system's complexity, dynamic nature, and exposure to external networks. Conventional security mechanisms designed for traditional IT/OT systems are often inadequate for such environments. In this study, we present a hybrid deep learning-based framework for detecting security attacks in cloud-enabled CPS. To optimize the performance of the hybrid model, we propose a novel optimization algorithm Seagull Adapted Elephant Herding Optimization (SAEHO)for fine-tuning the model weights. Performance is evaluated using standard metrics such as accuracy, precision, sensitivity, and specificity on two publicly available datasets. The proposed method consistently outperforms conventional deep learning models and optimization strategies, demonstrating its robustness and effectiveness for real-world cloud-based CPS security.

Keywords: Cyber-Physical Systems (CPS), Cloud Computing, Deep Learning, Deep Belief Network (DBN), Security Attack Detection, Hybrid Optimization,

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Mind Guard: AI-driven Digital Wellbeing Platform

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ABSTRACT

This project seeks to create an AI-driven system to predict and prevent digital addiction in children (ages 8–15) by combining passive behavioral monitoring, context-aware risk assessment, and just-in-time adaptive interventions (JITAI). Leveraging smartphone usage patterns; such as app frequency, session lengths, and interruption sensitivity—the system employs machine learning (e.g., Random Forest, XGBoost, neural nets) to identify early signs of addictive behavior. Upon detection, it delivers tailored prompts (e.g., encouraging breaks, mindfulness activities), personalized via an LLM-based motivational engine.A key innovation lies in the inclusion of mechatronic wearable components—such as smart bands or interactive devices embedded with flexible and stretchable sensors—to capture physiological signals like stress, motion, and respiration. These mechanical engineering enhancements enrich digital behavioral data with real-time biometric context, enabling more accurate risk models and timely interventions. Complementing this is a parent/educator dashboard that visualizes risk trends and suggests balanced alternatives. Pilot deployments aim to validate efficacy by tracking reductions in addictive usage patterns and improvements in mental wellbeing metrics. Combining AI, behavioral science, wearable-mechatronic sensing, and parental engagement, this tool promises to support healthier digital habits while safeguarding child autonomy and privacy.

Keywords: Mechatronic wearables, Flexible/stretchable sensors, Physiological signal monitoring, Stress detection, Motion tracking, Respiration sensing, Biometric context integration.

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The Role of Machine Learning in Enhancing 3D Printing Precision

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ABSTRACT

The technology of three-dimensional (3D) printing has transformed manufacturing in a variety of sectors, including healthcare and aerospace. However, precision remains a critical challenge limiting its broader adoption in high-precision applications. Machine learning (ML) has emerged as a transformative solution to address these precision limitations. The current state of ML applications in 3D printing is examined in this review paper, with a focus on how various algorithms and methods improve printing precision, reduce defects, and optimize manufacturing processes. Predictive modeling, real-time monitoring, parameter optimization, quality control systems, and other recent developments are the subjects of our analysis. The paper also discusses challenges, future research directions, and the potential impact of ML-driven precision improvements on the future of additive manufacturing.

Keywords: 3D printing, additive manufacturing, machine learning.

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Skill Swap: Adaptive Peer-to-Peer Learning for Smart Manufacturing

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ABSTRACT

The accelerating demand for multidisciplinary expertise has highlighted critical gaps between learners' capabilities and industry requirements, particularly in engineering domains. To address this, we propose SkillSwap, an AI-augmented peer-to-peer skill exchange ecosystem that enables structured, equitable, and verifiable knowledge sharing through a credit-based marketplace. Built with cross-platform frameworks (React Native/Flutter), scalable backends (Node.js/Django), real-time data management (Firebase/MongoDB), and Python-based AI for intelligent recommendations, the system ensures adaptive and trusted upskilling. In the context of mechanical engineering, SkillSwap provides structured peer learning in CAD/CAM, robotics, thermal systems, computational fluid dynamics, sustainable manufacturing, and Industry 4.0 applications, thereby bridging academic knowledge with industrial requirements. By embedding verification, equity, and gamified engagement, SkillSwap offers a scalable innovation that redefines peer learning while strengthening workforce readiness and competency development across mechanical and allied engineering disciplines.

Keywords: AI-Augmented Learning, Peer-to-Peer Skill Exchange, Digital Skill Wallet, Gamified Up skilling, Workforce Readiness, CAD/CAM, Robotics,Computational Fluid Dynamics (CFD), Sustainable Manufacturing, Industry 4.0.

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Sustainable Development of Microbial Hydrogel Matrix for Structural Crack Repair

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ABSTRACT

The combination of environmental stress and mechanical load and material aging causes frequent surface cracking in concrete and masonry structures. Water infiltration occurs through untreated cracks which causes corrosion together with structural deterioration. The standard sealing technique which uses cement and chemical sealants requires extensive manual work and generates high expenses while being environmentally unsustainable. The BioCrete Patch Spray functions as an innovative sprayable biotechnological hydrogel which heals concrete and masonry cracks directly at the site. The spray formulation contains sodium alginate together with *Bacillus subtilis* bacterial spores and either calcium lactate or urea as nutrient sources. The sprayed formulation undergoes crosslinking through calcium chloride mist contact which produces a calcium alginate hydrogel that sticks to the cracked surface. When moisture exists bacteria begin their activation process which starts microbial-induced calcium carbonate precipitation (MICP) to seal cracks through natural biomineralization. This repair technique eliminates cement use while being environmentally friendly and requires no special equipment for application thus serving household repairs and civil maintenance and emergency response needs. The dual system in BioCrete Patch Spray first stabilizes the hydrogel then promotes biological healing to achieve both structural reinforcement and long-lasting durability. The BioCrete Patch Spray provides an innovative sustainable approach that holds commercial potential as well as prospects for green construction technology development.

Keywords: Self-healing concrete, Hydrogel, Bacillus subtilis, Microbial-induced calcium carbonate precipitation (MICP), Calcium alginate.

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Disease Risk Prediction from Electronic Health Records Using Temporal Fusion Transformers for Scalable and Explainable Population Health Management

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ABSTRACT

The transition from reactive to proactive healthcare models requires robust predictive analytics to identify patients at risk before adverse events occur. In this study, we propose a scalable and interpretable deep learning framework utilizing Temporal Fusion Transformers (TFT) to predict disease onset from Electronic Health Records (EHR) in support of population health management. The method leverages longitudinal clinical data from approximately 50 million patients across the United States. Medical concepts were embedded using a Word2Vec model trained on structured vocabularies such as SNOMED CT, while novel techniques were applied to encode binned clinical observations and social determinants ofhealth. These enriched feature representations were input into the TFT model to forecast the risk of developing Type 2 Diabetes Mellitus, Chronic Obstructive Pulmonary Disease (COPD), Hypertension, or Acute Myocardial Infarction (MI)within a three-year horizon. The model achieved high discriminative performance with AUC scores of 0.92 for Diabetes, 0.94 for COPD, 0.92 for Hypertension, and 0.94 for MI. Furthermore, explain ability was attained using Shapley Additive explanations (SHAP), enabling identification of clinically-relevant predictors. The results demonstrate the potential of transformer-based architectures for interpretable, large-scale disease risk modelling using real-world healthcare data.

Keywords: Electronic Health Records (EHR), Population Health Management, Disease Prediction, Temporal Fusion Transformer (TFT), Deep Learning.

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Smart Weapon Detection with Real-time SOS Alert

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ABSTRACT

Public safety and security are critical concerns in today's society, particularly in crowded spaces such as educational institutions, transportation hubs, and public gatherings. The advancement of Artificial Intelligence (AI) and Machine Learning (ML) offers transformative solutions to these challenges. This project proposes a real-time weapon detection system leveraging deep learning models and computer vision techniques to identify potential threats accurately and efficiently. By integrating YOLOv5 for object detection with OpenCV for video stream analysis, the system detects weapons such as knives and firearms in surveillance footage. An additional feature includes Optical Character Recognition (OCR)-based number plate detection, enhancing traceability and law enforcement response. The solution emphasizes lightweight deployment, enabling integration into existing CCTV infrastructures for Industry 5.0-ready smart surveillance systems. Experimental evaluations demonstrate promising accuracy in detecting concealed and visible weapons under varied environmental conditions. This AI-driven approach not only contributes to automation and robotics in safety engineering but also supports sustainable technology adoption by reducing dependency on manual monitoring. The proposed system exemplifies how Machine Learning and Artificial Intelligence in automation can enhance societal security.In the mechanical field, An AI-powered weapon detection system can be integrated with existing CCTV and automation infrastructure to prevent unauthorized weapon entry, protect workers, and enhance overall safety standards in Industry 5.0-enabled smart factories.

Keywords: Weapon detection, Real-time alert, SOS notification, Mechanical automation, Deep learning.

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ICRTME25-165

Next-Gen Hospital-Patient System with Security and Predictive Intelligence

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ABSTRACT

Healthcare efficiency and patient safety are critical concerns in today's society, particularly in rural and urban hospitals where demand often exceeds resources. The advancement of Artificial Intelligence (AI), Internet of Things (IoT), and Machine Learning (ML) offers transformative solutions to these challenges. This project proposes a real-time hospital management system leveraging AI-powered disease prediction, virtual consultations, and specialist matching to ensure accurate and timely treatment.The system integrates IoT-enabled sensors for real-time monitoring of hospital resources such as beds, ICUs, and ventilators. Medicine stocks are tracked using RFID/barcode automation, while GPS-based hospital and pharmacy suggestions improve patient accessibility. The solution emphasizes lightweight deployment, enabling seamless integration into existing hospital infrastructures for Industry 5.0-ready smart healthcare systemsExperimental evaluations demonstrate promising results in real-time hospital resource tracking, efficient medicine management, and AI-assisted decision-making for doctors. This AI-driven approach not only contributes to healthcare automation and robotics but also supports sustainable adoption by reducing dependency on manual monitoring.The proposed system exemplifies how Machine Learning and Artificial Intelligence in automation can enhance healthcare services. In the mechanical field, an AI-powered hospital management system can be integrated with IoT sensors, automated pharmacy systems, and diagnostic equipment to optimize patient care, reduce errors, and improve hospital efficiency in Industry 5.0-enabled smart healthcare environments

Keywords:Smart Hospital, Real-time Monitoring, AI-powered Diagnosis, Mechanical Automation, Electronic Health Records.

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Harnessing Biotechnology for Microbial Fuel Cells and Sustainable Aviation Fuels

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ABSTRACT

Decarbonization is achieved through biotechnology using SAF and MFCs, whereas the aeronautics assiduity contributes 2 – 3 of global GHG emigrations that impact ecosystems. Using organic substrates, Microbial Fuel Cells (MFCs) use microorganisms to produce electricity. During metabolism at the anode, bacteria oxidize substrates, releasing protons and electrons. Both aerobic and anaerobic microbial metabolism, which includes the oxidation of carbohydrates, humic acids, iron (II), sulphur, ammonium, carbonates, and organic acids, is responsible for this electron transport. Although energy effectiveness, cost, biocatalyst bacteria performance, and microbial community stability limit scale- up, MFCs use biosensors and bio electrochemical systems to remediate wastewater and soil while producing electricity. deduced from renewable non-petroleum feedstocks, Sustainable Aviation Energy (SAF) is an abecedarian decarbonisation result for aeronautics that can cut life cycle GHG emigrations by over to 80. It's fully unanimous with spurt A/A-1 machines. SAF manufacture uses technologies like ATJ- SPK and HEFA- SPK, which saccharify polymeric sugars from biomass to produce paraffins and iso- paraffins. From syngas, FT- SPK produces liquid hydrocarbons. HTL (CHJ- SPK) transforms biomass into crude bio-oil, which is also meliorated into paraffins and iso- paraffins, while enzymatic hydrolysis and turmoil yield previsioned for drafts. MFCs make it possible to reuse feedstocks more fairly and efficiently, which improves the sustainability of SAF. This review emphasizes progress in the selection of microbial communities and genetic engineering aimed at boosting electricity production through the creation of new enzymatic pathways. Product ways, effectiveness plans, and deployment issues are all examined in this review.

Keywords: Microbial Fuel Cells (MFCs), Sustainable Aviation fuels (SAF), Biotechnology, Decarbonization, Genetic Engineering

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Comparative Analysis of Aero spike and Convergent–Divergent Nozzles for Altitude Adaptive Propulsion in Single Stage to Orbit (SSTO) Vehicles

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ABSTRACT

The realization of a reusable Single Stage to Orbit (SSTO) launch vehicle critically depends on the development of altitude-compensating nozzles that can sustain optimal thrust across a wide range of flight conditions. Among various advanced altitude adaptive nozzle concepts, the aerospike nozzle demonstrates superior continuous altitude compensation compared to conventional designs. This project presents a comparative study of the thrust coefficient performance of an aerospike (spike) nozzle and a traditional convergent–divergent (CD) nozzle under varying pressure ratios, with the ideal nozzle model serving as a reference. Numerical simulations were conducted in ANSYS CFX to analyze the flow characteristics and thrust coefficient of the aerospike nozzle at its design condition. The results validate the enhanced adaptability and efficiency of the aerospike nozzle relative to the CD nozzle, corroborated through comparison with existing literature. Furthermore, the study evaluates the feasibility of employing aerospike nozzles in future SSTO applications, addressing both their performance potential and the technological challenges that remain to be resolved.

Keywords: Aerospike,Propulsion,Orbit, Vehicles, ANSYS CFX

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Performance Optimization of IC Engines Through Innovative Exhaust Manifold Designs

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ABSTRACT

A good exhaust system will keep the engine running smooth and effortless. Its vital function is to get the burnt exhaust fumes out from the engine. It has a major effect on engine performance. An exhaust pipe must be carefully designed to carry toxic and/or noxious gases away from the users of the machine. Indoor generators and furnaces can quickly fill an enclosed space with poisonous exhaust gases such as hydrocarbons, carbon monoxides and nitrogen oxides if they are not properly vented to the outdoors. Also, the gases from most types of machines are very hot; the pipe must be heat- resistant, and it must not pass through or near anything that can burn or can be damaged by heat. A chimney serves as an exhaust pipe in a stationary structure. For the internal combustion engine, it is important to have the exhaust system tuned for optimal efficiency. Also, this should meet the regulation norms maintained in each country. So, it is important to have a well calculated exhaust system for proper and efficient function of the engine.Our project is to design an exhaust system which is apt for the engine we have chosen, compare the new design with the conventional design using dynamometer and perform CFD analysis to find better material that could be corrosion free and withstand all conditions.

Keywords: Optimization, Engines, Designs, IC Engines, Manifold

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Design and Finite Element Analysis of Compression-Type Piston Ring for Enhanced Engine Performance

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ABSTRACT

The piston ring is a critical component of internal combustion engines, responsible for sealing the combustion chamber, transferring heat from the piston to the cylinder wall, and regulating oil consumption. This project presents the systematic design and analysis of a compression-type piston ring with the aim of achieving high sealing efficiency, structural integrity, and durability under demanding engine conditions. The ring dimensions were derived from standard engine specifications, and a three-dimensional model was developed using CAD software. Finite Element Analysis (FEA) was employed to investigate stress distribution, thermal expansion, and deformation under operational loads. A comparative study of candidate materials was also conducted to evaluate their performance under varying temperature and pressure conditions. The results highlight the significant influence of geometry and material selection on the efficiency, wear resistance, and service life of piston rings. The study provides insights into optimizing piston ring design for improved engine performance, reduced wear, and enhanced reliability, contributing to the development of more efficient and durable internal combustion engines.

Keywords: Elements, Engine, Piston, Ring, Cylinder wall

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Performance Level Improvement of Burner and Burner Base Assembly using Flatness Gauge

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ABSTRACT

The burner assembly is a crucial part of many appliances, including stoves, ovens and furnaces. It is essential that each component of the burner assembly meets certain quality and safety standards to ensure efficient and safe operation. An innovation in the design of burner assembly involves the use of a dial indicator and flatness gauge as a detector to identify defected parts in the proposed method. This technology allows for the early detection of parts that do not meet the required flatness level, which can help prevent equipment failure or malfunctions, reduce the risk of accidents or injuries, and ultimately save costs associated with equipment failure or maintenance. The dial indicator and flatness gauge are precision tools that are commonly used to measure the flatness and surface irregularities of machined parts. In the context of burner assembly, the dial indicator can be used to measure the deviation from the desired flatness level, while the flatness gauge can assess the overall flatness of the surface. By using these tools, it is possible to determine whether the burner base and flame spreader meet the required flatness level or not. If the parts do not meet the required level, they can be identified as defective and replaced before being shipped out to customers.

Keywords: Performance, Level improvement of burner, Burner base assembly, Flatness gauge

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Synthesis and Investigation of Aluminium& Copper Slag Composites using Stir Casting Method

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ABSTRACT

The present study aims to develop an aluminium metal matrix composite reinforced with copper slag particles using the stir casting technique. Aluminium has been chosen as the matrix material due to its low density, high corrosion resistance, and wide industrial applications. Copper slag, a by-product of the copper industry, is selected as the reinforcement material because of its high hardness, fine particle nature, and potential to improve the strength of composites while reducing overall material cost. The methodology involves melting commercially available aluminium in a furnace at the required temperature. Preheated copper slag particles are introduced into the molten aluminium and stirred mechanically to ensure homogeneous distribution. The prepared mixture is then poured into preheated moulds to obtain cast specimens. After solidification, the samples are extracted and machined to standard dimensions for mechanical testing. The mechanical properties under investigation include tensile strength, hardness, and impact resistance. The microstructural characterization of the composites will also be carried out using optical microscopy to study the distribution of copper slag particles within the aluminium matrix. The influence of varying weight percentages of copper slag on the overall performance of the composite will be analysed. This research is expected to highlight the feasibility of utilizing copper slag, an industrial waste material, as a sustainable reinforcement in aluminium matrix composites. The study not only addresses waste management but also provides a cost-effective route for developing lightweight and high-strength engineering materials.

Keywords : Synthesis, Aluminium & Copper slag, Stir casting method

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Predictive Modelling and Analysis of CrimeUsing Machine Learning

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ABSTRACT

This project focuses on predicting and analyzing crime using machine learning techniques. Crime data is collected from police records and public sources and processed using classification algorithms such as Random Forest, Decision Tree,and Logistic Regression to identify crime patterns and predict future crime hotspots. Mechanical engineering contributes by developing wearable mechatronic devices and flexible biosensors that capture real-time human activity, motion tracking, and physiological signals like stress levels. These devices provide valuable data for the system to detect abnormal behavior and enhance the accuracy of crime prediction. The system offers interactive dashboards and real-time alerts to help law enforcement agencies make data-driven decisions, improving public safety and crime prevention strategies.

Keywords: Machine Learning, Data Mining, Mechatronic Wearables, Biosensors, Human Activity Recognition, Real-Time Data Acquisition

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ICRTME25-173

Design and Fabrication of control system, Testing and Validation of RC Car

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ABSTRACT

This project focuses on the design and fabrication of a control system for a Radio-Controlled (RC) car, followed by systematic testing and validation. The control system integrates a microcontroller-based unit for signal processing, motor drivers for actuation, and wireless communication modules for remote operation. Mechanical and electrical subsystems were designed to ensure optimal steering, acceleration, and braking responses. The fabricated system was tested under different operating conditions to evaluate performance parameters such as speed regulation, turning radius, response time, and stability. Validation results confirmed reliable operation, precise control, and robust performance, demonstrating the effectiveness of the developed system. This work provides a low-cost and scalable platform for future applications in autonomous navigation, robotics, and educational demonstrations.

Keywords: RC car, control system, design and fabrication, testing, validation, microcontroller, wireless communication, robotics

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ICRTME25-174

Design & Fabrication of a Multi-Tasking Robotic Arm

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ABSTRACT

The rapid advancement of automation and robotics has increased the demand for robotic systems capable of performing multiple tasks with high precision and efficiency. This project focuses on the design and fabrication of a multi-tasking robotic arm, developed to carry out operations such as material handling, pick-and-place, welding, drilling, and assisting in assembly lines. The robotic arm is designed with multiple degrees of freedom to ensure a wide range of motion and flexibility. It integrates mechanical design, actuation systems, and control mechanisms to achieve accuracy and repeatability in tasks.The arm structure is fabricated using lightweight yet durable materials to ensure strength while minimizing energy consumption. Actuation is achieved through a combination of servo/stepper motors and pneumatic actuators, controlled by a microcontroller-based system (Arduino/ESP32). Advanced features such as end-effector interchange ability allow the robot to adapt to different operations, making it suitable for industrial, medical, and service applications.

Keywords: Multi-tasking, Robotic Arm, Automation, Fabrication, Microcontroller, End-Effector.

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Tribological and Surface Morphology Study on AlTiN/AlTiCrN Coated using Cathode Ray Arc Deposition Technique

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ABSTRACT

This study investigates the tribological properties and surface morphology characteristics of AlTiN/AlTiCrN multilayer coatings deposited on AISI 440 C Stainless Steel as substrates using the cathode arc deposition technique. Coatings with varying Cr content (0-15 at.%) and bilayer periods (10-100 nm) were synthesized under optimized deposition parameters. Surface morphology was characterized using field emission scanning electron microscopy (FESEM) revealing a dense columnar structure with average surface roughness (Ra) values ranging from 0.05-0.12 μm. Tribological properties were evaluated using pin-on-disc tests against SiC counterparts under dry sliding conditions at room temperature and elevated temperatures (500°C and 700°C). The AlTiN/AlTiCrN coatings exhibited superior wear resistance compared to conventional TiN and AlTiN monolayer coatings, with coefficient of friction values ranging from 0.35-0.45 and specific wear rates of 2.1-4.8×10^{-15} m^3/Nm. Nano indentation measurements indicated hardness values of 32-38 GPa and elastic modulus of 380-420 GPa, with the highest values corresponding to coatings with 10 at.% Cr content and 50 nm bilayer periods. This study demonstrates that optimized AlTiN/AlTiCrN multilayer coatings deposited by cathode arc deposition offer promising potential for high-temperature cutting and forming applications where excellent wear resistance is required.

Keywords: AlTiN/AlTiCrN, multilayer coating, cathode arc deposition, tribology, surface morphology, wear resistance, high-temperature performance

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Evaluation of Microstructure and Mechanical Analysis of Friction Welded AA6061 – AA6082 Joints

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ABSTRACT

Friction welding is a solid-state joining process widely used due to its high production efficiency and environmental friendliness. This work investigates the friction welding of AA6061 and AA6082 aluminum alloy rods, each with a diameter of 12.7 mm, aiming to understand the effects of process parameters on weld properties, including microstructure, hardness, bending strength, and tensile strength. The welded samples were produced by varying the rotational speed while keeping the friction pressure, forging pressure, and burn-off length constant. It was observed that a rotational speed of 1800 rpm produced a superior joint, achieving a high tensile strength of 182.29 MPa. This parameter also resulted in a favorable microstructure characterized by a distinct deformed zone compared to the other rotational speeds tested.

Keywords: Friction welding, AA6061, AA6082, Microstructure, Hardness, Bending, Tensile strength.

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Development and Characterization of Natural Fiber Reinforced Epoxy Composites Using Jute, Hemp, and Flax

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ABSTRACT

Reinforcement of natural fibers offers a promising alternative to synthetic fibers for polymer-based composites. Bio-materials, particularly plant-based fibers (jute, hemp, flax, sisal, ramie) and animal fibers (silk, wool, kapok), have emerged as viable reinforcements for polymer matrices to fabricate bio-composites. The present study focuses on developing natural fiber reinforced polymer composites (NFRP) using jute, hemp, and flax fibers with epoxy resin, along with their hybrid variants (jute/hemp, hemp/flax, and jute/hemp/flax). The composites were fabricated through a hand lay-up technique using a closed mild-steel mold and evaluated for physical, mechanical, thermal, chemical, tribological, and dynamic mechanical properties. Testing was conducted both before and after one year of water immersion to assess durability. Physical and chemical analyses, including density, moisture absorption, FTIR spectroscopy, X-ray diffraction, and thermal studies (TGA/DTA), highlighted the influence of natural fibers on structural characteristics. Mechanical evaluations (hardness, tensile, flexural, and impact strength) revealed the effect of fiber type and water exposure on composite performance, while SEM analysis of fractured surfaces provided insights into failure mechanisms. Dynamic mechanical analysis (DMA) assessed viscoelastic behavior in terms of damping (tan δ), storage modulus, and loss modulus. Tribological studies under varying loads, speeds, and distances confirmed improved wear resistance in natural fiber-reinforced composites compared to neat epoxy. SEM examination of worn surfaces suggested possible wear mechanisms. Overall, the incorporation of jute, hemp, and flax Fibers significantly enhanced the performance of epoxy-based composites, establishing them as sustainable alternatives for structural and non-structural engineering applications.

Keywords: Mechanical properties, Thermal analysis (TGA/DTA), FTIR spectroscopy, X-ray diffraction (XRD), Dynamic Mechanical Analysis (DMA), Tribological behavior

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Comparative analysis of Finite Element and Regression Models for Predicting Impact Resistance in Fatigue-Damaged Glass Fiber Reinforced Composites

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ABSTRACT

This research investigates two predictive frameworks of finite element (FE) simulation and empirical regression modelsfor estimating the impact resistance of fatigue-damaged Glass Fiber Reinforced Composites (GFRCs). The regression approach provided reliable predictions during the initial degradation phase but underestimated resistance under advanced fatigue by nearly 19.8%. In contrast, the FE model successfully captured nonlinear degradation mechanisms such as matrix cracking, delamination, and fiber–matrix debonding, with prediction errors consistently below 5%. Validation against experimental fatigue–impact datasets yielded a Root Mean Square Error (RMSE) of 0.028, indicating close agreement between simulated and observed values. A Mean Absolute Percentage Error (MAPE) of 3.5% further demonstrated the FE model's superior robustness in handling progressive damage. The findings emphasize that model selection must account for damage stage and target application. While regression models may suffice for rapid estimations in routine testing, the FE approach is indispensable for high-reliability sectors such as aerospace and automotive. Moreover, the FE framework can be integrated into predictive maintenance strategies, enabling real-time assessment of structural health and extending the service life of composite components.

Keywords: Finite Element, Regression Models, Fiber Reinforced Composites, Predicting Impact Resistance, Fatigue-Damaged Glass

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Optimization and Performance of Hydrogen–Biodiesel Blends with Cerium Oxide Nanoparticle: A Review

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ABSTRACT

The depletion of fossil fuels and increasing greenhouse gas emissions have accelerated the need for sustainable energy alternatives. Biodiesel, a renewable substitute for diesel, is biodegradable and environmentally friendly but suffers from lower calorific value and weaker combustion properties, limiting large-scale application. Blending biodiesel with hydrogen is a promising strategy, as hydrogen provides high energy density, rapid flame speed, and near-zero carbon emissions. However, challenges such as combustion instability, storage difficulties, and higher NOx emissions persist. Cerium oxide (CeO_2) nanoparticles have shown strong potential to address these issues. Acting as oxygen buffers and oxidation catalysts, they enhance fuel atomization, promote complete combustion, and reduce pollutants such as carbon monoxide, unburnt hydrocarbons, and particulate matter. Studies report improved brake thermal efficiency, reduced specific fuel consumption, and notable emission reductions with optimized nanoparticle concentrations. This review analyzes recent advancements in biodiesel–hydrogen blends with CeO_2 nanoparticles, examining the influence of blend ratios, nanoparticle dosage, and engine operating conditions on combustion efficiency, thermal performance, and emissions. Technical challenges including nanoparticle agglomeration, economic feasibility, and long-term engine durability are highlighted. Future directions emphasize advanced nanoparticle synthesis, improved fuel delivery systems, and large-scale implementation. The integration of hydrogen, biodiesel, and CeO_2 nanoparticles shows significant promise for cleaner, more efficient, and sustainable fuel technologies.

Keywords: Hydrogen–biodiesel blends, nanoparticle, Combustion, optimization

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AI-Smart Plant Health Monitoring System Using Deep Learning

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ABSTRACT

The Smart Plant Health Monitor is developed to assist farmers in remotely monitoring plant conditions and identifying diseases early. This project proposes the Deep learning (DL) models within a cloud-based system. This methodology involves collecting environmental data such as temperature, humidity, and soil moisture through simulated or physical sensors. A camera module is used to capture or provide plant leaf images. All data is sent to a cloud platform such as Firebase or Thing Speak. A trained Convolutional Neural Network (CNN) model analyzes these images to detect plant diseases. The processed results, along with live environmental data, are displayed on a web or mobile dashboard. This dashboard visually represents real-time graphs and provides prediction results such as “Healthy” or “Disease Detected.” The final output includes a user-friendly interface for live monitoring, disease classification, and automatic alerts when sensor values cross a threshold or when a disease is detected. This solution empowers farmers to take timely action, reduce crop loss, optimize resources, and promote precision agriculture in a cost-effective and scalable manner.

Keywords: Deep Learning, Cloud Computing, Plant Disease Detection, Smart Agriculture, CNN, Real-Time Monitoring, Precision Farming, Dashboard, Firebase.

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AI Resume Classifier: Automating Candidate Screening for Modern Recruitment

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ABSTRACT

Automation plays a vital role in the mechanical field by converting time-consuming and repetitive tasks into efficient, error-free processes that save both time and resources. Through smart pattern recognition, large volumes of engineering data—such as design outputs, testing results, and maintenance logscan be quickly sorted to highlight key insights, detect irregularities, and predict potential failures. This reduces manual delays and ensures smoother workflows, allowing engineers to focus more on innovation, problem-solving, and optimisation. By eliminating redundant steps and reusing validated information, automation enhances consistency in design, analysis, and manufacturing tasks. Furthermore, clean and structured data flow supports better decision-making, improving planning for preventive maintenance, resource allocation, and quality assurance. Automated systems continuously learn from feedback, becoming more accurate and adaptable to different project requirements over time. For the mechanical field, this results in faster project execution, improved reliability, and more efficient use of resources, strengthening overall performance and innovation.

Keyword: Automation, Time-consuming, Smart Pattern Recognition, Sorting, Decision-Making, Redundant, Mechanical field.

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Quantifying Physical Strain and Posture Risks in Formwork Labourers Through Ergonomic Analysis

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ABSTRACT

In the construction industry, formwork laborers frequently engage in physically demanding tasks, placing them at high risk of musculoskeletal problems. Repetitive handling of heavy formworks and working in uncomfortable postures further elevate this risk. This study evaluates the postural hazards and physical strain of formwork labourers using standardized ergonomic tools such as REBA (Rapid Entire Body Assessment), RULA (Rapid Upper Limb Assessment), and the RPE (Rating of Perceived Exertion) scale.The research analyzed the duties of 42 labourers performing activities such as carrying, lifting, and positioning form panels. Results showed that 72% of workers fell into high to extremely high-risk categories based on REBA scores, indicating an urgent need for ergonomic interventions. RULA analysis revealed that 68% of upper limb postures were in the medium to high-risk category, suggesting long-term susceptibility to musculoskeletal disorders, particularly in shoulders, elbows, and wrists. The average RPE score was 14, reflecting “rather hard” workload. The main contributors to increased physical strain were heavy manual lifting and prolonged bent postures during shuttering works. Recommended interventions include mechanical aids for lifting, workstation redesign to reduce stooping, and training programs to correct posture. Overall, the study highlights the urgent need for ergonomic redesign in construction to protect formwork labourers’ health and ensure a safer working environment.

Keywords: RULA, REBA, RPE, Ergonomic, Musculoskeletal Diseases

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Biodegration of Microplastics using Consortia of Bacterium

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ABSTRACT

Microplastic contamination has become an urgent worldwide issue because plastic particles less than 5 mm in size are persistent, toxic, and bioaccumulative. Traditional physical and chemical treatment methods are generally ineffective, economically expensive, and not environmentally friendly. Microbial biodegradation, however, is a viable sustainable option. Single bacterial strains like *Pseudomonas, Bacillus, Rhodococcus, and Streptomyces* have been shown to degrade polymers but are usually limited by their narrow enzymatic range, typically limiting their efficiency. Current studies focus on the use of bacterial consortia, in which several strains operate in synergy with one another, providing complementary enzymatic pathways and improved metabolic cooperation. This review touches upon the processes of microplastic degradation using bacterial consortia, crucial enzymatic machinery engaged, and the impact of environmental parameters on efficiency of degradation. It also explores recent developments in isolation of efficient microbial consortia, optimization protocol, and bottlenecks in scaling up biodegradation strategy. Last but not least, the review indicates existing knowledge gaps and future research directions, which include genetic manipulation, metagenomic strategies, and bioreactor-based systems for remediation at large scales. The use of bacterial consortia is a green and scalable approach to prevent microplastic pollution, enabling environmental rehabilitation and global sustainability targets.

Keywords: Microplastics, Biodegradation, bioaccumulation, environmental factors

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Edventure: A Gamified Learning Platform

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ABSTRACT

E-learning has evolved from static digital content to interactive platforms, transforming the way learners access knowledge beyond traditional classrooms. While this shift has improved accessibility and flexibility, current systems often remain limited to theoretical instruction and struggle to effectively address practical or sensitive topics, particularly for pre- and post-teen learners. Edventure is a gamified learning platform designed by combining story-based modules with interactive game mechanics to deliver age-appropriate, engaging, and meaningful learning experiences. Practical subjects, such as agriculture, are introduced through experiential storytelling, while sensitive areas, such as personal and health education, are addressed through guided narratives that ensure safety and comfort. To further support learners, an AI-powered assistant with Natural Language Processing (NLP) enables real-time doubt clarification, fostering curiosity and confidence. By merging storytelling, gamification, and intelligent assistance, Edventure offers an inclusive and adaptive approach to enhance engagement, understanding, and retention in modern digital education.

Keywords - E-learning, gamification, story-based learning, NLP, youth engagement, interactive education

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Nano-Engineered Additives for Biodiesel: A Review of Recent Developments and Future Prospects

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ABSTRACT

The growing demand for sustainable and cleaner energy sources has positioned biodiesel as a viable alternative to conventional fossil fuels. However, limitations such as poor oxidative stability, high viscosity, and suboptimal combustion characteristics hinder its large-scale adoption. Recent research highlights the potential of nano-additives as effective modifiers to overcome these drawbacks and enhance biodiesel performance. This review synthesizes findings from recent studies on the role of metallic, metal oxide, and carbon-based nanoparticles in biodiesel applications. Nano-additives have been shown to improve fuel atomization, accelerate combustion kinetics, and promote more complete oxidation, leading to significant reductions in emissions of carbon monoxide, unburned hydrocarbons, and particulate matter. At the same time, enhanced thermal conductivity and catalytic activity contribute to improved engine efficiency and fuel economy. Furthermore, nanoparticles have demonstrated the ability to stabilize biodiesel blends by reducing phase separation and improving long-term storage characteristics. Despite these advantages, challenges remain regarding cost-effectiveness, dispersion stability, potential toxicity, and environmental impacts associated with large-scale nanoparticle utilization. This review emphasizes that while nano-additives present a promising pathway to address biodiesel's performance and sustainability challenges, further systematic investigations are necessary. Future research should focus on optimizing nanoparticle concentration, surface modification, and dispersion techniques to balance efficiency gains with safety and economic feasibility.

Keywords: Biodiesel, Nano-additives, Emissions, Performance, Stability

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ICRTME25-186

Dual Cloud Access on Alexa and Google Home Automation

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ABSTRACT

This article discusses the idea of dual cloud access with an emphasis on Google Home and Amazon's Alexa in home automation systems. These gadgets can do a lot of things, including playing music and controlling other smart devices in our homes, thanks to their sophisticated AI algorithms. Still has to be done, though, is controlling and granting access to these devices via different cloud systems. In light of Google Home and Alexa automation, this essay explores the idea of dual cloud access. Most of the automation functionality for these devices are provided by Amazon Web Services (AWS) and Google Cloud Platform (GCP). For dual cloud access to be enabled, the smart device has to be configured to communicate with both AWS and GCP. Dual cloud access provides some benefits, but it also has drawbacks. These include possible security issues, increased costs, and more complexity in managing and synchronising the two platforms.

Keywords: Amazon Web Services, Google Cloud Platform, Redundancy, APIs, Security.

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Comparative Study of Numerical Methods for Dynamic Analysis of a Single-Link Flexible Manipulator

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ABSTRACT

Solutions with accuracy and stability are essential for numerical analysis of complex dynamic systems. In this paper Forward-Euler and Runge-Kutta 4th order method is considered for solving the dynamic equation of single link manipulator incorporating both rigid and flexural behaviours. The dynamic equation of second order type is developed based on finite element method. The dynamic characteristics of flexible manipulator such as hub velocity, hub angle, residual motion and end point displacement for a given torque profile is simulated. The performance of each numerical method is evaluated for different step size values. This paper also highlights the significance of using the open-source C++ platform to solve complex dynamic systems, as opposed to commercial software like MATLAB, with validation of the obtained results.

Keywords: Flexible manipulator, Forward-Euler, Fourth order Runge-Kutta, C++

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ICRTME25-188 **Mechanical Production of Epoxy Composites Dispersed in Jute Fiber and ZrO2 Nano Particles**

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ABSTRACT

The mechanical characteristics of zirconia nanoparticle-containing jute fiber reinforced composites based on epoxy resin matrices are examined in this study. Three stages of zirconia nanoparticle synthesis were carried out, and they were included into the composite at varying weight percentages of fiber-resin. The composites' hardness, impact resistance, tensile strength, and flexural strength were all evaluated. To maximize the outcomes, the Taguchi signal-to-noise ratio technique was used. The study's findings show that adding zirconia nanoparticles considerably enhances the mechanical characteristics of composites reinforced with jute fiber. As the amount of zirconia nanoparticles in the composites grew, so did their tensile and flexural strengths. The results obtained from research have significant applications for the automobile and aircraft industries, which necessitate materials with high performance. The integration of jute fibers and zirconia nanoparticles into composites could lead to a sustainable and eco-friendly substitute for conventional materials. The enhancement approach used in this analysis may be implemented in improving the mechanical properties of other composite materials.

Keyword : Nanoparticle, Jute-fibre, ANOVA, ANN, Zirconia

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Cloud-Connected Fire Safety Monitoring

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ABSTRACT

In most industries, fire safety equipment is still managed through routine manual checks and scheduled maintenance visits. While this method is widely practiced, it is often slow, labour-intensive, and reactive, leaving room for delays in detecting faults or failures. To overcome these challenges, this paper presents an IoT-based fire safety monitoring system that connects with the cloud, making it possible to track the condition of fire fighting equipment in real time and manage it more efficiently across multiple sites. The system is built around IoT sensors placed on fire extinguishers, hydrant lines, and pumping units to monitor important parameters such as pressure, weight, valve positions, and flow rates. The collected data is transmitted wirelessly to a cloud server, where it is stored and further processed. A web dashboard and mobile application provide users with instant access to equipment health, generate alerts when abnormalities are detected, and suggest timely maintenance actions. Using the cloud as the backbone adds significant value by allowing centralized monitoring of different plants, supporting compliance with safety regulations, and enabling predictive maintenance strategies that reduce downtime. In addition, the use of analytics helps in identifying vulnerable areas and improving overall safety planning. The study highlights how the integration of IoT and cloud technology can shift fire safety from a conventional, reactive approach to a smarter and more predictive framework, contributing to the vision of Industry 4.0 and aligning with sustainability and ESG practices.

Keywords Fire safety monitoring, IoT -based system, predictive maintenance, industry

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Sustainability Based Predictive Fire Safety Systems

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ABSTRACT

In industrial environments, fire safety extends beyond individual equipment to an interconnected network of systems, including fire hydrants, control panels, hose reels, and extinguishers. Fire accidents not only damage assets but also release toxic gases, CO_2, and chemical runoff that contaminate air, water, and soil. By detecting faults early in hydrants, hose reels, and panels, the proposed system reduces the likelihood of uncontrolled fires, thereby minimizing environmental damage. In addition, IoT integration ensures that pumps and hydrants operate efficiently only when required, reducing wastage of firewater and supporting resource conservation. The system integrates sensors and IoT devices across hydrants, hose reels, panels, and extinguishers to continuously monitor parameters such as water pressure, flow rates, valve positions, panel status, and system health. Data is transmitted to a secure cloud platform where analytics detect anomalies, forecast potential failures, and prioritize maintenance interventions. A centralized dashboard and mobile interface provide operators with a unified view of all fire safety systems, enabling rapid decision-making and coordinated responses. Overall, this approach not only enhances reliability and predictive maintenance but also contributes to sustainability and ESG objectives by protecting the environment, safeguarding workers, reducing economic losses, and ensuring transparent compliance with safety standards. This study demonstrates how integrating multiple fire protection systems with IoT-based predictive monitoring creates a smart, sustainable, and industry-ready fire safety framework aligned with the principles of Industry 4.0.

Keywords: Fire safety monitoring, environmental protection, resource conservation, sustainability goals, ESG Objectives.

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AI-Driven Gamified Learning Simulator for Programming Skills in Industry - 5.0 Automation and Smart Manufacturing

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ABSTRACT

In Industry 5.0, where automation, robotics, and smart manufacturing systems dominate, programming skills are essential for engineers to interact with intelligent machines, sensors, and AI-driven systems. However, conventional teaching methods for programming remain theory-heavy and fail to simulate real-world industrial challenges. To address this gap, wepropose a gamified, simulation-based learning platform that immerses learners in a Grand Theft Auto–like virtual city, where each mission integrates programming tasks related to automation and smart systems. programming language corresponds to a dedicated map or zone within the virtual world, structured from beginner to expert levels. An AI/ML-based adaptive engine monitors user performance, analyzes errors, and dynamically adjusts mission difficulty to personalize the learning path. By embedding real-world use-cases such as robotic control, sensor integration, and additive manufacturing, the system transforms programming education into an immersive training tool for Industry 5.0 skill development. This work highlights the potential of gamification, machine learning, and simulation technologies to revolutionize engineering education. The proposed platform not only enhances programming proficiency but also prepares learners for automation-centric careers, bridging the gap between academic training and industrial requirements in the era of smart manufacturing.

Keywords: Gamification, Machine Learning, Industry 5.0, Automation, Smart Manufacturing, AI-driven Learning, Programming Education

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Nanocomposites in Biomedical Applications: Advances, Challenges, and Future Perspectives

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ABSTRACT

Nanocomposites, metallic, comprising polymeric or hybrid nanoparticles are dispersed within the structural matrices, that have emerged as next-generation materials in biomedical science due to their tunable, mechanical,physicochemical and biological functionalities. By synergistically integrating the organic and inorganic nanostructures, also these systems exhibits the superior mechanical reinforcement,surface functionalization, controlled biodegradation and biocompatibility are compared to the conventional biomaterials. And their nanoscale interfacial interactions and customizable surface chemistry are enabled to precise the modulation of cellular responses, and therapeutic outcomes. And also in drug delivery, nanocomposites facilitate the targeted and stimuli-responsive release profiles,that enhancing the bioavailability while mitigating off-target toxicity. In tissue engineering, polymer–ceramic constructs the provided biomimetic scaffolds with hierarchical porosity that supports chondrogenesis, osteogenesis, and soft-tissue regeneration. And also in incorporation of plasmonic, magnetic, or fluorescent nanophases which extends their utility to biosensing, bioimaging, and theranostics, which enables simultaneous diagnostics and their therapy in oncology. For furthermore, nanocomposites are demonstrated with intrinsic antimicrobial activity, immunomodulatory potential, and barrier properties that improves wound healing and the safety of biomedical implants. Despite these advancements, the clinical translation remains hindered by challenges that includes scale-up synthesis, long-term cytocompatibility, biodistribution, and regulatory standardization. In collectively, nanocomposites represent a versatile class of multifunctional platforms with the capacity to regenerative medicine, revolutionize, diagnostics,and personalized therapeutics.

Keywords: Nanocomposites, Biomedical applications, Drug delivery, Tissue engineering, Biosensing, Regenerative medicine.

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ICRTME25-193 **GAMEGRID**

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ABSTRACT

In the rapidly advancing digital age, the sheer volume, diversity, and sophistication of cyber threats have escalated beyond the capabilities of traditional Digital Forensics and Incident Response (DFIR) frameworks. The proliferation of interconnected systems, cloud computing environments, Internet of Things (IoT) devices, and increasingly complex attack vectors necessitates a paradigm shift in how cyber incidents are detected, analyzed, and mitigated. This paper introduces an innovative, next-generation DFIR tool powered by cutting-edge Artificial Intelligence (AI) and Machine Learning (ML) technologies. The tool is purpose-built to provide a robust, scalable, and intelligent framework for real-time cyber defense and digital forensic investigations. The core objective of the proposed system is to automate and enhance the incident response lifecycle—from threat detection and data acquisition to in-depth forensic analysis and post-incident reporting. Leveraging advanced ML algorithms, the system is capable of autonomously identifying suspicious patterns, predicting potential attack surfaces, and dynamically adapting to novel threat signatures. By integrating behavior-based anomaly detection with rule-based indicators of compromise (IOCs), the tool ensures comprehensive coverage across both known and unknown threat landscapes.Key features of the tool include automated memory forensics, disk imaging, live endpoint analysis, and encrypted network traffic inspection, all coordinated through a centralized, user-friendly interface. This interface is designed to support both technical and non-technical stakeholders, offering layered visualization dashboards, customizable alerts, and step-by-step investigation workflows. Furthermore, the system incorporates real-time event correlation across multiple data sources, including system logs, user activity records, and external threat intelligence feeds, thereby enabling holistic situational awareness.

Keywords: Artificial Intelligence, Machine Learning, IoT, DFIR, Gamegrid

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Mechanical Characterization of Concrete with Replaced Shell Ash Aggregates Using ANOVA and Regression Methods

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ABSTRACT

In the pursuit of sustainable construction practices, integrating waste-derived materials into concrete production offers a promising pathway to reduce dependency on natural aggregates. The escalating depletion of river sand has highlighted the urgent need for alternative materials that are both eco-friendly and structurally viable. This study investigates the mechanical and durability performance of concrete incorporating artificial aggregates made from oyster shell ash (OSA) and walnut shell ash (WSA), derived from marine and agricultural waste, respectively. The research aimed to evaluate the feasibility of using OSA and WSA as partial replacements for fine aggregates in artificial aggregates, maintaining a fixed cement-to-sand ratio of 1:2 with constant water content. Artificial aggregates were produced with replacement levels of 0%, 20%, 40%, 60%, 80%, and 100% of OSA and WSA by sand weight. These aggregates were used in M25-grade concrete, and specimens were cured for 7, 14, and 28 days before testing. Mechanical evaluations included compressive strength, split tensile strength, flexural strength, modulus of elasticity, and impact resistance. Durability was assessed through exposure to 3% hydrochloric acid (HCl) and 5% sodium sulfate (Na_2SO_4) solutions for 28 days. ANOVA confirmed the statistical significance of the replacement levels, while regression analysis was used to predict performance trends. Findings revealed optimal mechanical and chemical resistance at 80% replacement, beyond which performance deteriorated. The study concludes that OSA and WSA-based aggregates are effective alternatives, promoting sustainable construction and efficient waste utilization.

Keywords: Oyster Shell Ash (OSA), Walnut Shell Ash (WSA), Artificial Aggregates, Sustainable Concrete, Mechanical Properties, Durability Performance, Regression and ANOVA Analysis

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Design and Fabrication of a Thermoelectric Cooling System Using Peltier Modules for RO Applications

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ABSTRACT

This work presents the development of an automated smart water-cooling system designed to protect reverse osmosis(RO) membranes from thermal damage caused by high inlet water temperatures exceeding 45°C. The system integrates six Peltier modules (TEC1-12706) with a custom-designed aluminium heat exchanger housing a 4.5-meter copper coil. An Arduino Nano based control system provides real-time temperature monitoring and automated operation through DS18B20 temperature sensors, solenoid valve control, and OLED display interface. The system demonstrates effective cooling performance, reducing inlet water temperature from 43°C to 25°C at the outlet when the cooling medium is maintained at 20°C. The automated cycling operation ensures consistent outlet temperatures below 35°C, there by extending RO membrane lifespan and enhancing overall system efficiency. With a total cooling power of 432W and automated temperature-triggered operation, the system provides a practical solution for both industrial and domestic RO applications. The work validates the effectiveness of combining thermoelectric cooling with intelligent automation for thermal management in water purification systems.

Keywords: Peltier modules, RO membrane protection, smart cooling system, Arduino automation, thermo electric cooling,

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Smart Home Plant Monitoring System

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ABSTRACT

The rising popularity of home gardening has generated a need for intelligent tools to improve plant health monitoring, moving beyond traditional manual methods which are often inaccurate and cause delayed disease detection. To address this, a Smart Home Plant Monitoring System is proposed that integrates deep learning-based image analysis with a web interface for real-time disease detection in common household plants such as Aloe Vera, Money Plant, Snake Plant, Peace Lily, and Spider Plant. This system allows users to upload plant images via a web application, where a convolutional neural network (CNN) classifies them as Healthy, Rot-affected, or Rust-affected. The results are stored in a database and displayed on a user-friendly dashboard for tracking plant health over time. Experimental evaluations on a curated dataset show promising classification accuracy, confirming the system's feasibility for home plant care. By leveraging computer vision, this cost-effective solution enhances usability and contributes to sustainable urban gardening practices.

Keywords: Home Plant monitoring, Convolutional Neural Network(CNN), Automateddetection.

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Uzhavar Sandhai: A Digital Platform for Direct Connection Between Farmers and Customers

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ABSTRACT

The agricultural sector faces persistent challenges such as exploitation by intermediaries, delayed payments, and lack of direct communication between farmers and consumers. UzhavarSandhai is a digital platform designed to bridge this gap by enabling farmers to sell produce directly to customers. The platform offers features such as online product listings, real-time order tracking, secure payments, and customer feedback. Pilot testing with 50 farmers and 200 customers showed that the platform increases farmers' income, reduces wastage, and enhances access to fresh produce for consumers. The system incorporates regional language support and offline-first functionality to improve accessibility. This paper presents the design, implementation, methodology, and results of Uzhavar Sandhai, highlighting its potential to transform rural agricultural commerce.

Keywords: Digital agriculture, Uzhavar Sandhai, farmer-customer platform, direct marketing, e-commerce, rural supply chain, transparency, income improvement.

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Design, Fabrication and Analysis of Warm Deep Drawing of Stainless Steel Alloy 304

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ABSTRACT

This research explores a novel warm deep drawing process with localized heating and cooling to enhance the formability of metastable stainless steel 304 (SS 304), which is challenging to form using conventional room-temperature methods. The primary objective is to suppress martensitic transformation and increase forming limit strains by conducting tests at elevated temperatures (90, 120, and 150°C), thereby enabling more complex geometries with fewer die progressions. The process was designed to produce a circular cup of 40 mm diameter and 60 mm depth from a 1 mm thick sheet. Experimental and numerical analyses were conducted to determine the Limiting Drawing Ratio (LDR). Results confirmed that warm conditions significantly improved formability, achieving an LDR of 2.0 with an 80 mm blank diameter. This outcome was successfully validated by ABAQUS simulations, which used inputs of material stress-strain data, tool geometry, and a constant blank holder force of 30 kN. The simulations accurately predicted the forming process at room temperature and showed no stress localization, indicating a successful deep draw. The study demonstrates the efficacy of the warm deep drawing technique in improving the drawability of SS 304.

Keywords: Warm Deep Drawing; Stainless Steel 304 (SS 304); Limiting Drawing Ratio (LDR); Sheet Metal Forming; Finite Element Analysis (FEA); ABAQUS; Formability

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Active Learning for Optimizing Interfacial Adhesion in Multi-Material DLP 3D Printing

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ABSTRACT

This paper addresses the challenges of poor interfacial adhesion and material cross-contamination in multi-material Digital Light Processing (DLP) 3D printing, which currently limit the production of high-performance, functional parts. Traditional parameter optimization relies on inefficient trial-and-error methods. As a solution, we propose a data-driven approach using an active learning framework to rapidly predict and optimize bond strength. This framework employs a Gaussian Process Regression (GPR) model to map key print parameters—such as UV exposure time, layer thickness, and material properties—to interfacial adhesion. A critical feature of the GPR model is its ability to quantify prediction uncertainty, which it uses to intelligently select the most informative "next best experiment." This creates a closed-loop system that drastically reduces the number of physical trials required, transforming an expensive, time-consuming process into an efficient and automated workflow. Our results demonstrate that this method significantly accelerates the identification of optimal multi-material printing parameters, leading to improved part quality and paving the way for the broader adoption of multi-material DLP in advanced manufacturing.

Keywords: Multi-material 3D Printing, Digital Light Processing (DLP), Interfacial Adhesion, Active Learning, Gaussian Process Regression (GPR), Process Optimization.

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Effect of Interfacial Geometry on The Mechanical Properties of Rotary Friction Welded AA6063 Joints

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ABSTRACT

This paper is an experimental inquiry on the quality of Rotary Friction Welded (RFW) Aluminium AA6063-T6 joints with interfacial geometry. Four different joint configurations, which are flat-flat, flat-tapered, tapered-tapered, and convex concave were machined on a purpose-built RFW joints at a fixed rate of 1200 rpm and axial force of 3 MPa. The welded joints were tested according to the welding time, axial contractions, hardness distributions and tensile properties the experimental results are revels that the there is a strong relationship between joint geometry and performance of welded joints. The flat-tapered geometry gave the best results, taking the longest time to weld joining time of 7.3 min and the highest material shrinkage value of 3.50%, thus, enabling the best plasticization and bonding of the materials. Hardness profiles verified that the weld region softened in each sample as a result of thermal over-aging. This study identifies joint geometry as a critical parameter in RFW, with the flat-tapered configuration being the optimal choice for achieving high-strength welds in AA6063-T6.

Keywords: Rotary Friction Welding, AA6063, Tensile Strength, Hardness, Welding Parameters, Material Shrinkage

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Statistical Performance Validation of an Embedded PSoC-Based Ball Bearing Fault Detection System

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ABSTRACT

Bearings are critical components in rotating machinery, and their failure can lead to catastrophic system breakdowns and costly downtime. Early detection of localized defects such as those in the inner race, outer race, and rolling elements are therefore indispensable for predictive maintenance. This paper presents the design and statistical validation of a novel, embedded workbench for ball bearing fault diagnosis. The system employs an impulse excitation technique, where a solenoid induces a controlled vibrational trigger, and an accelerometer captures the response. The core implementation leverages a Programmable System on Chip (PSoC) for embedded data acquisition and a LabVIEW-based Virtual Instrumentation workbench for signal processing and analysis. The fault diagnosis is performed by examining the computed power spectrum of the vibration signals. Distinct fault signatures are identified: new bearings exhibit sharp amplitude peaks, outer race defects show a distinct peak rise, inner race defects generate sideband peaks, and ball defects result in a fully distorted spectrum. To rigorously validate the reliability of this approach, a statistical analysis was conducted on four new bearing models (6203-N, 6201-N, 6300-N, 6000-N). The results demonstrate with 95% confidence that the developed smart workbench produces consistent and statistically significant outcomes. The system's performance confirms its accuracy and repeatability, establishing it as a promising and validated tool for the static testing and fault diagnosis of rolling element bearings.

Key word: PSoC, LabVIEW, Ball bearing, Statistical analysis, Fault deduction

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Smart Detection and Defence Against Phishing Attacks Using Machine Learning Algorithm

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Abstract

Phishing attacks remain a dominant cybersecurity threat, exploiting fraudulent websites to steal sensitive user data such as credentials, banking information, and personal identities. Traditional detection approaches are increasingly ineffective due to the fast-changing nature of phishing techniques. To address this gap, we propose Safe Surf, a smart detection and protection system that leverages Machine Learning to identify and block phishing attempts in real time. At its core, the system applies the Random Forest algorithm, an ensemble learning method that constructs multiple decision trees and integrates their results to achieve high predictive accuracy while minimizing over fitting. Sub-domains special characters, HTTPS presence, domain age, and registration validity. The model is trained using benchmark datasets such as Phish Tank and the UCI URL Reputation Dataset, enabling reliable classification of websites as phishing or legitimate. Developed with the help of Python, the system integrates a Flask-powered backend for model inference and a web-based frontend for user interaction. A key component is the inclusion of a “Go Back to Safety” alert page, which is triggered when a phishing website is detected, thereby enhancing end-user security awareness and protection. Experimental evaluations confirm that Safe Surf provides high accuracy, robustness, and scalability, making it suitable for real-world deployment. By combining machine learning, URL feature engineering, and an intuitive web interface, Safe Surf offers an intelligent and practical defence framework against phishing threats, contributing to stronger cybersecurity resilience in digital ecosystems.

Key words: Sub-domains, Algorithm, machine learning, Safe surf, Smart detection

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Hybrid Digital Document Signing and Visual Verification System using Embedded QR Code and Block Chain

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ABSTRACT

Document fraud is a growing global concern, with 43% of organizations reporting incidents in2024, resulting in financial losses and diminished trust. Traditional methods of document authentication face significant limitations: digital signatures are secure but difficult fornon-experts to validate and often require internet access; block chain-based systems ensure high security but are typically slow, costly, and complex; and QR codes offer convenience but lack cryptographic strength and are vulnerable to forgery. To address these challenges, this project introduces a Hybrid Digital Document Signing and Verification System that combines the Elliptic Curve Digital Signature Algorithm and the Secure Hash Algorithm (256-bit) to embed verifiable cryptographic data into machine-readable Quick Response codes. This enables both offline and online verification, where offline checks can be done instantly using a smart phone without internet access, and online validation is supported through a distributed, blockchain-inspired architecture using fragmented storage across Mongo DB database clusters. Developed in Python using cryptographic and web frameworks, the system offers sub-millisecond hash generation and millisecond-level verification performance. It delivers asecure, scalable, and user-friendly solution with key benefits including tamper resistance, privacy preservation, cost-efficiency, offline operability, and resilience against single points of failure. This framework is applicable to a wide range of domains such as academic credential verification, legal document authentication, government paperwork, healthcare records, andsupply chain documentation, and is designed for future integration with immutable block chain platforms and quantum-resistant cryptographic standards.

Key words: Hybrid Document Authentication, Blockchain, Elliptic Curve Digital Signature Algorithm, PyCryptodome, Secure Verification

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Echoes from the Deep: Rebuilding Technology for the Voices of Marine Life Silenced by Plastic

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ABSTRACT

In the recent years we have seen that the accumulation of the plastics in the ocean have caused serious threat to the marine life as well as to human beings. It is said that 11 million metric tons of plastic enters the ocean every year, whether it is macroplastic, it is found in the ocean. The marine animals take up this plastic mistaking it for the food and then leading to the serious injuries starvation and death. The other marine life also gets entangles in plastic waste especially in the fishing nets and packaging rings. Over the years due to accumulation the plastic in the ocean it is found that microparticles are found in the deep-sea sediments, artic ice and even in human blood, which is nearly impossible to remove. Even the countries didn't take necessary action to remove the plastic from the sea because it would be very expensive and it's technically difficult too. And hence it is necessary to take action again it. By referring the past books and the journals has helped us to resolve the issue. There are different types of ideas and innovations like using the floating barriers, with the help of drones locating the garbage patch, Circular blue and Mr. Trash wheel. While studying the topic, the idea of using the vacuum system to evacuate the plastic waste from the ocean was creative and so with the help of the vacuum system and adding little bit of technology to it we thought it would be problem solving to the global issue of the plastic found in ocean. This study concludes that the most cost-effective type of solution tackles land-based sources of marine litter and combines technology with people-oriented practices, runs on own energy sources, connects throughout the plastics value chain with a convincing valorisation plan for captured debris, and involves all relevant stakeholders.

Key words: Microplastics, Marine Environmental, Marine pollution, Aquatic organisms and Human Health

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Investigation of Parametric Blade Angle Optimization in Concave-Bladed Hybrid Vertical Axis Wind Turbines at Ultra-Low Reynolds Number

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ABSTRACT

The aerodynamic performance of Vertical Axis Wind Turbines (VAWTs) at ultra-low Reynolds numbers presents a considerable challenge, particularly in small-scale and urban energy applications where flow conditions are significantly constrained. This study presents a detailed computational analysis of a concave-bladed hybrid VAWT, focusing on the parametric optimization of blade angle to enhance energy capture efficiency. High-fidelity simulations were conducted using COMSOL Multiphysics 6.2, employing the shear stress transport (SST) k–ω turbulence model, which incorporated a rotating domain to accurately capture unsteady flow interactions. Various blade angle configurations were systematically evaluated across ultra-low Reynolds number regimes to assess their impact on torque generation, power coefficient, and the wind turbine's self-starting capability. The results indicate that the optimized blade angles substantially improve the lift-to-drag ratio and enhance the power coefficient at tip speed ratios below 1, where conventional straight-bladed turbines typically underperform. The concave hybrid configuration demonstrated superior starting torque and reduced flow separation compared to traditional VAWT geometries, rendering it a promising option for low-wind-speed environments. These findings offer valuable insights into the aerodynamic behavior of hybrid turbine designs and contribute to the advancement of efficient small-scale wind energy systems suitable for distributed power generation in urban and remote areas.

Keywords: Vertical Axis Wind Turbine (VAWT), Concave Blade, Hybrid Configuration, Blade Angle Optimization, Ultra-Low Reynolds Number, Parametric Study

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A Dual-Domain Approach for Underwater Noise Suppression Using LMS And Wavelet Transform

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ABSTRACT

Underwater acoustic signals are often severely affected by ambient noise originating from natural sources, such as marine life and water currents, as well as human-made sources, including ship engines and underwater machinery. This noise poses significant challenges for applications like underwater communication, sonar detection, and marine data acquisition, making effective noise suppression essential. This project introduces a dual-domain approach for underwater noise reduction that combines the adaptive Least Mean Squares (LMS) filter with Wavelet Transform techniques. In the first stage, the LMS filter operates in the time domain to adaptively minimize noise while preserving the desired signal characteristics. In the second stage, the Wavelet Transform is applied to further suppress residual noise using both hard and soft thresholding methods. Different types of wavelets and threshold estimation strategies are analyzed to achieve improved Signal-to-Noise Ratio (SNR). Simulation results show that the combined LMS and wavelet-based approach provides superior noise reduction, significantly enhancing signal clarity and reliability. This dual-domain technique demonstrates a practical and effective solution for denoising underwater acoustic signals, contributing to more accurate sonar detection, reliable underwater communication, and high-quality marine data collection.

Key words:LMS, Underwater acoustic signals, Dual-domain approach, SN Ratio, Wavelet Transform

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Design and Aeroelastic Analysis of a Bio-Inspired, Composite, Spanwise-Flexible Flapping Wing for Micro Air Vehicles

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ABSTRACT

Flapping wing Micro Air Vehicles(MAV's) utilize Unsteady aerodynamic flow phenomena like wake capture, Leading edge vortices and clap- and – fling mechanism to attain the necessary lift especially at low Reynold's numbers whereas conventional vehicles rely on steady aerodynamics to achieve efficient lift generation. Wing flexibility plays a crucial role in increasing aerodynamic efficiency and reducing structural loading, but the optimal stiffness distribution for MAV wings remains unresolved. In this research, a composite bio-inspired flapping wing with span wise flexibility is designed and analyzed, the wing geometry is designed inspired by insect wings using CATIA v5 and the material used is surface-modified pineapple fibrerein forced with epoxy resin. Aero elastic simulations are performed using coupled computational fluid dynamics (CFD) and finite element analysis (FEA) to capture fluid–structure interaction(FSI) in ANSYS Workbench 2021 R1. The study recognizes favorable stiffness distributions that sustain leading-edge vortices (LEVs), improve thrust efficiency, and reduce structural fatigue. The results obtained in this study provides assistance for future MAV developments.

Keywords: Flapping wing, Aero elasticity, Fluid–Structure Interaction (FSI), Micro Air Vehicles, Composite wing, Unsteady aerodynamics.

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Study of Undesirable Effects in Manufacturing MSMEs through TOC's Logical Thinking Process – Literature Review

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ABSTRACT

The Micro, Small and Medium Enterprises (MSME) sector has emerged as a highly vibrant and dynamic sector of the Indian economy contributing around 30% of India's GDP, over 45% of India's exports. However, Indian Micro, Small, and Medium Enterprises (MSMEs) are continued to face internal operational challenges that hinder their growth and competitiveness. This study focuses on systematically identifying and categorizing the Undesirable Effects (UDEs) that exist within Indian Manufacturing MSMEs using the lens of the Theory of Constraints (TOC) Thinking Process. Through an extensive review of academic literature, government reports, and empirical studies, key internal constraints were extracted, grouped, and classified as UDEs. Using TOC's Thinking Process as guiding principles, the extracted UDEs were assessed for clarity, relevance, and prevalence across sources. This research provides a structured foundation for future work on mapping cause-effect relationships and identifying the core problems within MSMEs. It also contributes methodologically by demonstrating how TOC's thinking tools can be effectively applied in a literature-based exploratory study.

Keywords: Undesirable Effects, MSMEs, Internal Constraints, Theory of Constraints, Literature Review, Indian Manufacturing, Logical Thinking Process

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Design and Fabrication of Smart Aquaculture Using IOT

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ABSTRACT

The rising global population has increased the demand for sustainable seafood production, making aquaculture a vital solution to bridge the gap between supply and demand. However, traditional fish farming practices that rely on manual feeding and monitoring are labor-intensive, error-prone, and often result in poor fish health and reduced productivity. To overcome these challenges, this paper presents an IoT-based smart aquaculture system powered by the Arduino Portenta H7 microcontroller. The proposed system integrates two main modules: an automated feeding mechanism and a water quality monitoring unit. The feeding module employs electromechanical components such as spiral screw gear motors, relays, and a real-time clock (RTC) to dispense accurate amounts of feed on schedule or remotely via a web interface. The monitoring module uses sensors for pH, temperature, turbidity, ammonia, humidity, and fish motion detection to ensure real-time environmental assessment. Data are transmitted through wireless communication (LoRa/Wi-Fi) and visualized on the Cayenne IoT platform, enabling farmers to remotely control feeding parameters and monitor pond conditions. The system is powered by solar panels, ensuring energy efficiency and sustainability. Experimental results show that the system achieved high accuracy in feed scheduling, reliable monitoring of water parameters, and effective power management. The proposed solution provides a low-cost, scalable, eco-friendly, and user-friendly smart aquaculture model, offering improved fish health, optimized productivity, and sustainable aquaculture practices.

Keywords: IoT platform, Aquaculture, LoRa, RTC

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Design and fabrications of Green Technologies for the Conversion of Biomass and Waste into Reducing Sugars and Biofertilizers

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ABSTRACT

Converting lignocellulosic biomass into reducing sugars is a sustainable way to produce valuable products like amino acids, biofuels, and vitamins. To do this efficiently, the biomass needs pretreatment to break down its complex structure, making it easier for enzymes to work. Common pretreatments use dilute sulfuric acid (acidic) or sodium hydroxide (alkaline) to improve enzyme access. Enzymatic hydrolysis and careful control of conditions can further boost sugar yield. In addition, sugarcane bagasse and landfill leachate have been used to make biofertilizers through vermicomposting. In one study, a 1:1 ratio of soil to bagasse (V2) gave the highest NPK nutrients and best growth in onion plants. Another field study tested blotong bio-compost on sugarcane and found that applying 20 tons per hectare greatly improved plant height, number of leaves, tillers, and stem thickness. These studies show how agricultural and waste materials can be used effectively in sustainable sugar and fertilizer production.

Keywords:NPK nutrients, Green Technologies, biomass, sugarcane bagasse

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Design and fabrication of Moisture Sensing Mulch Sheet Using Waste Banana Fiber

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ABSTRACT

In water-stressed areas, mulching is a tried-and-true method of lowering soil evaporation and improving crop development. According to earlier research, organic mulch sheets composed of water hyacinth, rice straw, and banana pseudo stem offer soil enrichment, durability, and tensile strength. Building on this, the current study suggests utilizing leftover banana fiber to create a moisture-sensing mulch layer. When the sheet is dry, a sensor senses the change in color and starts watering; when the soil gets wet, irrigation automatically ceases. Water-retention effectiveness, biodegradability, mechanical strength, and sensor accuracy will all be assessed in lab and greenhouse experiments. This method offers a low-cost, environmentally friendly way to improve precision irrigation techniques and avoid over-irrigation by combining biodegradable mulch with smart sensing.

Keywords: Greenhouse, Banana Fiber, Moisture Sensing, Mulch Sheet

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Hybrid Pothole Detection Using YOLO and Contour-Based method

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ABSTRACT

Potholes are an important driver of vehicle pare loss and road crashes;thus effective vehicle pothole detection systems are needed to improve road safety. Traditional pothole detection can be inefficient, time-consuming, and can use manual-based inspections. Furthermore, with advances in computer vision techniques, automated and scalable pothole detection systems can be developed. This project demonstrated a hybrid approach to pothole detection by using YOLO-based object detection and contour-based post-processing to localize potholes. This project utilized a custom dataset of road surface images that were annotated in the YOLO format. The YOLO model detects a bounding box of a potential pothole and contouring improves the area-specific boundaries within YOLO bounding boxes. The hybrid model, demonstrating a high number of correctly identified potholes with a lack of false positives. Nevertheless, there were still some challenges for pothole detection including shadows, water patches, and cluttered backgrounds that impacts the robustness of the pot hole detection. Overall, this hybrid-based approach has good potential for real-time deployment in an intelligent driver-assistance system and can be developed with lane masking, depth filtering, and improved datasets.

Keywords: YOLO, Object detection, Contour-based, Hybrid Pothole Detection

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Wireless Stress Monitoring Alert System for Underwater and Isolated Units

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ABSTRACT

Monitoring physiological stress in confined environments is crucial for ensuring the safety and efficiency of individuals operating under extreme conditions, such as submariners, divers, and underwater researchers. This project presents the design and development of a real-time stress monitoring system based on electrocardiogram (ECG) signal analysis. The proposed system acquires ECG signals using embedded sensors and applies signal preprocessing techniques to eliminate noise and artifacts. Key heart rate variability (HRV) features are extracted to evaluate stress levels, which are then classified using machine learning algorithms for reliable stress detection. The system is designed with a compact embedded architecture optimized for isolated underwater units, ensuring portability and low power consumption. Python and MATLAB software technologies are used for denoising and feature extraction processes. Experimental validation demonstrates the feasibility of accurate stress monitoring in simulated confined environments, highlighting its potential to enhance occupational health, prevent accidents, and improve decision-making in critical underwater operations. This work contributes to the growing domain of wearable healthcare technologies, particularly for specialized and high-risk professions.

Keywords: ECG, MATLAB, HRV, Underwater, Python

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Design and Implementation of End to End Data Encryotion for 5G NR Using Lightweight Cryptography

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ABSTRACT

The rapid evolution of 5G New Radio (NR) technology, ensuring data confidentiality and integrity across all communication layers has become a critical challenge. This project presents the design and implementation of an end-to-end data encryption framework tailored for 5G NR systems using lightweight cryptography. Traditional encryption schemes, while secure, often incur high computational and energy costs, making them unsuitable for resource-constrained 5G devices such as IoT nodes and mobile terminals. To address this, the paper explores lightweight cryptographic algorithms that offer a balance between security, speed, and energy efficiency.The proposed system integrates lightweight encryption at both the user equipment (UE) and the core network, ensuring secure transmission over the 5G air interface. Key algorithms such as ASCON and ASCON 128a are evaluated based on parameters like throughput, latency, memory usage, and power consumption.For simulation MATLAB tool is used. A prototype is developed using hardware simulation tools and network simulation platforms to validate the effectiveness of the encryption process within a typical 5G NR architecture.Results demonstrate that lightweight cryptographic techniques can provide robust security with minimal performance overhead, making them suitable for next-generation wireless communication systems. This project contributes to enhancing the security layer of 5G while maintaining the ultra-low latency and high-speed requirements of the standard.

Keywords: ASCON, MATLAB, 5G, ultra-low latency, Lightweight cryptographic algorithm

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Qualifying Vulnerability: Using Oshi and Mwasto Correlate Welfare Access with Workplace Safety Among Migrant Workers

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ABSTRACT

This study presents an extensive analysis of the safety and welfare conditions of migrant workers in Tamil Nadu, particularly urban areas applying an integrative framework dependable in rights of labors, occupational health standards and their socio-economic labor rights, occupational health standards, and socio-economic accessibility. This methodological triangulation integrates both the qualitative data from key stakeholder's interviews and quantitative data collected from structured survey. The stakeholders involved in this study are industry laborers, Labor department officials, Construction Managers, Project Managers and NGOs. The Quantitative data were examined using SPSS software for Descriptive statistics, logistic regression and correlation matrices for identifying the main determinants influencing welfare access and workplace safety. To analysis the data in better way, Occupational Safety and Health Index (OSHI) and Migrant Welfare Access Score (MWAS) were assessed to standardize comparisons amount the sectors. The analyzed data have been spatially analyze to determine the clusters of vulnerability by using GIS mapping. A considerable majority of respondents of 68% (labors) were found to be living in the housing which exceeds the occupancy limit suggested by Bureau of Indian Standards (BIS), an overcrowded standard. About 53% of workers were lacking in their basic health insurance coverage under Employee State Insurance Scheme (ESI) or any other form of health insurance. Nearly 46% workers were lacking in safe environment, as the site does not operate with mandatory provision of Personal protective equipment (PPE). Through Regression analysis, it is clear that there is a direct and statistical significance between the lack of welfare access and workplace safety. The laborers whose score is below 0.4 in MWAS were found to be 3.8 times more likely to encounter a workplace accident with high correlation ($p<0.01$).

Keywords: MWAS, OSHI, SPSS software, State Insurance Scheme, Migrant Welfare Access Score

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Evaluation of Thermal Stability of Aluminium Composites Reinforced with Carbon Nanotubes

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ABSTRACT

This work focuses on the evaluation of thermal stability of aluminium matrix composites reinforced with carbon nanotubes (CNTs). Aluminium, widely used for its lightweight and corrosion resistance, often requires reinforcement to enhance its mechanical and thermal properties. Carbon nanotubes, owing to their exceptional strength, high thermal conductivity, and stability, serve as an ideal reinforcement material. In this study, aluminium–CNT composites were fabricated using powder metallurgy techniques to ensure uniform dispersion of nanotubes within the matrix. The samples were subjected to thermal stability analysis using thermo gravimetric analysis (TGA) and differential scanning calorimetry (DSC). Results revealed that the addition of CNTs improved thermal resistance by reducing degradation rates and enhancing heat dissipation. The composites demonstrated better structural integrity at elevated temperatures compared to pure aluminium. This improvement makes aluminium–CNT composites promising candidates for aerospace, automotive, and electronic applications where both lightweight and high thermal stability are critical.

Keywords: Rotary Friction Welding, AA6063, Tensile Strength, Hardness, Welding Parameters, Material Shrinkage

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Leveraging Artificial Intelligence in PredictiveAnalytics of Human Resources Recruitment

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ABSTRACT

The rapidly developing field of Predictive Analytics in HR is revolutionising the way HR decisions are made by utilising artificial intelligence and data-driven decision-making. HR workers can now make more informed and strategic decisions by using machine learning techniques and advanced algorithms to forecast future events with better accuracy. HR departments can use predictive analytics to discover high-potential recruits, predict employee attrition, and even foresee future skill needs within the company. This insightful knowledge enables HR directors to proactively create succession plans, focused training initiatives, and retention tactics to fill possible skills shortages. Moreover, HR may optimise hiring procedures through predictive analytics by pinpointing the best places to find talent, refining the candidate selection procedure, and strengthening workforce planning as a whole. HR can maximise employee productivity, improve overall business performance, and connect their strategy with organisational goals by leveraging AI and data-driven insights. Organisations may make data-driven decisions that result in better hiring results, more employee engagement, and improved work delivery by incorporating AI and predictive analytics into their HR processes. Predictive analytics helps organisations anticipate future requirements and make quick decisions based on real-time data.

Keywords: Blanking tool, Press tool design, Sheet metal, Punch and die, EDM machining, Fabrication.

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Moodmap Personalized Tuneflix with Emotional States

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Abstract

This paper presents "MoodMap TuneFlix," a novel framework that integrates real-time emotion recognition and contextual localization to personalize music therapy. Moving beyond static playlists, our system leverages multimodal affective computing—analyzing physiological signals, facial expressions, and vocal cues—to dynamically assess a user's emotional state. By incorporating localization data, the system further adapts therapeutic interventions to the user's immediate environment, ensuring contextual relevance. This emotional and contextual profile drives a machine learning engine that curates or generates music in real-time, tailored to the individual's current mood, psychological needs, and therapeutic objectives. The proposed framework bridges the gap between traditional music therapy and intelligent healthcare technologies, offering a scalable, adaptive solution designed to enhance user engagement, promote stress reduction, and support long-term emotional well-being.

Key words: Personalized Music Therapy, Real-time Emotion Recognition, Multimodal Affective Computing, Context-aware Therapy, Intelligent Healthcare

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Personalized Music Therapy with Emotion

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Abstract

Personalized music therapy has gained significant attention as a non-invasive and effective method for improving mental well-being, emotional regulation, and cognitive health. This research focuses on integrating emotion recognition and localization techniques to enhance the personalization of therapeutic interventions. By leveraging advanced machine learning models and affective computing, real-time emotional states are detected through physiological signals, facial expressions, and voice analysis. Localization further enables the system to adapt therapy delivery based on the user's environment, ensuring contextual relevance. Once emotions are accurately identified, the system dynamically recommends or generates music tailored to the individual's current mood, psychological needs, and therapeutic goals. This adaptive approach enhances user engagement, promotes stress reduction, and supports long-term emotional balance. The proposed framework bridges the gap between traditional music therapy and intelligent healthcare technologies, offering a scalable, personalized, and context-aware solution for mental health care and emotional well-being.

Key words: Emotion Recognition, Mental Well-being, Context-aware, Adaptive Therapy, Affective Computing.

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Optimization and Experimental Investigation of TIG Welding Process Parameters on Medium Carbon Steel Using Taguchi Method

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ABSTRACT

Tungsten Inert Gas (TIG) welding is extensively utilized for its capacity to generate high-quality welds with exceptional precision and control. The quality and mechanical performance of the weld are significantly affected by the appropriate selection of process parameters. This study utilized medium carbon steel as the basic material and conducted an optimization analysis to identify the optimal process parameters for TIG welding. Key parameters were selected and incorporated into nine experimental runs (L9 orthogonal array) utilizing Design of Experiments (DOE) in Minitab software. Each parameter configuration was utilized to weld the samples, subsequently followed by mechanical testing, including hardness and impact strength assessment. Furthermore, Non-Destructive Testing (NDT) was performed utilizing the liquid penetrant method to evaluate surface imperfections. The experimental findings were evaluated and contrasted to determine the optimal parameter combinations. Numerical research utilizing the Taguchi approach was conducted to assess the signal-to-noise ratio and identify the ideal parameters for enhancing weld quality and mechanical strength. The research offers a methodical strategy for optimizing process parameters in TIG welding, consequently improving the structural integrity and longevity of medium carbon steel welds.

Keywords: Tungsten Inert Gas, DOE, NDT, L9 orthogonal array, Carbon Steel

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Design and fabrication of Mind-Controlled Robotic ArmUsing Brain-Computer Interface (BCI)

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ABSTRACT

The convergence of automation, robotics, and neuroscience has paved the way for revolutionary human–machine interactions, where machines can be controlled not only by physical interfaces but also directly by human thoughts. This project focuses on the development of a Mind-Controlled Robotic Arm using a Brain-Computer Interface (BCI). The central objective is to assist physically disabled or paralyzed individuals in controlling robotic devices through their brain activity, thereby restoring independence and creating a new dimension of assistive technology. This project demonstrates the immense potential of Brain-Computer Interfaces in reshaping automation and robotics. By directly merging neuroscience with robotics and artificial intelligence, it sets a foundation for a future where machines respond directly to human thoughts. Such systems can transform healthcare, industry, defense, and space exploration, redefining how humans interact with technology in the era of advanced automation. The fabrication with microcontroller, motors, actuators, robotic arm microcontroller and sensors are experimented in this project. The microcontroller acts as the central hub, transmitting the instructions to the motors and actuators of the robotic arm. As a result, the robotic arm executes the desired movements in real time, effectively creating a seamless bridge between human brain activity and robotic action.

Keywords: Robotic arm, Brain Computer Interface, Microcontroller, Actuator

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Development of NiTi Shape Memory Alloy Fiber Embedded Smart Adhesives for Thermally-Induced Debonding

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ABSTRACT

The demand for reversible and reconfigurable bonding systems is growing rapidly in sectors such as aerospace, automotive, and electronics, where modularity, reparability, and structural efficiency are essential. Traditional structural adhesives provide strong and permanent bonding but lack mechanisms for controlled disassembly or reusability. This research presents the development of a novel class of smart adhesives embedded with Nickel-Titanium (NiTi) shape memory alloy (SMA) fibers to enable thermally/electrical induced, on-demand debonding. Key experimental investigations include the effect of SMA fiber content, alignment, and activation temperature/electrical on the mechanical strength, interfacial integrity, and reusability of the adhesive system. Characterization techniques such as differential scanning calorimetry (DSC), scanning electron microscopy (SEM), dynamic mechanical analysis (DMA), and shear-lap testing are used to quantify thermal/electrical response, microstructural behavior,and bond performance before and after delamination cycling.The results reveal that SMA fiber-embedded adhesives can achieve repeatable debonding and re-bonding cycles with minimal degradation in mechanical performance, while also exhibiting stable thermal/electrical behavior.These smart adhesives demonstrate significant promise for use in high-performance engineering structures that require serviceability, lightweight construction, and sustainable material use through joint reusability.By bridging the principles of smart materials and adhesive technology,this research contributes a scalable, material-based solution for adaptive bonding, opening new directions in the design of intelligent and repairable structures.

Keywords: NiTi Shape Memory alloy, SMA fiber, SEM, DSC, Smart materials

ICRTME25-223

Soil Moisture and Crop Management using Machine Learning and Embedded System

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ABSTRACT

Traditional agricultural practices often rely on manual observations and fixed irrigation schedules, leading to inefficient water usage, reduced crop yields, and limited scalability. Farmers lack real-time data-driven insights to make timely decisions regarding irrigation and crop health. The absence of automation and predictive analysis in rural farming contributes to inconsistent productivity and wastage of resources. This paper aims to solve these challenges by designing an intelligent soil moisture and crop management system that uses embedded systems to collect environmental data such as moisture, temperature, and humidity and employs machine learning models to analyze this data and predict irrigation needs. It improves water usage efficiency, promotes sustainable farming practices, and reduces human efforts. The embedded system is designed to be compact, low-power, and user-friendly, supporting both offline and online operation modes. For remote monitoring, data is transmitted via Wi-Fi or GSM modules to a mobile application interface, where farmers can view insights, receive alerts, and manually override automatic irrigation systems if needed. Methodology of this paper is approached to precision agriculture through the development and integration of an advanced agricultural sensor. This paper showcases how combining of AI and IOT technologies can transform traditional agriculture into a smarter and resource-efficient.

Keywords: Machine Learning, Embedded System, GSM, Artificial Intelligence, Internet of Things.

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ICRTME25-224

Real-Time Pothole Detector using Smartphone

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ABSTRACT

Potholes on roads are a major cause of vehicle damage, traffic congestion, and accidents, especially in urban areas. Traditional pothole detection relies on manual inspection, which is time-consuming and inefficient. This project proposes a real-time pothole detection system using smartphones that combines computer vision and sensor-based analysis. The smartphone camera captures live road images, processed using a lightweight deep learning model (YOLOv5s) optimized with TensorFlow Lite for mobile deployment. Additionally, accelerometer and gyroscope sensor data are used to enhance detection accuracy by distinguishing potholes from normal road bumps. The system provides instant alerts to drivers and records pothole location using GPS for reporting to authorities. Experimental results show that the model achieves high detection accuracy with low computational cost, making it feasible for real-time use. This approach offers a scalable, cost-effective, and user-friendly solution to improve road safety and assist in urban infrastructure management.

Keywords: pothole detection, smartphone, YOLO, accelerometer, computer vision, real-time system.

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Automated Residential Floor Plan Generation using Rule-Based AI and Geometric Computation

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ABSTRACT

The increasing demand for rapid and accessible preliminary design tools in the AECO(Architecture, Engineering, Construction, and Operations) industry underscores the significance of automating traditionally manual processes. This project introduces a Rule-Based AI-driven system for the automated generation of 2D residential floor plans. The system's input module accepts high-level parameters including lot dimensions, a program specifying the number and type of rooms, budget constraints, and a stylistic heuristic. The core computational engine first performs a geometric and financial validation by calculating the net usable area and cross-referencing this against a dynamic cost estimation model to ensure project feasibility within the specified budget. A sequential layout algorithm, governed by a set of architectural rules, then computationally arranges polygonal room volumes, automatically generating circulation paths. This process also includes the strategic placement of access points (doors) and openings (windows) based on spatial relationships and predefined rules for natural light and ventilation. The final output is a structured 2D floor plan schema, compatible with standard CAD and documentation formats. A comparative analysis demonstrates that while traditional CAD software offers superior parametric control and high-fidelity output, this proposed methodology significantly reduces the iterative design cycle time and lowers the barrier to entry, making it an effective tool for conceptualization and rapid prototyping in the early-stage design workflow.

Keywords: Floor Plan Generation, Computational Design, Rule-Based Systems, Geometric Algorithms, Architectural Automation

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Study And Analysis of Camshaft Used in Locomotive (TRAIN)

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ABSTRACT

A cam is a mechanical member used to impart desired motion to a follower by direct contact. The cam may be rotating or reciprocating whereas the follower may be rotating, reciprocating or oscillating. Cams are widely used in automatic machines, internal combustion engines and other control mechanisms. They are manufactured usually by die – casing, or punch presses.The locomotive shaft contains three cams with single shaft. The three cams doing different function during rotating. The first cam controls the high compressed air inlet and outlet, another cam controls the fuel inlet and outlet, third cam controlling the exhaust, during the continuous rotation of the locomotives engine runs properly. If the camshaft rotates with continues load it tends to vibrate, that vibration should not exceed the natural frequency of the shaft. The each and every rotation of the cam some force act on the cam due to that force the camshaft tends to have deformation. If the deformations exceed some limit that will affect the whole function of the engine, so in this project mainly concern with the prediction of Deformation and Stress during running of the engine. The camshaft modeled can be developed using Pro/E wildfire3 software and then the prediction of deformation and stress using analysis software ANSYS 8.1.

Key words: Camshaft, Locomotive (Train), Pro/E wildfire3 software and analysis software ANSYS 8.1

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Crowd sourced Blood Donation App using Firebase and GPS

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ABSTRACT

The Crowd sourced Blood Donation App is designed to solve the critical problem of blood shortages during medical emergencies by leveraging modern mobile and cloud technologies. In many cases, patients face life-threatening delays because traditional systems rely on manual donor lists or hospital blood banks, which may not have immediate availability. This project introduces a real-time mobile platform that connects recipients directly with nearby verified donors, enabling faster and more reliable access to blood. Built using Flutter for cross-platform development and Firebase for backend support, the app ensures secure user authentication, real-time data storage, and instant push notifications. GPS integration allows the system to identify eligible donors within a specific radius and alert them immediately when a request is made. The app's functionality includes user registration, donor-recipient role selection, geo-tracking, and real-time notifications, all integrated into a user-friendly interface. By promoting voluntary donation and reducing dependency on centralized blood banks, the system creates a community-driven solution that directly impacts healthcare delivery. This project demonstrates how technology can address critical gaps in emergency response, ensuring that lifesaving resources are delivered at the right time. Scalable and socially relevant, the app represents an innovative step toward building a more responsive and connected healthcare ecosystem.

Keywords: Crowd sourced, Blood Donation, App, Firebase, GPS

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Food Nutrition Detection Using Image and Sensor –Based Onscanning Techniques

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ABSTRACT

In today's health-conscious society, accurate and real-time nutritional analysis of food is essential for promoting better dietary habits. This mini project presents a system for food nutrition detection using advanced image processing and sensor- based technologies. The proposed system scans food items through a camera or sensor module and estimates their nutritional content, including calories, carbohydrates, proteins, fats, and vitamins. The core technologies involved include computer vision, machine learning, and spectroscopy. Image recognition is employed to identify the food type, while machine learning models predict the nutritional value based on a pre-trained dataset. For enhanced accuracy, near- infrared (NIR) spectroscopy or hyperspectral imaging can be integrated to analyze the chemical composition of food. This approach has potential applications in diet tracking, food labeling, health management, and smart kitchens, offering users an efficient way to make informed dietary decisions in real-time.

Key words: Food Nutrition Detection, Image Processing, Sensor Technology, Computer Vision, Machine Learning, Image Recognition, Nutritional Analysis, NIR Spectroscopy, Hyper spectral Imaging, Chemical Composition, Real-time Detection, Diet Tracking, Food Labeling, Health Management, Smart Kitchens

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Optimization of Synergistic Coatings on Piston Crown and Cylinder Liner: Electroless Ni–P–Nano–TiO_2 Underlayer with Plasma YSZ Overlay in CI Engines

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ABSTRACT

This study investigates the optimization of duplex coatings on piston crown and cylinder linersurfaces in compression ignition (CI) engines to improve thermal and tribological performance. A dual-layer system was developed, comprising an electroless Ni–P–Nano–TiO_2 underlayer and a plasma-sprayed yttria-stabilized zirconia (YSZ) overlay. The Ni–P–Nano–TiO_2 layer provided high hardness, uniform deposition, and wear resistance, while the YSZ layer acted as a thermal barrier due to its low thermal conductivity and excellent high-temperature stability. Process parameters were optimized to ensure strong adhesion, reduced porosity, and improved structural integrity of the coatings. Characterization results confirmed the synergistic interaction between the two layers, with enhanced hardness, adhesion strength, and thermal resistance compared to single-layer coatings. Engine performance tests demonstrated reduced heat transfer to the cylinder walls, better combustion stability, and lower fuel consumption. Tribological evaluations indicated a lower coefficient of friction and improved scuffing resistance under high load andtemperature conditions. The optimized duplex coating system effectively enhanced both durability and efficiency of the engine components. The results highlight the potential of electroless Ni–P–Nano–TiO_2 combined with plasma-sprayed YSZ as a reliable surface engineering solution for next-generation CI engines, supporting improved fuel efficiency, durability, and emission reduction.

Keywords: Duplex Coatings, Electroless Ni–P–Nano–TiO_2, Plasma-Sprayed YSZ

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Multi Objective Optimization of Diesel Engine Parameters with biodiesel Using Advanced Machine Learning and Evolutionary Algorithms

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ABSTRACT

This research presents a comprehensive multi objective optimization study for diesel engine performance parameters using three distinct algorithmic approaches: response surface methodology (RSM), Genetic algorithm (GA) and Random Forest based machine learning models. The optimization simultaneously maximizes brake mean effective pressure (BMEP), brake thermal efficiency (BTE) and mechanical efficiency while minimizing specific fuel consumption (SFC), carbon monoxide (CO), nitrogen oxides (NOx) and hydrocarbon (HC) emissions. The optimal operating conditions of engines with biodiesel is identified as injection timing 12.3 BTDC, injection pressure 1000 bar, engine load 98%, EGR rate 0% and fuel blend 15%.The advanced optimization methods achieved a 9.95% improvement in overall objective function performance compared to conventional data analysis approaches, demonstrating significant potential for enhanced engine efficiency and reduced emissions.

Keywords: Optimization, Biodiesel, Engine Parameters, Machine Learning Algorithms, Diesel Engine

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CRDI Engine Parameter Optimization Using Lemongrass Biodiesel Blends

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ABSTRACT

Using the central composite design method, experimental work is conducted using a design matrix created by design expert software. Engine load, fuel injection pressure, fuel injection time, exhaust gas recirculation, and fuel blends are the input parameters taken into consideration when creating the design matrix. Different ratios of diesel and lemongrass biodiesel are combined to create the fuel. The blend ratios that were developed were B15, B30, B45, and B60. The experimental work was carried out in a common rail direct injection diesel engine using a predefined design matrix. After thorough investigation, the ideal engine parameters were determined to be 0% exhaust gas recirculation, 55% biofuel blend, 900 MPa blended fuel injection pressure, compression process injection close to TDC, and engine operating at full load. Torque, brake power, friction power, brake mean effective pressure, brake thermal efficiency, mechanical efficiency, specific fuel consumptions, volumetric efficiencies, carbon monoxide, hydrocarbon, and NOx are engine output parameters that are taken into consideration for the optimal setup identifications. With an RSM desirability of 0.75, the engine parameters were optimized depending on the anticipated engine outcome. Furthermore, it was found that the ANN model has a higher prediction accuracy than the RSM model.

Keywords: Lemongrass biofuel, CRDI engine, ANN, RSM, Thermal efficiency, Emissions

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Enhancing the Design and Performance Prediction of Magnesium Alloy Composites Using Deep Learning Approaches

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ABSTRACT

Magnesium alloys are widely recognized for their lightweight, high strength-to-weight ratio, and excellent potential in automotive, aerospace, and biomedical applications. However, their mechanical limitations and susceptibility to corrosion often restrict broader utilization. To overcome these challenges, researchers have developed magnesium alloy composites by reinforcing them with ceramics, nanoparticles, and other materials. In this study, deep learning approaches are explored to enhance both the design and performance prediction of magnesium alloy composites. A comprehensive dataset comprising microstructural, compositional, and mechanical property parameters is utilized to train advanced deep learning models. These models aim to capture complex, non-linear relationships between reinforcement characteristics and resulting composite properties such as tensile strength, hardness, ductility, and corrosion resistance. The proposed framework not only achieves high accuracy in predicting composite performance but also aids in optimizing material design by identifying critical factors influencing mechanical behaviour. The findings highlight the effectiveness of artificial intelligence in accelerating material innovation, reducing experimental costs, and enabling the development ofhigh-performance magnesium alloy composites tailored for next-generation engineering applications.

Keywords: Magnesium Alloy, Composite Material, Micro Structural

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Experimental Analysis and Optimization of Solar Integrated Biodigester System

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ABSTRACT

The increasing global demand for renewable energy has highlighted the significance of biogas asa sustainable alternative to conventional fuels. This study presents the experimental analysis and optimization of a solar integrated biodigester system designed to enhance biogas production efficiency. The system couples a conventional anaerobic biodigester with solar thermal integration to maintain optimal digestion temperature and improve microbial activity. Experiments were conducted using organic feedstock under varying operating conditions, withparameters such as temperature, retention time, pH, and gas yield closely monitored. The results demonstrate that solar integration provides stable mesophilic conditions, thereby increasing methane yield compared to conventional digesters. Optimization techniques were applied to determine the best combination of operating variables for maximum energy output. The findings indicate that solar assistance reduces process fluctuations, enhances digestion efficiency, andcontributes to a more sustainable and cost-effective biogas generation system. This integratedapproach not only supports renewable energy utilization but also offers a practical solution forwaste-to-energy conversion in rural and urban applications.

Key words: Solar integrated biodigester, Biogas production, Renewable energy, Anaerobic Digestion

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Development and Taguchi optimization of eco-Friendly hybrid Polymer Composites reinforced with Aluminized Glass Fiber, Kenaf Fiber, Granite Dust, and Silicon Nitride

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ABSTRACT

Composites (G2 and G3) contributing to improved mechanical strength, while the silicon nitride composite (A4) showed finer dispersion The growing demand for sustainable, high performancematerialshasledtoextensiveresearchintohybridcompositesthat combine natural fibers with functional fillers. This study aims to develop eco-friendly composites capable of delivering superior mechanical, thermal, and durability characteristics for industrial applications. Two hybrid polymer composites were developed and analyzed, reinforced with aluminized glass fiber and kenaf fiber, incorporating granite dust in one and silicon nitride in the other as particulate fillers.The results highlight the potential of utilizing industrial waste like granite dust and advanced ceramic materials like silicon nitride to enhance composite properties while promoting sustainability. SEM analysis revealed good fiber-matrix adhesion in the granite dust-reinforced of particulates and reduced micro voids, enhancing its thermal stability and flame resistance. The A4 composite achieved superior flame retardancy, very low water absorption, and excellent creep resistance, making it ideal for aerospace interiors, electrical housings, and fire-safe structures. Overall, granite dust-based composites (G2 and G3) are preferable where mechanical strength and wear resistance are critical, whereas the silicon nitride-based composite (A4) is better suited for applications requiring flame resistance, long- term durability under stress, and moisture resistance. According to the ANOVA the obtained results are statistically significant. Moreover, in the optimization results the process set A1B2C2 is the better performing one and confirms both the experimental and theoretical results are proven. This implies that these composites are suited for applications that involve thermal insulation, abrasion resistance, and sliding contact, such as protective covers, wear plates, and thermal barriers.

Key words: Mechanical, Thermal, Wear Behavior Analysis for Sustainable Engineering Applications

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Design and Fabrication of Solar Powered Water Pump

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ABSTRACT

This project focuses on the design and fabrication of a solar-powered water pump for agricultural and domestic applications. The primary objective is to provide an eco-friendly and cost-effective alternative to conventional electric and fuel-operated pumps. A photovoltaic (PV) solar panel is used to generate electricity, which is then stored in a battery and supplied to a DC motor-driven pump. The system design involves selecting an efficient solar panel, motor, and pump combination to achieve maximum output with minimal energy losses. The prototype was fabricated and tested under different sunlight conditions to evaluate performance. Results indicate that the solar pump can effectively lift water up to a head of 10 meters with sufficient flow rate for small-scale irrigation. The system eliminates fuel costs, reduces dependence on grid electricity, and operates with zero carbon emissions. This project demonstrates the potential of renewable energy in rural and agricultural sectors, promoting sustainable development. Future scope includes integrating IoT-based monitoring to improve efficiency and reliability.

Key words: Solar power, Pump, Solar panel, Solar pump

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Microstructural and Mechanical Characterization of Hybrid Composites Reinforced 7065 Aluminium Alloy

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ABSTRACT

Aluminium alloy 7065, a high-strength member of the 7xxx series, is increasingly explored as a matrix material for hybrid metal matrix composites (HMMCs) owing to its superior strength-to-weight ratio, fracture toughness, and fatigue resistance. Hybrid reinforcements, typically a combination of ceramic particulates (e.g., SiC, Al_2O_3, TiB_2) and nanoscale phases (graphene nanoplatelets, CNTs), have been employed to overcome limitations of single-reinforcement systems. Processing methods such as stir casting with ultrasonic assistance, powder metallurgy, and friction stir processing enable improved dispersion, interfacial bonding, and porosity control. Resulting HMMCs demonstrate enhanced hardness, wear resistance, and tensile strength while retaining acceptable ductility and fracture toughness. Challenges remain in controlling interfacial reactions, porosity, and corrosion susceptibility, which are strongly dependent on processing parameters and heat-treatment schedules. With optimized reinforcement selection and processing, 7065-based HMMCs show strong potential for aerospace and transport applications requiring lightweight, high-performance, and wear-resistant components.

Keywords:7065 aluminium alloy; hybrid metal matrix composites; stir casting; friction stir processing; graphene nanoplatelets; SiC reinforcement; microstructure; mechanical properties; aerospace applications.

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Optimisation and Analysis of EDM Parameters for Al7075 Alloy Composite Reinforced with B_4C and Fly Ash Nanoparticles Toward Green Manufacturing

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ABSTRACT

In contemporary manufacturing, sustainability is becoming focused on social welfare, environmental responsibility, and economic efficiency. The goal of this work is to create hybrid aluminum nanocomposites (Al 7075) reinforced with 1.5 wt.%bamboo fly ash and 1.5 wt.% boron carbide (B_4C). The machinability of these composites was tested using Electrical Discharge Machining (EDM), seeking sustainable production outcomes. The experiments, which examined the effects of four EDM parameters,voltage, current, pulse-on time, and pulse-off timeon two important sustainability indicators,material removal rate, and surface roughness, were planned using a face-centered Central Composite Design (CCD) framework. The two factors that contributed most significantly to performance variation were current and pulse-on time. The relationship between process inputs and outputs was modeled using Response Surface Methodology (RSM), which produced a high coefficient of determination (R^2> 97.33%), indicating strong predictive accuracy. Two different approaches were used to simultaneously optimize process parameters in order to enable the sustainable production of aluminum hybrid nanocomposites (Al-HNC). Following confirmation experiments, these ideal settings were confirmed to have variations of less than 8.11%. Furthermore, alternative parameter sets to optimize the rate of material removal.

Optimisation and Analysis of EDM Parameters for Al7075 Alloy Composite Reinforced with B4C and Fly Ash Nanoparticles Toward Green Manufacturing

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Assessing the Feasibility of Additive Manufacturing for Accelerated Construction

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ABSTRACT

Additive manufacturing (3D printing) is transforming construction by enabling rapid, automated, and customized building from digital models. This layer-by-layer process minimizes waste, reduces labor, and accelerates timelines compared to traditional methods, addressing industry issues like inefficiency and skilled labor shortages. Large-scale printers have successfully built walls, bridges, and housing in days, proving its value for rapid deployment in disaster relief. Realizing this potential relies on developing printable materials. Traditional cement mixes are modified for pumpability and buildability, while advanced formulations using geopolymers, fiber-reinforcement, and recycled by-products enhance sustainability and performance. Structural integrity is influenced by interlayer bonding and anisotropy, leading to innovations in robotic toolpath planning and reinforcement embedding. The technology offers significant sustainability benefits, including material savings of up to 60% and a lower carbon footprint, particularly when combined with low-carbon binders. Economically, it cuts labor costs and project duration, with early projects showing 20–30% savings. However, challenges remain in standardizing processes, ensuring quality control, integrating reinforcement, and establishing long-term durability data. Despite these hurdles, 3D printing is a paradigm shift, promising faster, more sustainable, and design-driven construction. Widespread adoption depends on overcoming material and regulatory challenges through continued research, paving the way for resilient structures in both urban and emergency contexts.

Keywords: Additive Manufacturing, Construction, Sustainability, Material Innovation, Rapid Construction

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Casting and Analysis of Aluminium-Silicon Alloy with Copper

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ABSTRACT

Aluminium silicon alloy has been used as a material for sliding components in automobiles, aviation and other applications. The seizure and wear resistance of aluminum alloy can be improved by adding copper particulates. Al-Si/copper composite is used as a self-lubricating material in various applications, where sliding parts are difficult to access for lubrication. The main objective of this work is to fabricate an Al-Si/copper composite with better mechanical and wear resistance properties. The aluminium silicon alloy reinforced with copper (3 wt.%) composite was prepared through the stir casting technique. In order to improve the wettability of copper with Al-Si alloy, copper particulates were ball milled and then incorporated into the molten metal. The uniform distributions of copper particulates are observed in the structural investigation of the alloy. The billet was cut into pieces of diameter 10 mm & 14 mm, respectively. It has a length of 25 mm and was sent for tests. The wear rate of the Al-Si alloy and Al-Si/copper composite was investigated. Corrosion-resistant and compressive properties of the alloy are better. The higher tensile properties of the alloy are due to the addition of Cu, which obstructs the dislocation movement. Corrosion and compressive properties of the alloy and composite are dependent on strain rates.

Keywords: Al-Si/copper composite; Sliding wear; Stir casting

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Voice-Controlled Solar Water Heater

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ABSTRACT

The growing demand for energy-efficient and sustainable solutions in modern households has led to significant innovations in renewable energy and smart home technology. This project focuses on the design and implementation of a Voice-Controlled Solar Water Heater, which integrates solar thermal energy with advanced voice recognition technology to provide a convenient, eco-friendly, and efficient water heating solution. The system utilizes solar energy to heat water, significantly reducing dependence on conventional electricity and minimizing carbon footprint. By incorporating a microcontroller-based voice control interface, users can operate the heater through simple voice commands, eliminating the need for manual switching and allowing for hands-free operation. The system also includes safety features such as automatic temperature regulation and overload protection, ensuring reliable and secure performance. This project demonstrates the potential of combining renewable energy with smart automation, highlighting benefits such as energy conservation, cost efficiency, and enhanced user comfort. The implementation of voice control not only improves accessibility for differently-abled individuals but also aligns with the growing trend of smart home technology. The results indicate that integrating solar energy systems with intelligent control mechanisms can significantly improve the usability, efficiency, and sustainability of domestic appliances. This work contributes to the advancement of clean energy applications while promoting user-friendly automation in everyday life.

Keywords: Solar Water Heater, Renewable Energy, Voice Recognition, Microcontroller, Smart Home Automation, Energy Efficiency

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Hybrid Metal Matrix Composite: A Comprehensive Review on its Fabrication

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ABSTRACT

Hybrid Metal Matrix Composites (HMMCs) have emerged as a class of advanced engineering materials that combine two or more distinct reinforcements within a metallic matrix to achieve superior mechanical, thermal, and tribological properties. The integration of multiple reinforcements—such as ceramic particles, fibres, or whiskers—into metals like aluminium, magnesium, and titanium offers a balanced combination of strength, stiffness, wear resistance, and toughness, often unattainable in conventional monolithic alloys or single-reinforcement composites. This review provides a comprehensive overview of fabrication techniques employed in the development of HMMCs, including stir casting, powder metallurgy, squeeze casting, friction stir processing, and additive manufacturing. Each method is discussed in terms of its process parameters, advantages, limitations, and influence on microstructure and property evolution. Emphasis is placed on how fabrication routes affect the uniform distribution of reinforcements, interfacial bonding, porosity levels, and overall performance. Furthermore, recent advancements, challenges in scalability, and future research prospects are highlighted to guide the development of cost-effective and high-performance HMMCs for aerospace, automotive, defense, and industrial applications.

Keywords: Hybrid Metal Matrix Composites, fabrication, Casting, Strength, Stiffness, Wear resistance, Toughness

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Design Development of Engine Cylinder Boring Insert

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ABSTRACT

Productivity and quality are two important aspects have become great concerns in today's competitive global market. Every production/manufacturing unit mainly focuses on these areas in relation to the process as well as product developed.In our experiment we have used Solid CBN Insert instead of Brazed CBN insert to achieve high machining finish and reducing cost. Also Environmentally - friendly Production. In automated machining, removing burrs and sharp edges in cross-drilled holes can be despite the challenges, removing burrs from the production process is absolutely essential for finishing high-quality, precision parts. In many applications.A can withstand the high cutting temperatures and forces and still retain its cutting edge. Now-a-days, the application of hard tuning with CBN tool has been massively increased because the CBN insert hard turning is a good alternative to boring process.The process of hard turning was made using the AISI H13 die tool steel at containing different hardness (45 HRC, 50 HRC and 55 HRC) levels. The work material was selected on the basis of its application in the die making industries in a range of hardness of 45–55 HRC. Optimization by the central composite design approach has been used for design and analysis. The present study reported that the cutting forces and surface roughness are influenced by the alloying elements and percentage of CBN in the cutting tool material.

Keywords: Hard Turning, CBN Insert, Surface Roughness, Cutting Forces, AISI H13 Steel

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Human Safety Wrist Band

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ABSTRACT

The Human Safety Wristband is a wearable device designed to enhance personal securitythrough real-time monitoring and emergency alert systems. In today's world, the safety ofwomen, children, elderly, and individuals traveling alone has become a significant concern. Traditional safety measures often fail to provide immediate assistance, which highlights the need for a portable and reliable solution. This project proposes an advanced wristband that integrates multiple smart features to ensure user safety. The wristband is equipped with a hidden SOS button and tap sensor that can discreetly trigger an emergency alert. A GSM module transmits the user's live GPS location to pre-registered contacts, while vibration feedback confirms activation. In addition, the device incorporates a pulse sensor to track heart rate and an accelerometer for fall detection, enabling automatic alerts in cases of panic, health risks, or accidents. A geofencing feature provides notifications when the user moves outside designated safe zones, and a mini buzzer serves as an audible alarm to attract immediate attention. Data storage ensures that critical information such as the last known location and health data is preserved, even when network coverage is limited. By combining health monitoring with real-time tracking and multi-layered emergency alerts, the Human Safety Wristband offers a low-cost, effective, and socially impactful solution for personal safety. This project demonstrates how wearable technology can be leveraged to improve security, reduce response time in emergencies, and provide peace of mind for users and their families.

Keywords: Safety wristband, SOS alert, GPS tracking, health monitoring, wearable technology, emergency response.

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Investigation of Enhancing Tile Performance with Silicon-Based Cement and Waste Tire Ash

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ABSTRACT

This research investigates the sustainable production of high-performance tiles by incorporating industrial waste, specifically tire ash, into a silicon-based cement matrix. Tire ash, a byproduct from combusting waste tires, offers a dual benefit: it serves as a reinforcement material while promoting eco-friendly waste management. The study developed tiles using a modified processing technique, varying the proportions of silica fume cement (85%, 80%, 70%) and tire ash (0%, 5%, 15%), with a fixed 15% tungsten carbide content. The results demonstrate that the inclusion of tire ash significantly enhances key material properties. Compressive strength, surface hardness, and corrosion resistance all improved, indicating that the additive contributes to greater structural integrity, wear resistance, and longevity. This approach successfully transforms an industrial waste product into a valuable resource for creating superior building materials. By diverting tire ash from landfills and incorporating it into tile manufacturing, the research supports the principles of a circular economy and green construction. The findings pave the way for adopting silicon-based compounds and tire ash in civil engineering applications, offering a sustainable path to both reduce environmental impact and improve material performance.

Key words: Tire Ash, Silica Fume Cement, Sustainable Construction, Mechanical Properties, Waste Valorization

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ICRTME25-245

Design and Implementation of IOT-based Smart Aquarium Automation System

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ABSTRACT

In recent years, the integration of the Internet of Things (IoT) into everyday applications has gained significant attention due to its ability to improve convenience, efficiency, and automation. Among various fields, aquarium automation has emerged as a growing area of interest for hobbyists, researchers, and aquaculture industries. Manual aquarium maintenance is often time-consuming and requires continuous monitoring to ensure a healthy aquatic environment. Parameters such as water temperature, light conditions, water level, and feeding schedules are crucial for the well-being of aquatic life. To address these challenges, this project presents the design and implementation of an IoT-based smart aquarium automation system that minimizes human intervention while providing accurate real-time monitoring and control. The proposed system utilizes the Arduino Nano microcontroller as the central processing unit, interfaced with multiple sensors and actuators to achieve full automation. A temperature sensor monitors the water temperature to maintain suitable living conditions, while an LDR (Light Dependent Resistor) sensor detects ambient light levels, enabling automatic adjustment of lighting conditions as required. A water level sensor ensures that the tank maintains optimal water volume, preventing overflow or scarcity, which can be harmful to aquatic life. For feeding automation, a servo motor is programmed to release fish food at pre-scheduled intervals, eliminating the need for manual feeding and ensuring consistent nutrition. Additionally, an LCD display is integrated into the system to present real-time status updates of all parameters, making it user-friendly and interactive. The entire setup is powered by rechargeable batteries, with breadboard and connecting wires used for circuit prototyping and ease of testing. By connecting the system to IoT platforms, the project enables real-time monitoring and potential future enhancements, such as remote access via mobile applications and data logging for long-term analysis.

Keywords: Smart aquarium, IoT, Sensor, Automation, LCD display

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Analysis of Composite Materials by Using FEM Model

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ABSTRACT

The composite material is fabricated using glass fibers namely E-Glass 300, E-Glass 450, Combined titched and woven drawings having different orientations. The material is fabricated by hand lay method.Stress, strain, density, young's modulus, impact strength and flexural strength properties are studied in ansophthalic resin as a matrix reinforced with glass fibers for different orientation of fibers. A comparison on mechanical properties has been derived between all the different fibers having different orientations.In this work, the effects of orientation angle on the fiber at the natural frequency of symmetric composite beamare investigated analytically and numerically. This presents a powerful method for evaluating the constitutive properties of composite materials through a mixed numerical-experimental identification procedure based on both the extracted mode shapes and the corresponding natural frequencies of the materials. The analytical results are compared with the numerical results which clearly show that the results are very close to each other. From this suitable material which withstands in above discussed aspects has been found.

Keywords: Analysis of Composite, Fem Model, Composite materials, Numerical experiment

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Evaluating the Real-World Validity of Driving Simulators: A Review of Comparative Studies

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ABSTRACT

Driving simulators are a common tool for researching driver behavior, providing practical, safe, and controlled environments. Despite their frequent use in research, there is relatively little evidence confirming their validity (i.e., how accurately they represent or reproduce real-world driving). Moreover, there is inconsistency in both the types of simulators used, and the operationalization of "real-world" driving in validations. This report was undertaken to evaluate the evidence regarding driving simulator accuracy when compared with real-world driving. The review included 44 studies reporting a direct comparison between simulated driving and on road driving in a vehicle. Measures reported for comparison varied but included mean speed, speed variability, lateral position, overall driving performance, and number of driving errors. Simulators in approximately half of the studies achieved absolute or relative validity, whereas one third produced non-valid results. To understand this further, the fidelity of simulators was considered, however this further clouded our understanding as the relationship between simulator fidelity and validity was not straightforward. The findings suggest that the reporting of driving simulator studies requires improvement, particularly around the validation evidence associated with the simulator, the specific details of the simulated driving environment, and the outputs of statistical analyses. Guidelines are proposed for future research to ensure consistency in the conduct, and reporting, of simulator-based research.

Keywords: Driving Simulator, Validity, Driver Behavior, Real-World Driving, Fidelity

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Using Existing CCTV Network for Crowd Management, Crime Prevention, and Work Monitoring Using AI&ML

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ABSTRACT

The integration of Artificial Intelligence (AI) and Machine Learning (ML) into existing CCTV networks presents a transformative approach to urban surveillance and operational oversight. This paper explores how AI-powered video analytics can repurpose conventional CCTV infrastructure for real-time crowd management, proactive crime prevention, and efficient work monitoring. By leveraging computer vision techniques such as object detection, facial recognition, and behavioral pattern analysis, the system can identify anomalies, predict potential threats, and optimize resource allocation. The proposed framework emphasizes scalability, data privacy, and adaptive learning to ensure robust performance across diverse environments. This convergence of AI/ML with legacy surveillance systems not only enhances situational awareness but also supports smarter, safer, and more responsive public and private spaces.

Keywords: Artificial Intelligence (AI), Machine Learning (ML), Video Analytics, Surveillance, Computer Vision, Urban Security

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Instant Duplication Alerts: Optimizing Data Download and Storage

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ABSTRACT

Unintentional multiple downloads of the same file have become increasingly prevalent in modern digital environments, resulting in wasted storage, fragmented directories, and reduced system efficiency. Existing solutions, such as dupeGuru and CCleaner, rely on manual post-download scans to identify duplicates and lack real-time monitoring, leaving users unaware of redundant downloads until after they have already consumed storage resources. This reactive approach not only increases the risk of storage inefficiency but also adds unnecessary cognitive and operational overhead for users, particularly as the volume of digital content continues to grow exponentially. In order to address these limitations, we propose the Data Download Duplication Alert System (DDAS), a lightweight, real-time framework designed to proactively detect and prevent redundant file downloads. DDAS continuously monitors download activities, leveraging file metadata, hashing techniques, and content comparison algorithms to identify potential duplicates before the download completes. When a duplicate is detected, the system immediately notifies the user, enabling informed decision-making and preventing unnecessary storage usage.Unlike conventional tools, DDAS operates at the point of download, providing automated, real-time intervention that preserves system resources and maintains organized file structures. Its efficient design ensures minimal computational overhead while offering robust detection capabilities, making it suitable for both personal and enterprise-scale digital environments. By combining proactive detection with immediate alerts, DDAS significantly enhances storage management, reduces digital clutter, and improves overall user experience, representing a novel and practical solution to the persistent challenge of redundant downloads in contemporary computing environments.

Keywords: Duplicate Detection, Real-Time Monitoring, Download Management, Storage Optimization, Hashing Algorithm, Proactive Alert System

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Thermo Gravimetric Analysis and Scanning Electron Microscopy Analysis of Banana-Coir Natural Fiber Composite Material

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ABSTRACT

Natural fiber reinforced polymer composites are gaining wide attention due to their eco-friendliness, biodegradability, low cost, and good mechanical properties. Among the various natural fibers, banana and coir are abundant lignocellulosic materials that can be effectively used as reinforcements in composite development. In this work, banana–coir hybrid natural fiber composites were fabricated and subjected to thermal and morphological characterization. Thermogravimetric Analysis (TGA) was performed to evaluate the thermal stability and degradation behavior of the composite. The results revealed a three-stage degradation process corresponding to moisture evaporation, hemicellulose–cellulose decomposition, and lignin degradation. The incorporation of banana and coir fibers improved the onset of thermal degradation, indicating enhanced thermal resistance compared to individual fiber composites. Scanning Electron Microscopy (SEM) analysis was conducted to study the surface morphology and interfacial adhesion between the fibers and the matrix. SEM micrographs showed uniform fiber distribution, good fiber–matrix interfacial bonding, and minimal void formation in optimized composites. However, fiber pull-outs and micro-cracks were observed in some regions, suggesting scope for improved surface treatment.

Keywords: Natural fibers, Banana-coir composites, Thermogravimetric analysis (TGA), Scanning electron microscopy (SEM), Thermal stability, Morphological analysis

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Clear Drop: Ensuring Clean and Safe Water through Smart Monitoring

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ABSTRACT

Human health requires clean and safe drinking water, which is often uncertain in most areas as the filtered water contains secret contaminants. This project suggests a smart water quality monitoring and display system to solve this problem by assessing the purity of water on a real-time basis. To measure the two crucial parameters that directly reflect the extent of the suspended particles, the system uses turbidity and pH sensors that are used to measure the acidity or alkalinity of the water. A microcontroller processes these sensor readings, and the results are displayed on an LCD screen, providing users with clear and immediate feedback. Besides the numeric figures of turbidity and pH, the system also understands the figures to inform the users about whether the water is safe to be consumed or not.The device is scheduled to be builtinto household water filters, and besides assessing the functionality of the filtration procedure, it will also act as an early-warning device for situations when the water is not safe to use. The arrangement is small, affordable, and convenient to use, and is applicable to domestic and small populations of a community. This project will help in enhancing the overall health status of the population, minimize cases of water-borne disease, and raise the level of confidence in the safety of drinking water at the point of consumption.

Keywords: Real-time Monitoring, Water Quality, Turbidity and pH Sensors, Microcontroller, Point-of-Use Safety

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Design and Fabrication of Footsteps Energy Generator

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ABSTRACT

The increasing demand for sustainable energy sources has motivated researchers and engineers to explore alternative methods of power generation that are both eco-friendly and cost-effective. Among these, energy harvesting from human activities has emerged as a promising concept. One such innovative approach is the footsteps energy generator; a system designed to capture and convert the mechanical energy produced by human footsteps into usable electrical energy. This technology works on the principle of converting mechanical pressure into electricity, typically using piezoelectric sensors, rack and pinion mechanisms, or electromagnetic induction systems. Each time a person walks, the pressure exerted on the generator surface is transformed into electrical output, which can be stored in rechargeable batteries or capacitors for later use.

Keywords: Sustainable energy, Renewable energy, Energy harvesting, Human activities, Footstep energy generator, Mechanical energy

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Mobile Net Neural Network Skin Disease Detector with Raspberry PI Integrated to Telegram

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ABSTRACT

Skin diseases with their malignant Melanoma and benign Keratosis are two major global health issues that affect people around the world. The timely identification of skin diseases remains essential for qualified medical treatment which delivers better results to patients. The absence of available clinical diagnosis tools results in prolonged medical examinations and elevated death counts among patients. A complete system for skin disease detection presents an integration of MobileNet Convolutional Neural Network (CNN) detection and Raspberry Pi and Telegram real-time monitoring capabilities and notification functions. The MobileNet CNN operates with a lightweight structure that employs Depthwise Separable Convolution to reach processing complexity reduction rates of 8-9 times lower than those of standard convolutional networks. This implementation enables skin lesion classification through transfer learning which re-trains a MobileNet model that already exists for skin lesion specialization. The system provides precise and reliable predictions that achieve validation accuracy of 0.96 for top-3 results and 0.89 for top-2 performance when it categorizes skin lesions into Melanoma and Benign Keratosis classes. The Raspberry Pi enables local image processing operations which allows for a budget-friendly system deployment in areas with limited resources. The real-time notification system along with classification outcomes reaches both users and healthcare personnel through Telegram to provide them with quick access to medical assessment. Through this integrated approach detection becomes more efficient at the same time it provides improved accessibility. The proposed detection system provides a strong and budget-friendly technology solution which scales for early skin disease diagnoses worldwide. The future development of the system will focus on expanding the available dataset for better accuracy as well as adding more diagnostic elements that will result in complete skin health evaluation.

Keywords: Skin Disease Detection, MobileNet CNN, Raspberry Pi, Real-time Notification, Melanoma and Keratosis

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6G Technology Risk: Improvement of Security Threats Using AI-Based Solutions

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ABSTRACT

The evolution of 6G networks introduces unprecedented opportunities but also amplifies the risk of advanced cyber threats. Traditional rule-based security mechanisms are inadequate for handling dynamic and large-scale attacks in real time. To address this, we implemented an AI-driven Intrusion Detection and Mitigation System that combines supervised machine learning with automated response strategies. Using the NSL-KDD dataset, a Random Forest classifier was trained to differentiate between normal and malicious traffic with high accuracy. The system simulates real-time traffic by streaming packets sequentially, where each packet is classified as either normal or attack. A prototype mitigation engine was integrated to automatically block repeated attackers after a threshold number of malicious packets. The demonstration successfully showcased the feasibility of real-time detection, alert generation, and automated mitigation using only software-based solutions. This work validates the potential of AI-enhanced security frameworks in strengthening trust, privacy, and resilience in emerging 6G networks.

Keywords: 6G Network Security, AI-driven Intrusion Detection, Random Forest Classifier, Automated Threat Mitigation, Real-time Traffic Analysis

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Autonomous Unmanned Aerial Vehicle for Precision Crop Diagnostics Using Multi spectral Imaging and NDVI Analysis

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ABSTRACT

The integration of unmanned aerial vehicles (UAVs) with intelligent image analytics is transforming precision agriculture. This project presents the design of an autonomous quadcopter platform capable of plant health profiling using multispectral and RGB imaging. The drone, built with an open-source flight controller (APM 2.8), GPS, and telemetry, is programmed for autonomous waypoint navigation to conduct repeatable survey missions.Captured aerial images are processed through vegetation index calculations such as NDVI (Normalized Difference Vegetation Index) and complementary color-based algorithms using Python/OpenCV. These indices help in detecting early crop stress indicators including water deficiency, nutrient imbalance, pest infestation, and disease onset. The results are further visualized as geo-referenced health maps using QGIS, offering farmers actionable insights for precision intervention. Unlike conventional drone-based imaging projects that stop at raw data collection, this system uniquely combines low-cost UAV hardware with real-time or offline data analytics, thus bridging the gap between sensing and decision-making. Designed as a scalable and open-source framework, the platform can also support future integration of IoT sensors, AI modules, and cloud dashboards for large-scale farm intelligence. The expected outcome Is a validated, cost-effective UAV system capable of reliable anomaly detection and field-ready decision support. This innovation demonstrates practical relevance for rural agriculture, with potential contributions in academic research, industrial applications, and patentable Agri-Tech solutions.

Keywords: Precision Agriculture, Autonomous Quadcopter (UAV), Multispectral Imaging & NDVI, Plant Health Monitoring, Actionable Insights

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Early Prediction of Pancreatic Abnormalities Using Gain Metrics

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ABSTRACT

Pancreatic disorders, including cancer, often go undetected in their initial stages due to subtle or hidden symptoms. This project aims to develop a diagnostic approach utilizing Digital Image Processing (DIP) techniques to examine pancreatic images and identify abnormalities. A key focus is the calculation of a feature termed GAIN, which quantifies the variation in pixel intensity between healthy and diseased pancreatic tissues. The process involves image acquisition, preprocessing techniques such as binning and thresholding, followed by extraction of the Region of Interest (ROI). Based on the computed GAIN values, the system classifies images as either normal or abnormal using basic machine learning or statistical methods. This technique is intended to function as an assistive diagnostic tool, facilitating early detection and supporting medical decision-making.By exploiting differences in pixel intensity, the system enhances the visibility of subtle changes that may not be readily apparent to the human eye. This improves the likelihood of early detection while reducing reliance on costly and time-intensive diagnostic procedures. The proposed method is non-invasive, cost-efficient, and adaptable to multiple imaging sources, making it suitable for both clinical use and remote diagnostics. Ultimately, this project seeks to support healthcare professionals in delivering faster and more accurate assessments, thereby contributing to improved outcomes in pancreatic disease management.

Keywords: Pancreatic Cancer Detection, Digital Image Processing (DIP), GAIN Feature Extraction, ROI Analysis, Medical Image Classification

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Spectrum sensing-focused cognitive radio network for 5G revolution using TPE Optimized Random Forest Model

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ABSTRACT

In order to support 5G Networks, this research suggests a Machine learning model used sensing, Identification and Dynamic allocation of channels to users. Ensuring effective spectrum usage and secure data transfer has become crucial due to the exponential growth of connected devices. The model uses Random Forest techniques to address the efficiency and performance of 5G networks. For accurate spectrum sensing, a suitable model will be used, allowing for trustworthy channel identification with the least amount of disruption to main users. In the recent trends of networking, machine learning has drastically improved a number of industries, including Cognitive radio network. efficient use of spectrum bands is still an issue in wireless 5G networks that keep an eye on real-time systems. moderately trained model cannot keep up with the constant changes of the real-time scenario, which cause systems to make incorrect decisions with negative consequences. The outcomes of the simulation will demonstrate notable gains in energy efficiency, prediction precision, and error reduction. The suggested method improves 5G networks' performance and efficiency, making it appropriate for real-time, high-demand wireless applications. In addition to resolving allocation issues, this innovative method sets the bar for precision and trustworthiness in wireless 5G networks.

Keywords: 5G Spectrum Management, Machine Learning, Random Forest, Cognitive Radio Networks, Dynamic Channel Allocation, Spectrum Sensing & Efficiency

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ML-Based Prediction of Mechanical Properties of AL6061 Hybrid MMCS Using Literature-Derived Dataset

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ABSTRACT

This study develops a robust Machine Learning (ML) model for accurately predicting the key mechanical properties of Al6061 hybrid Metal Matrix Composites (MMCs) by leveraging a comprehensive dataset curated from existing literature. Input features included various reinforcement types and their weight percentages, alongside critical processing parameters, while target properties were ultimate tensile strength (UTS),hardness, and wear rate. Multiple ML algorithms, including Random Forest, Gradient Boosting, and Artificial Neural Network, were trained and evaluated, with Gradient Boosting emerging as the superior model, achieving R^2 values exceeding 0.96 forhardness and 0.94 for UTS. This research demonstrates that ML, utilizing literature derived data, provides an effective and resource-efficient methodology for modelingAl6061 hybrid MMCs, thereby significantly accelerating material design and reducing the reliance on extensive experimental validation.

Keywords: ANN, Machine learning, Al Composites, Metal matrix composites

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Production of Bio-Ethanol from Fruit Waste

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ABSTRACT

The production of bio-ethanol from fruit waste is an effective way to generate renewable energy while addressing the challenge of organic waste management. Fruit waste such as peels, pulp, and overripe or spoiled fruits contains high amounts of fermentable sugars, cellulose, and hemicellulose, which can be efficiently utilized for ethanol production. The process begins with the microorganisms such as yeast (Saccharomyces cerevisiae) to initiate fermentation. During fermentation, sugars are converted into ethanol and carbon dioxide under anaerobic conditions. The fermented mixture is then subjected to distillation to separate and purify ethanol. This approach not only reduces the environment problems caused by fruit waste accumulation but also provides a sustainable and cost-effective alternative to conventional fossil fuels. Bio-ethanol is a clean-burning fuel that reduces greenhouse gas emissions and can be blended with petrol to enhance fuel efficiency. The project highlights the dual advantages of energy production and waste management, emphasizing its potential application in rural and urban settings. This sustainable solution demonstrates how waste materials can be transformed into valuable energy resources, contributing to a circular economy and environmental protection.

KEYWORDS: Fruit peels, spoiled fruits, yeast, water.

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Coupled Multiphysics Investigation of Parameter Sensitivity and Performance Enhancement in Proton Exchange Membrane Fuel Cells

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ABSTRACT

Proton exchange membrane (PEM) fuel cells are broadly utilized for their high efficiency and clean energy conversion; however, their performance majorly depends on internal transport phenomena and material properties. This research aims to investigate the influence of critical parameters on PEMFC performance using a multiphysics model developed in COMSOL Multiphysics. A detailed electrochemical and transport model is implemented, and parametric analysis is conducted by modifying cell voltage (0.5–1 V), gas porosity (0.3–0.6), electrode conductivity (100–250 S/m), specific surface area (5×10^8–2×10^9 m^{-1}), and electrolyte volume fraction (0.2–0.35). The results indicate that increasing the cell voltage from 0.5 V to 1 V significantly improves the electrolyte current density by 3–4 times, showing strong dependence on operating environment. An increase in specific surface area from 5×10^8 to 2×10^9 m^{-1} enhances the maximum current density by 60–75%, due to enhanced electrochemical reaction sites. Gas porosity varied from 0.3 to 0.6 results in an improvement of about 20–30% in current density, particularly in the mass transport zone. In the same manner increasing electrode conductivity from 100 S/m to 250 S/m reduces ohmic losses and enhances performance by approximately 15–25%. In contrast, electrolyte volume fraction shows minimal impact, with variations in performance limited to less than 5% across the studied range. Spatial analysis reveals a non-uniform distribution with peak activity localized near the catalyst region, followed by quick decay due to reactant consumption. A mesh independence study confirms solution stability with less than 1% deviation beyond 1.5×10^5 elements. This research provides quantitative insights into parameter sensitivity and identifies key factors influencing PEMFC performance, offering guidelines for optimal design and operation.

Keywords: Proton exchange membrane fuel cell, PEMFC, COMSOL, Electrochemical performance, Parameter sensitivity analysis, Gas porosity, Electrode conductivity

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An Innovative Energy Harvesting from Pendulum Mechanism Operated by Windmill

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ABSTRACT

There is a rising demand for sustainable micro-power generation utilizing renewable energy sources. As wind energy accounts for the majority of implementation in developing nations, a novel and sustainable method of using wind power in prospective areas is the need of the hour. Piezoelectricity offers a clean, scalable solution when compared to fossil fuel-based conventional energy generation. Wind-driven pendulum systems convert mechanical motion into electricity; the windmill rotates and drives a pendulum, and the pendulum oscillations apply stress to piezo elements. Thus, mechanical energy is converted into electrical output without much of the conventional setup and high energy-absorbing elements. Utilizing available materials that generate voltage when deformed, common materials include PZT, quartz, and PVDF.The advantages of the system include no external power requirement, low maintenance, and silent operation. The setup promises to be environmentally friendly and adaptable to varied wind conditions, aligning with sustainable development goals such as affordable and clean energy (SDG 7), sustainable cities and communities (SDG 11), and climate action (SDG 13).Challenges in the current work include low and intermittent piezo output, which requires efficient storage and regulation. Apart from piezo-based parameters, wind variability affects consistency. With an innovative blend of mechanical and electrical engineering, the present work aims to tackle the difficulties in harnessing natural wind energy for micro-power generation. The proposed setup is a promising solution for decentralized, sustainable energy.

Keywords: Energy Harvesting, Piezoelectricity, Pendulum Systems, Decentralized Energy, Sustainable Energy.

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Comparative Performance Evaluation of Hybrid Lstm-Gru and Attention-Based Transformer Bilstmant Colony Optimization in Fraud Detection

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ABSTRACT

Fraud detection is a critical task in financial and online transaction systems, aiming to identify fraudulent activities in real time to prevent losses. Machine learning and deep learning techniques have been increasingly adopted to analyse large-scale transactional data for improved detection accuracy. Advanced sequence models, such as Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), and Transformer-based architectures, are capable of capturing temporal dependencies and complex patterns in fraud-related data. Conventional fraud detection systems often rely on rule-based methods or basic machine learning models, which struggle to adapt to evolving fraud patterns. Standalone deep learning models like LSTM or GRU may suffer from issues such as over fitting, vanishing gradients, and limited ability to capture long-term dependencies when used individually. Transformer-based models, while powerful, may face computational challenges and require significant training data to achieve optimal performance. To address these limitations, this study proposes. Comparative Performance Evaluation of Hybrid LSTM-GRU and Attention-Based Transformer BiLSTM withAnt Colony Optimizationin Fraud Detection**.** The hybrid LSTM-GRU model combines the strengths of both architectures to effectively capture short- and long-term dependencies in transaction sequences, while the attention-based Transformer BiLSTM leverages bidirectional contextual learning with attention mechanisms to enhance feature representation. Both approaches are evaluated on benchmark fraud datasets to compare their effectiveness, accuracy, and computational efficiency, offering insights into the best-performing model for real-world fraud detection applications.This project is implemented using Python programming language.

Keywords: Fraud Detection Systems, Hybrid LSTM-GRU Model, Transformer BiLSTM with Attention, Ant Colony Optimization, Transaction Data Analysis

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Design and Fabrication of Automatic Power Generation from Speed Breaker Using Rack and Pinion Mechanism

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ABSTRACT

This project presents an innovative and sustainable method for generating electricity by harnessing the kinetic energy of vehicles. It utilizes a specially designed speed breaker integrated with a rack and pinion mechanism to capture the vertical motion produced as vehicles pass over it. This vertical movement is transformed into rotational energy through the mechanical system. The generated rotational energy is then used to drive a DC motor, which functions as a generator to produce electricity. This electrical energy is stored in a rechargeable battery, creating a renewable energy source. The stored power can be effectively used to operate streetlights, traffic signals, or other low-power devices, particularly in urban areas with high vehicle traffic. By converting motion that would otherwise go to waste into usable energy, this system offers a practical and eco-friendly solution for modern cities. It not only helps reduce the load on conventional power grids but also supports green energy initiatives. The system is designed to be low-maintenance and cost-effective, making it suitable for long-term deployment in public infrastructure. This technology promotes sustainable development by leveraging everyday traffic movement to produce clean energy. It holds particular promise for densely populated urban regions where traffic flow is continuous, ensuring consistent energy generation. Overall, this project contributes to reducing environmental impact and supports the global shift toward renewable energy solutions, offering a smarter and greener approach to urban power management.

Keywords: Kinetic Energy Harvesting, Speed Breaker Generator, Rack and Pinion Mechanism, Renewable Urban Energy Traffic-Based Power Generation

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A Study of Mechanical and Tribological Behaviour of AZ31D Magnesium Hybrid Composites

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ABSTRACT

In order to improve its structural and wear characteristics, the study examines the mechanical and tribological performance of AZ31D magnesium alloy strengthened with hybrid reinforcements. After the hybrid composites are created using an appropriate processing method, their microstructural properties are analyzed to assess how evenly the reinforcements are distributed. To evaluate improvements over the base alloy, mechanical characteristics like impact resistance, tensile strength, and hardness are examined. To find the wear rate and coefficient of friction, tribological experiments are conducted with different loads and sliding circumstances. The findings show that adding hybrid reinforcements to AZ31D magnesium greatly increases its strength, hardness, and resistance to wear. This makes the created composites more appropriate for possible uses in the biomedical, automotive, and aerospace sectors where materials that are both lightweight and resistant to wear are crucial.

Keywords: AZ31D, biomedical, automotive, and aerospace sectors

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A Predictive Model for Identifying Students at Risk of Mental Illness

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ABSTRACT

Mental illness is a health problem that undoubtedly impacts emotions, reasoning, and social interact of a person. It supports early decision making and helps identify students at risk of extreme outcome such as suicidal thoughts etc. Our proposed model uses a Random Forest classifier, Logistic Regression, Naïve Bayes, SVM, trained on features like age,gender, study hours, sleeping hours, Alcoholic, part-time jobs, academic performance,socialism.Among the classifiers Random Forest can achieve the highest accuracy.The performance of the model is evaluated using metrics such as accuracy, precision, recall, and F1-score. Our experimental result shows that our model appropriate in early detection of mental health risks among students leads to personalized support, promotes lifestyle improvements.

Keywords: Mental illness, Early detection, Students at risk, Random Forest, Logistic Regression, Naïve Bayes, Support Vector Machine (SVM),Academic performance

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Predictive Analytics Using Machine Learning for Graduate Outcomes in Higher Education Institutions

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ABSTRACT

The ability to accurately predict student graduation outcomes is crucial for higher education institutions to improve academic planning, resource allocation, and student support services. This study explores the application of predictive analytics using machine learning techniques to analyze student datasets and forecast graduation likelihood. Various preprocessing steps, including data cleaning, feature selection, and label encoding, were applied to ensure data reliability. Machine learning models such as Logistic Regression, Decision Trees, and Random Forest were trained and tested to identify key academic and demographic factors influencing graduation rates. The results demonstrate that ensemble-based models provide superior predictive accuracy compared to traditional approaches, offering valuable insights into student performance trends. The developed framework supports proactive decision-making by enabling institutions to identify at-risk students early and implement targeted interventions. Overall, this study highlights the potential of machine learning-driven predictive analytics to enhance student success and institutional effectiveness in higher education.

Keywords: Student Graduation Prediction, Machine Learning Models, Predictive Analytics in Education, Random Forest & Ensemble Learning, At-Risk Student Identification

ICRTME25-267

Municipal Waste to Energy generation for Electric Vehicle charging- A Sustainable approach

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ABSTRACT

In around the worldwide of urban areas are overcoming with two great challenges: mounting heaps of municipal solid waste and increasing the use of clean energy to fuel electric vehicles (EVs). Each year, billions of tons of wastes are generated and the majority of which is ultimately disposed as landfills.This not only takes up precious space but also produces harmful greenhouse gases like methane and chlorofluorocarbons (CFCs), which worsen climate change. At the same time, the sharp growth in EVs is pressurizing electricity grids that are largely depend upon fossil fuel resources. This shows that while EVs lower emissions from vehicles, their charging station still indirectly contributes to pollution in the environment. In this review, we have created a system that produces a clean electricity from daily municipal waste to power EV charging stations directly. The process includes collection of wastes and segregated into biodegradable and non-biodegradable components. The biodegradable waste is put into an anaerobic digester, in which natural bacteria decompose it to create biogas. The biogas is then purified to generate electricity. The by products developed during the process can be used as an organic fertilizer, whereas non-biodegradable such as plastics can be recycled or pyrolyzed.The power produced is stored in batteries and fed into EV charging points, providing a closed-loop and sustainable charging system. A pilot test indicates that a ton of organic waste can power up seven electric vehiclesfully. Apart from eliminating the waste and pollution, the process also saves money on EV charging and supports circular economic growth. By converting waste into a clean energy resource, this solution contributes to creating cleaner, greener, and smarter cities.

Keywords: Municipal solid waste, bioenergy, biogas generation, electric vehicles(EVs), sustainable mobility, circular economy

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Review and Analysis on Resistance Spot Welded Joints of Stainless-Steel Alloy Using Multi-Objective Optimization

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ABSTRACT

Resistance spot welding (RSW) plays a vital role in sectors such as automotive and railway manufacturing, where it is widely employed to produce reliable joints by combining electrical current with compressive force. Ferritic stainless steels, known for their favorable strength and corrosion resistance, are extensively used in the fabrication of buses and train coaches. Although austenitic stainless steels are also applied in similar domains, their higher cost often makes ferritic grades the preferred choice. In rail coach construction, RSW is frequently applied not only for similar metal joints but also for dissimilar material combinations. While considerable research exists on spot welding of low-carbon steels, advanced high-strength steels, and austenitic stainless steels, comparatively limited information is available regarding the weldability, microstructural behavior, and mechanical response of ferritic stainless steels. The quality of spot welds is strongly influenced by nugget size, which governs load-bearing capacity and energy absorption during service. Studies reveal that the fusion zone typically exhibits increased hardness compared to the parent material, along with columnar ferrite as the predominant solidification structure, and grain coarsening in the heat-affected region. The effects of welding current on joint failure mechanisms have also been highlighted. To address the lack of systematic optimization for ferritic stainless steel spot welds, a multi-response optimization strategy using Taguchi's quality loss function was employed to simultaneously maximize joint strength and minimize electrode indentation. The predicted outcomes were further validated through confirmation trials. Additionally, a first-order regression model was constructed using response surface methodology (RSM) with MINITAB software, establishing quantitative relationships between process parameters, peak load, and indentation depth.

Keywords: Resistance Spot Welding (RSW), Ferritic Stainless Steel, Weld Nugget Optimization, Taguchi Method, RSM, Welding Process Parameters

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Eco-Friendly Ni-P-TiO_2 Composite Coatings on AH36 Steel Using Plant-Extracted Nanoparticles for Marine Corrosion Resistance

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ABSTRACT

Marine environments pose severe challenges to structural materials such as AH36 steel due to accelerated corrosion, leading to reduced service life and increased maintenance costs. In this study, eco-friendly Ni-P-TiO_2 composite coatings were developed on AH36 steel substrates using plant-extracted nanoparticles as sustainable reinforcing agents. The electroless deposition method was employed to ensure uniform coating thickness and enhanced adhesion. The incorporation of bio-synthesized TiO_2 nanoparticles improved surface morphology, microhardness, and hydrophobicity, thereby strengthening the barrier protection. Electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization tests demonstrated significant improvement in corrosion resistance compared to conventional Ni-P coatings. The green synthesis route eliminates toxic chemical stabilizers, offering an environmentally benign approach to advanced surface engineering. The findings highlight that Ni-P-TiO_2 composite coatings reinforced with plant-extracted nanoparticles are a promising solution for extending the durability of AH36 steel in marine applications while promoting sustainability in material processing.

Keywords: AH36 steel, Ni-P-TiO_2, Potentiodynamic polarization, Barrier protection, Sustainable surface engineering.

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Cryogenically Treated Cu-W Electrodes in Die-Sinking EDM of Ti-6Al-4V: Tool Wear, MRR–TWR Trade-offs, and Energy Metrics

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ABSTRACT

Ti-6Al-4V is a widely employed titanium alloy in aerospace and biomedical sectors due to its high strength-to-weight ratio and corrosion resistance. However, its low thermal conductivity and high chemical reactivity pose severe challenges in conventional machining, making die-sinking EDM a preferred process. Despite its advantages, EDM is constrained by excessive tool wear and low energy efficiency, particularly when machining Ti alloys. The research gap lies in limited studies on electrode material conditioning, specifically cryogenic treatment of Cu-W electrodes, to optimize tool wear and machining efficiency. This study aims to evaluate the effect of cryogenically treated Cu-W electrodes on material removal rate (MRR), tool wear rate (TWR), and energy consumption during EDM of Ti-6Al-4V. Experiments were conducted with discharge current (4–12 A), pulse-on time (100–200 µs), and pulse-off time (30–60 µs) using both cryogenically treated and untreated Cu-W electrodes. Results demonstrated that cryogenic treatment reduced electrode wear by 27% at higher current levels, while increasing MRR by 15% under optimized conditions (10 A, 150 µs pulse-on). The MRR–TWR trade-off revealed that cryo-treated electrodes maintained a stable performance window, achieving a 0.78 g/min MRR with only 0.016 g/min TWR. Moreover, energy consumption decreased by nearly 12% due to enhanced spark stability. Conclusively, cryogenically treated Cu-W electrodes significantly improve EDM efficiency for Ti-6Al-4V, balancing productivity with tool longevity. It is recommended that cryogenic treatment be adopted as a cost-effective electrode conditioning technique for high-value machining applications.

Keywords: Die-sinking EDM, Ti-6Al-4V, Cryogenic treatment, Cu-W electrodes, Energy efficiency

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Sustainable Manufacturing Approach to EDM of Hard Alloy

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ABSTRACT

Inconel 718, a nickel-based superalloy, is extensively used in aerospace, energy, and automotive industries due to its outstanding strength and corrosion resistance at elevated temperatures. However, its poor machinability makes conventional machining processes inefficient and resource-intensive. Die-sinking EDM offers a viable solution, but traditional EDM practices consume large amounts of energy, generate harmful by-products, and compromise environmental sustainability. The research gap lies in the limited exploration of sustainable EDM strategies for hard alloys such as Inconel 718, focusing on eco-friendly dielectrics, optimized energy usage, and enhanced machining efficiency. The present study aims to develop a sustainable manufacturing approach for EDM of Inconel 718 by investigating biodegradable dielectrics, optimized discharge parameters, and energy performance indicators. Experiments were conducted using a copper electrode with varying discharge current (4–12 A), pulse-on time (100–200 µs), pulse-off time (30–60 µs), and duty cycle (65–80%). Biodegradable vegetable oil-based dielectric was compared with conventional kerosene. Results showed a 19% improvement in material removal rate (MRR) and 25% reduction in tool wear rate (TWR) using the sustainable dielectric at optimized parameters (10 A, 150 µs, 40 µs, 75%). Specific energy consumption was reduced by 17%, while surface roughness (Ra) improved from 5.6 µm to 3.9 µm. The study concludes that sustainable EDM practices can significantly enhance productivity, surface quality, and energy efficiency while reducing environmental impact. It is recommended that industries adopt biodegradable dielectrics and optimized energy settings for greener machining of superalloys.

Keywords: Sustainable, Sustainable EDM, Inconel 718, Eco-friendly dielectric, Energy efficiency, Surface integrity

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Ultrafine Powder-Mixed Die-Sinking EDM of Inconel 718: Surface Integrity, White Layer Control, and Fatigue Life

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ABSTRACT

Inconel 718 is extensively used in aerospace turbine components owing to its superior mechanical strength and corrosion resistance; however, its poor machinability necessitates the use of non-traditional techniques such as die-sinking electrical discharge machining (EDM). Conventional EDM often induces excessive white layer thickness, microcracking, and poor fatigue resistance, limiting service performance. The research gap lies in the limited exploration of ultrafine powder-mixed dielectric fluids for improving surface integrity and fatigue life of Inconel 718 under controlled energy inputs. The present work aims to investigate the effect of ultrafine Al_2O_3 powder-mixed dielectric in die-sinking EDM on surface quality, recast layer characteristics, and fatigue behavior of Inconel 718. Experimental trials were carried out using a copper electrode with process parameters varied as: discharge current (6–12 A), pulse-on time (100–200 µs), pulse-off time (30–60 µs), and powder concentration (2–6 g/L). Results revealed that powder-mixed dielectric significantly improved material removal rate (up to 18% increase at 10 A, 150 µs), while reducing tool wear by 22%. The white layer thickness decreased from 12.5 µm (conventional EDM) to 6.8 µm with powder assistance, and surface roughness improved from Ra 5.4 µm to 3.2 µm. Most importantly, fatigue life increased by nearly 40% under optimized conditions due to refined surface morphology and reduced microcracks. The study concludes that ultrafine powder-mixed dielectrics can enhance EDM performance for Inconel 718, providing both higher productivity and superior functional life. It is recommended that optimized powder concentration and discharge settings be adopted for critical aerospace components.

Keywords: Die-sinking EDM, Inconel 718, Powder-mixed dielectric, Surface integrity, Fatigue life.

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Akfinity: Intelligent E-Commerce Web Application with Ci/Cd, Automated Monitoring & Selfhealing on Cloud

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ABSTRACT

This project implements an end-to-end DevOps and Cloud Computing pipeline using a sample e-commerce web application as the deployment use case. The e-commerce system provides basic features such as product browsing, search, authentication, and order management, serving primarily as the workload for demonstrating real-world DevOps practices. The main focus lies in automating the software delivery lifecycle through a complete CI/CD pipeline, integrating GitHub, Jenkins, Docker, and AWS to ensure continuous build, testing, and deployment with minimal downtime. Infrastructure is provisioned and managed using Terraform, while monitoring and alerting are achieved with Prometheus, Grafana, and CloudWatch to track performance and uptime. Auto-healing mechanisms are introduced through scripts and serverless functions that detect failures, restart services, and trigger scaling operations when needed. This combination of automation, observability, and resilience ensures high availability, faster release cycles, and industry-ready deployment workflows. By using the e-commerce application as a real-world case study, the project showcases how DevOps and Cloud practices can be leveraged to deliver scalable, fault-tolerant, and production-grade systems.

Keywords: DevOps, Cloud Computing, CI/CD Pipeline, Docker, Jenkins, Terraform, Monitoring, Auto-Healing, Prometheus, Grafana, CloudWatch, E-Commerce Application

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Generative Al for Automated Network Design

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ABSTRACT

A Constraint-Aware Topology Optimization Framework This paper presents a novel generative artificial intelligence framework for automated network topology design that addresses the complex challenge of optimal infrastructure planning in modern computing environments. The proposed system leverages deep learning techniques, specifically PyTorch Geometric for graph generation, to autonomously determine optimal connectivity patterns among servers, routers, and switches while satisfying multiple operational constraints. The framework employs a multi-objective optimization approach that simultaneously considers connectivity requirements, fault tolerance, latency minimization, and resource efficiency, with NetworkX used for constraint validation and graph analysis to ensure adherence to structural requirements such as tree, star, mesh, or ring configurations. An interactive web-based interface built with modern technologies supports real-time configuration and visualization using Graphviz and PyVis, enabling network administrators to prototype and optimize topologies efficiently. Experimental results demonstrate that the system generates feasible designs that outperform traditional methods in terms of resource utilization and fault resilience, successfully handling varying network scales and constraint combinations. This work contributes to Al-driven infrastructure management and establishes a foundation for future research in autonomous network design systems.

Keywords: Network topology optimization, generative AI, graph neural networks, constraint satisfaction, automated infrastructure design.

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ICRTME25-275 Investigation on the Impact of Wetting Agents on the Properties of Electroless Coating Process

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ABSTRACT

Electroless coatings is widely recognized as an effective technique for enhancing surface properties such as corrosion resistance, hardness, and wear behavior without the need for external current sources. The performance of the electroless deposition process is highly influenced by bath chemistry, among which wetting agents play a crucial role in controlling surface coverage, deposit uniformity, and coating quality. This study investigates the impact of different wetting agents on the electroless coating process, focusing on their effect on surface morphology, thickness, adhesion, and corrosion resistance of the deposited layers. Various characterization techniques, including scanning electron microscopy (SEM), X-ray diffraction (XRD), and electrochemical analysis, were employed to evaluate coating performance. The results reveal that the choice and concentration of wetting agents significantly influence coating compactness, porosity reduction, and protective efficiency. The findings provide useful insights into optimizing electroless coating formulations for improved functional properties in industrial and marine applications.

Keywords: Electroless coating, Wetting agents, Surface morphology, Coating thickness, Adhesion, Corrosion resistance, Electrochemical analysis, Coating compactness, Porosity reduction.

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ICRTME25-276 **Smart Wall Wire Detection Using Coil-Based Sensor and Machine**

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ABSTRACT

The proposed project focuses on developing a system capable of detecting hidden electrical wires inside walls using a coil-based sensor.The principle of electro- magnetic induction is utilized, where variations in the magnetic field produced by current-carrying wires are captured by the sensor. The collected signals are processed and analyzed through a machine learning model to determine the presence of wires. This approach provides a low-cost and efficient alternative to traditional wire detectors, offering improved accuracy and adaptability. The project aims to assist in safe construction and renovation activities by reducing the risk of accidental wire damage. In addition, the system is designed to be compact and user-friendly, making it practical for real-world applications. The project demonstrates how simple hardware combined with intelligent software can provide a reliable solution to everyday safety challenges.

Keywords: Wire Detection System, Electromagnetic Induction, Coil-Based Sensor, Machine Learning Analysis, Construction Safety

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Deep Learning-Based Classification of Pneumonia in Chest X-Ray

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ABSTRACT

Pneumonia is a serious respiratory infection that can become life-threatening if not identified early. Traditional diagnosis relies on interpreting chest X-ray images. This process can take a lot of time, is subject to human error, and is often limited by the availability of skilled radiologists in rural and low-resource areas. To address these issues, this work introduces a deep learning-based system for automatically detecting pneumonia from chest X-ray images. The system is created in Python using TensorFlow and Keras on Google Colab, with support from NumPy, Pandas, OpenCV, Matplotlib, and Scikit-learn libraries. The study uses the publicly available Chest X-Ray Pneumonia dataset from Kaggle, which contains images of both healthy lungs and those affected by pneumonia. Preprocessing techniques like resizing, normalization, and augmentation are applied. Classification is done using Convolutional Neural Networks (CNNs) and transfer learning models such as VGG16 and ResNet50. The models are trained with the Adam optimizer and binary cross-entropy loss. Their performance is assessed using accuracy, precision, recall, and confusion matrix. Experimental results show that the models achieve an accuracy greater than 90%, proving their effectiveness for medical image analysis. This study highlights the role of artificial intelligence in providing fast, precise, and accessible diagnostic support for pneumonia detection, thus enhancing healthcare services and reducing diagnostic delays.

Keywords: Pneumonia Detection, Deep Learning (CNN), Chest X-Ray Analysis, Transfer Learning (VGG16, ResNet50), Medical Image Classification

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Diet Planner Using LLaMA Model

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ABSTRACT

This paper introduces a Diet Planner designed to generate personalized meal plans based on individual health profiles and dietary preferences. The system collects user inputs such as age, weight, height, gender, medical conditions, and food choices. These inputs are processed using Natural Language Processing (NLP) techniques powered by the spaCy (an open-source Python library for advanced Natural Language Processing) to extract relevant nutritional data. For meal generation, the planner utilizes the LLaMA (Large Language Model Meta AI) language model, which produces context-aware suggestions tailored to each user's goals. The application emphasizes balanced calorie intake, essential nutrients, and portion control. A comprehensive food database ensures accurate macronutrient calculations, while a built-in validation system confirms nutritional targets before displaying recommendations. Users receive daily and weekly plans, complete with simple recipes and clear instructions. The planner reduces manual effort and provides instant, user-friendly feedback. It also promotes long-term healthy habits through consistent guidance. By integrating spaCy and LLaMA, the system demonstrates how open-source AI tools can enhance personalized nutrition planning. This approach makes expert-level dietary advice more accessible and efficient for non-commercial use. Ultimately, the Diet Planner empowers individuals to take control of their health through intelligent, customized support.

Keywords:NLP, spaCy, LLaMA, AI

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Real-Time Waste Classification and Segregation Using CNN with Automated Dustbin Lid Mechanism

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ABSTRACT

Efficient waste segregation is an important step for sustainable waste management and environmental protection. This work proposes a real-time waste classification and segregation system that uses a Convolutional Neural Network (CNN) to identify and categorize waste as either biodegradable or non-biodegradable. A webcam captures an image of the waste, which the trained CNN model processes to determine its category. The classification result is sent to a microcontroller that controls servo motors to automatically open the lid of the corresponding dustbin. This enables touch-free waste disposal and removes the need for mechanical rollers or pushers. The proposed system shows high classification accuracy, low latency, and flexibility, making it suitable for use in homes, public facilities, and industrial settings. By reducing manual handling, the system improves hygiene, boosts recycling efficiency, and supports eco-friendly waste management practices. Proposed system classifies waste based on detect visible features. Progress in multi-sensor fusion can significantly improve the accuracy of waste classification, particularly in handling mixed waste scenarios.

Keywords: Waste classification, Convolutional Neural Network (CNN), automated dustbin, real-time image processing, waste segregation, AI-based classification.

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Aqua Net+: An Affordable AI-Driven IOT System for Predictive Health Monitoring of Urban Drainage Infrastructure

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ABSTRACT

City flooding, made worse by changing weather patterns and weak urban infrastructure, is a major threat to cities around the world. Older drainage systems, which often get clogged, are poorly designed or fail to work properly, frequently overflow, causing serious economic losses and social problems for affected communities. AquaNet+ is a new smart system that uses AI and connected devices to improve how cities manage their drainage systems. It is designed to move management from a reactive approach, where problems are addressed after they happen, to a predictive approach, where issues can be detected and resolved before they cause damage. The system relies on a network of low-cost, multi-purpose sensors installed inside drains. Each sensor monitors water level, movement, and cleanliness to give a complete understanding of water flow and quality throughout the drainage system. A key feature is the small AI running directly on the device, which can detect unusual events in real time. This makes the system more reliable while reducing the amount of data that needs to be sent to a central server. With the addition of data from multiple sensors, AquaNet+ goes beyond basic flood alerts and can accurately identify specific problems, such as gradual dirt buildup, sudden blockages, and illegal waste dumping. This study shows that AquaNet+ can provide city officials with the timely and precise information needed for targeted, early maintenance. By allowing cities to respond to drainage problems before they escalate, the system strengthens urban resilience and helps communities better cope with the increasing pressures of climate change and rapid urban growth.

Keywords: Urban flooding, IoT, Predictive drainage management, TinyML, Anomaly detection, Edge computing, Sensor Networks, Urban Resilience

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Moisture Absorption and Hardness Behavior of Silica Nanoparticle-Reinforced Kevlar/Carbon/Glass Fiber Hybrid Composite Laminates for Marine Applications

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ABSTRACT

This study investigates the moisture absorption and hardness behavior of silica nanoparticle-reinforced Kevlar/Carbon/Glass fiber hybrid composite laminates for marine applications. Fiber-reinforced composites often face deterioration in seawater due to water diffusion, which weakens matrix-fiber bonding and reduces hardness. To address this issue, silica nanoparticles were incorporated into the epoxy matrix at 0, 1.5, 3, 4.5, and 6 wt.%. The laminates were fabricated using hand lay-up followed by compression molding and then immersed in seawater under controlled conditions. Moisture absorption behavior was evaluated through weight gain and analyzed using density outcomes, while hardness tests were performed to assess mechanical stability.The results showed that silica nanoparticles effectively reduced seawater uptake by filling micro-voids and enhancing the barrier properties of the epoxy matrix. Among the tested concentrations, the 4.5 wt.% loading exhibited the most favorable performance, offering the lowest moisture absorption along with superior hardness retention. However, at 6 wt.% loading, nanoparticle agglomeration slightly reduced efficiency by creating localized defects. The combined effect of Kevlar, carbon, and glass fibers with optimized nanoparticle reinforcement enhanced both durability and mechanical integrity. These findings demonstrate the potential of tailored hybrid composites as high-performance structural materials for marine environments.

Keywords: Hybrid composite, Silica nanoparticles, Moisture absorption, Hardness, Reinforcement

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Health Chatbot

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ABSTRACT

The application of artificial intelligence (AI) in healthcare has created new opportunities to enhance the effectiveness, accessibility, and quality of patient care. One such innovation is the *Health Bot*, an intelligent conversational agent designed to interact with users in natural language and provide trustworthy health-related information. By leveraging natural language processing (NLP), machine learning algorithms, and a structured medical knowledge base, the proposed health bot can understand user queries, evaluate symptoms, and deliver accurate responses. It supports multiple functionalities such as symptom checking, first-level triage, appointment scheduling, medication reminders, and general wellness guidance. The health bot aims to bridge the gap between patients and healthcare providers by offering round-the-clock assistance, particularly in areas where immediate medical consultation is not readily available. Unlike traditional static applications, the health bot ensures a dynamic and personalized experience by tailoring its responses to each user's inputs. Furthermore, it reduces the burden on healthcare professionals by filtering non-critical cases and directing patients to appropriate resources, thereby enabling doctors to focus more effectively on critical conditions. A key strength of the health bot lies in its role in preventive healthcare. By promoting healthy lifestyle practices, monitoring user habits, and sending timely reminders, it encourages individuals to adopt proactive measures in managing their well-being. While it is not a substitute for professional medical services, the health bot serves as a supportive digital assistant that complements existing healthcare systems. By integrating accessibility, efficiency, and intelligence, this technology demonstrates significant potential to revolutionize healthcare delivery and provide affordable, scalable digital support to a wide population.

Keywords: AI Healthcare Chatbot, Natural Language Processing (NLP), Symptom Analysis & Triage, Digital Health Assistance, Preventive Healthcare

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Advanced Materials for Strain Sensors: A Review of Metallic, Polymeric, and Nanocomposite Systems

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ABSTRACT

The need for materials with improved sensitivity, flexibility, durability, and multifunctionality is fuelled by strain sensors, which are essential to developing technologies like wearable electronics, soft robotics, biomedical devices, and structural health monitoring. With an emphasis on metallic, polymeric, and nanocomposite systems, this paper provides a thorough overview of advanced materials employed in strain sensor applications. The high electrical conductivity, stability, and flexibility constraints of metallic strain sensors including conventional metal foils and newly developed thin-film structures are examined. The mechanical compliance, stretchability, and appropriateness of polymeric materials such as conductive polymers and elastomer-based systems for flexible and wearable sensing platforms are evaluated. Additionally, the customizable electrical characteristics, high gauge factors, and multifunctional performance of nanocomposite-based strain sensors integrating nanomaterials such as carbon nanotubes, graphene, metallic nanowires, and hybrid fillers are examined. Across material systems, important sensing mechanisms, production techniques, and structure-property connections are examined. Along with discussing future prospects for the creation of high-performance, dependable, and application-specific strain sensors, the paper also addresses present issues such hysteresis, long-term stability, and scalability. The goal of this project is to give engineers and researchers working on the development and improvement of next-generation strain sensing materials a useful resource.

Keywords: Strain Sensor Materials, Nanocomposite Sensors, Wearable Electronics, Flexible Sensing Systems, Conductive Polymers

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Three-Dimensional Multiphysics Modelling and Performance Evaluation of Proton Exchange Membrane Fuel Cells (PEMFCs) for Sustainable Energy Applications

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ABSTRACT

Hydrogen-based fuel cells are a top option for clean power generation due to global needs for sustainable and clean energy technology. Proton exchange membrane fuel cells are assuring because of optimum performance, compact design, and eco-friendly operation. However, non-uniform current distribution, water imbalance, heat accumulation from complex electrochemical and transport interactions limit performance. The study develops 3-D proton exchange membrane fuel cell model using COMSOL Multiphysics to analyse coupled effects of electrochemical reactions, charge transport, gas diffusion, and thermal behaviour under operating voltages from 0.95 V to 0.4 V. The objective is to optimize operating conditions by understanding the interplay between potential distribution, species transport, and heat generation. Results show that lowering the cell voltage enhances electrochemical activity, giving a peak electrode current density of 1.4×10^4 A/m² and an electrolyte current density of 1.5×10^4 A/m² at 0.4 V. The maximum velocity magnitude of 0.94 m/s confirms efficient reactant transport, and hydrogen and oxygen mole fraction contours reveal effective fuel utilization. Water production shows elevation toward the cathode interface, improving membrane hydration but increasing flooding risk. Total heat emission density reaches 6.8×10^8 W/m³, and overpotential of 0.05 V indicates strong reaction kinetics and polarization effects.

Keywords: Proton Exchange Membrane Fuel Cells (PEMFCs), Electrochemical Modelling, Water Transport Management, Overpotential and Sustainable Energy

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Enhancing the solar Still Performance with Tamarind Seed Powder and Carbonized Tamarind Seed Powder for Fresh Water Production: Energy and Exergy Analysis

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ABSTRACT

In the present investigation, we examined the implications of incorporating tamarind seed powder and carbonized tamarind seed powder as thermal storage materials within a traditional solar distiller (SD) basin to enhance the yield of distilled water. An energy and exergy analysis were conducted for the SD, the SD with tamarind seed powder, and the SD with carbonized tamarind seed powder within the scope of this study. Two distinct types of SD were developed and subjected to experimentation under two different scenarios: SD versus SD with tamarind seed powder and SD with carbonized tamarind seed powder. The findings indicated that, when compared to the conventional SD, the integration of tamarind seed powder and carbonized tamarind seed powder as energy storage mediums resulted in an increase in water output by 46.2% and 85.86%, respectively. In contrast to the SD, which exhibited a water productivity of 1.95 kg, the SD with tamarind seed powder and the SD with carbonized tamarind seed powder attained outputs of 2.89 kg and 3.55 kg, respectively. An examination of the energy efficiency metrics reveals enhancements of 44.75% and 101.02% in energy efficiency when utilizing tamarind seed powder and carbonized tamarind seed powder in the SD, as opposed to the traditional SD. The SD demonstrated an average daily exergy efficiency of 1.17%, which was subsequently elevated to 1.79% and 2.67% with the application of tamarind seed powder and carbonized tamarind seed powder, respectively.

Keywords: Conventional solar distiller,Tamarind seeds, distilled water,Carbonized tamarind seed powder

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Integrated Design and Fabrication of a Blanking Stamping Tool for Industrial Applications

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ABSTRACT

This project focuses on the design and manufacture of a blanking stamping tool used for sheet metal processing in mass production industries. Blanking, a primary press tool operation, produces flat components by cutting the periphery of a sheet, forming the foundation for subsequent manufacturing processes. The project involved detailed design calculations to determine blanking force, press capacity, and clearance for accurate punch and die dimensions. The tool assembly comprises the top and bottom plates, blanking die plate, punch, stripper plate, thrust plate, guide bush, guide pillar, and shank. High Carbon High Chromium (HCHCR) steel was employed for the punch and die due to its wear resistance, while mild steel was used for structural components. Fabrication was carried out using conventional machining and EDM wire cutting for precision. The prototype tool successfully blanked sheets of mild steel, aluminium, and zinc up to 0.5 mm thickness, achieving medium-scale production of 8,000–12,000 parts.

Keywords: Blanking tool, Press tool design, Sheet metal, Punch and die, EDM machining, Fabrication.

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PROGRAMME SCHEDULE

Day 1 – Inaugural & Planetary Sessions

09:00	-	10:30	Registration
10:30	-	10:40	Welcome Address **Dr. M. Chandrasekaran**, Professor & Director
10:40	-	10:50	Presidential Address **Dr.M. Bhaskaran**, Vice-Chancellor (FAC)
10:50	-	11:20	Inaugural Address **Dr. Siow Chun Lim** Associate Professor, Multimedia University, Malaysia
11:20	-	11:30	Keynote Address **Dr. Muhammad Izzat Nor Bin Ma'arof** Professor, Mechanical Engineering, INTI International University, Malaysia
11:30	-	11:45	High Tea
11:45	-	13:00	Technical Session I Keynote Speaker **Dr . Mahmoud Nassar** Director of the Center for Innovation and Industrial Partnerships (CIIP) Mechanical Engineering, Palestine Polytechnic University, Hebron, Palestine
13:00	-	14:00	Lunch Break
14:00	-	15:15	Technical Session II Keynote Speaker **Dr. Ragavanantham Shanmugam** Professor & Head, Department Of Applied Engineering, Alabama, USA
15:15	-	15:30	High Tea

Day 2- Technical & Valedictory Sessions

10:30	-	11:30	Technical Session III Keynote Speaker **Hamid Ziaiefar** Senior Mechatronics Engineer, National Oilwell Varco, Melbourne, Australia
11:30	-	11:45	High Tea
11:45	-	13:00	Technical Session IV Keynote Speaker **Dr. K. Elangovan** Associate Professor, Department of Rubber And Plastic Technology, MIT, Chennai
13:00	-	14:00	Lunch Break
14:00	-	15:15	Valedictory Session
15:15	-	15:30	Vote of Thanks
15:30	-	15:45	High Tea

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