4TH SLIIT INTERNATIONAL CONFERENCE ON ENGINEERING AND TECHNOLOGY (SICET) 2025

"NEXT GENERATION ENGINEERING FOR DIGITAL AND SUSTAINABLE SOLUTIONS"

BOOK OF ABSTRACTS

The articles published in the proceedings are based on engineering research and some are of professional interest. All published papers have been refereed in anonymity by at least two subject specialists.

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Preface

It is my great pleasure to present the proceedings of the 4th SLIIT International Conference on Engineering & Technology (SICET 2025). SICET continues to grow as a platform where rigorous scholarship meets practical impact—bringing together researchers, students, industry practitioners, and policymakers to co-create solutions for the public good.

This year's programme reflects both scale, international and quality. We received 176 submissions, from which 102 papers were selected through a double-blind review process. To broaden participation and practical skills, we ran 11 pre-conference workshops, 5 of which were international, featuring hands-on tutorials and emerging methods from global partners. Ensuring fairness and depth in evaluation, over 250 reviewers contributed to the double-blind process, with meta-review and TPC decisions taken per track to balance novelty, reproducibility, and societal impact.

SICET's intellectual breadth spans 11 technical tracks—from Next-Generation Communications & Networking, AI & Data-Driven Engineering, and Clean & Renewable Energy to Mechatronics & Robotics, Thermal & Fluid Engineering, Biomedical Engineering & Smart Health Systems, Sustainable Built Environment, Circular Economy, ICT for Societal Development, Next-Generation Transportation, and Construction Dynamics & Digitalisation. Our community is proudly international, with authors and institutions represented from Australia, Bangladesh, Canada, India, Japan, Kosovo, Maldives, Portugal, Russia, South Korea, the United Kingdom, and the United States, alongside Sri Lankan universities and research institutes.

The technical agenda is anchored by two distinguished Keynote Speakers—Prof. Sofiène Affes (INRS, Canada) and Prof. Andrey Koucheryavy (SPbSUT, Russia)—and complemented by two timely panel discussions: *"The Future of Research in Sri Lanka: Vision for 2030"* and *"AI in Engineering: Our Perspective."* Reflecting our commitment to translation and impact.

Our publication pathway ensures visibility and archival value. Proceedings are planned via the ACM International Conference Proceedings Series (ICPS), with selected papers invited to partner journals, including Advances in Science & Technology (AST), Key Engineering Materials (KEM), ARIS² etc.

I am deeply grateful to the Vice Chanceller and the University management, Dean of Engineering, Technical Programme Committee, Publication Committee, Track Chairs, over 250 reviewers, Workshop chairs and Logistics Committee, the Organising Committee, and our many volunteers for their exemplary service from Faculty of Engineering of SLIIT; to our authors for entrusting us with their best work; and to our partners and supporters for enabling this community to thrive. I must thank all our Sponsers who made this event a success. I invite all participants to engage with these proceedings—build on the ideas presented here, challenge assumptions, and collaborate across disciplines and borders to advance knowledge and deliver meaningful impact.

Prof. Dush N. K. Jayakody
General Chair, SICET 2025

Message from the Chancellor

It is with great pleasure that I extend my warmest congratulations to the organizers of the 4th SLIIT International Conference on Engineering & Technology (SICET 2025) and to all the authors whose work is featured in these proceedings. SICET continues to serve as a reputable, multidisciplinary forum that unites researchers, practitioners, and students to exchange ideas that advance engineering and technology for the benefit of society.

This year, the conference received 176 submissions from around the globe, including contributions from the UK, Australia, Canada, Europe (notably Portugal and Cyprus), China, Pakistan, and many others. Additionally, we welcomed representation from nearly all universities and research institutes in Sri Lanka. Following a rigorous peer-review process conducted by multiple independent reviewers, 102 papers were accepted for presentation across various technical tracks, demonstrating our community's commitment to quality and relevance. Selected papers will be published in the conference proceedings and featured in select journals, ensuring global visibility and lasting accessibility for the research presented.

SICET 2025 encompasses eleven technical tracks that cover both core and emerging areas of engineering. I am particularly pleased to highlight the introduction of an Industry Track this year, an initiative aimed at strengthening collaboration between industry and academia, fostering technology transfer, and inspiring solutions with real-world impact. This vital connection between research and practice is crucial for Sri Lanka's innovation ecosystem and for the professional growth of our graduates.

I would like to express my sincere gratitude to the Technical Program Committee, Track Chairs, Reviewers, Publication Partners, Sponsors, and the many dedicated staff and student volunteers whose efforts made this conference possible. To all authors and participants, I wish you fruitful discussions, the establishment of meaningful new partnerships, and continued success in your research endeavors.

With best wishes for a productive and memorable SICET 2025.

Prof. Lakshman L. Ratnayake
Chancellor - SLIIT

Message from the Vice-Chancellor

It is with great pleasure that I welcome you to the 5th International Conference on Engineering and Technology (SICET 2025), organised by the Faculty of Engineering at SLIIT. SICET has established itself as a respected forum where research, practice, and education come together to address important challenges in engineering and technology. This year, the conference brings together participants from around the world, along with a strong representation from Sri Lanka's universities and research institutes. This demonstrates both the diversity of our scholarly networking and the importance of international collaboration in today's world.

As Sri Lanka moves forward in a knowledge-based economy, producing highly capable researchers and graduates is essential. SLIIT is committed to supporting this effort through various research funding opportunities, industry partnerships, and international engagements. I am confident that the discussions at this conference will focus on real challenges and practical solutions that can contribute to a sustainable and progressive future. This year's conference has received more than 170 submissions from international scholars and various universities and research institutes in Sri Lanka. Such participation reflects the confidence of the academic community in SICET as a valuable platform. The technical program that spans over a wide range of areas, from next-generation communications and artificial intelligence to clean energy, smart health systems, and sustainable cities, showcases that these themes closely align with SLIIT's research priorities and its commitment to addressing real needs in society. The inclusion of an Industry Track further reflects our culture of collaboration, where academic research is connected with practical applications to create a meaningful impact for communities and industry alike.

The publication opportunities offered by SICET through international partners and SLIIT's own journals ensure that the outcomes of this conference will reach beyond these sessions and support future research and development. We are also privileged to host keynote speakers Prof. Sofiène Affes from the Institut national de la recherche scientifique (INRS), Canada, and Prof. Andrey Koucheryavy from The Bonch-Bruevich Saint-Petersburg State University of Telecommunications (SPbSUT), Russia, whose insights will guide and inspire the discussions.

The success of this conference comes from the contributions of its participants, and their commitment gives SICET its true value. I would also convey my appreciation to the organising committee and the Faculty of Engineering for the effort and dedication that made this event possible. All participants are encouraged to engage actively, share knowledge, and build meaningful collaborations. I am confident that SICET 2025 will mark another important step in advancing engineering, technology, and related fields.

Professor Lalith Gamage
Vice Chancellor/ Chief Executive Officer, SLIIT

Message from the Senior Deputy Vice-Chancellor & Provost

SICET 2025 is both a showcase of frontier research and a classroom without walls. This edition brings our community together in a hybrid format, welcoming participants on site and online. The spirit of SICET is collaborative and future-facing—uniting scholars, students, industry, and policymakers to translate ideas into solutions that benefit society.

The Technical Programme reflects academic rigor and translational relevance. From 176 submissions, 102 papers were selected through a double-blind review process—with 35 international paper submissions, sessions balanced for novelty, innovation, and societal impact.

The audience is proudly global, with participation from institutions in Sri Lanka, Australia, Bangladesh, Canada, India, Japan, Kosovo, the Maldives, Portugal, Russia, South Korea, the United Kingdom, and the United States—a testament to SICET's growing international reach. This diverse participation underscores the global impact of our work. Two distinguished Keynote Speakers anchor the agenda: Prof. Sofiène Affes (INRS, Canada) and Prof. Andrey Koucheryavy (SPbSUT, Russia). In addition, two timely panel discussions—*"The Future of Research in Sri Lanka: Vision for 2030"* and *"AI in Engineering: Our Perspective"*—bring together national leaders from the NSF, NRC, the Ministry of Science & Technology, senior academics, and advisors to examine policy, talent pipelines, and innovation pathways.

The conference features a unique Industry Connect stream that highlights deployable solutions and university–industry partnerships with tangible outcomes. These outcomes include pipelines for internships, joint R&D, and sponsored capstones, demonstrating the real-world impact of our work. The publication pathway underscores quality and visibility.

I extend my sincere appreciation to the authors, reviewers, Track Chairs, the Technical Programme Committee, the organizing team, sponsors, and the Faculty of Engineering of SLIIT. Their invaluable contributions have been instrumental in making SICET 2025 a resounding success. I encourage participants to mentor generously, ask bold questions, and convert the insights gained this week into sustained collaborations that yield global benefits.

Prof. Nimal Rajapakse
Senior Deputy Vice-Chancellor & Provost, SLIIT

Message from the Dean, Faculty of Engineering

It is a pleasure to extend my warmest greetings to all participants of SICET 2025 and to present this message on behalf of the Faculty of Engineering (FoE), SLIIT. SICET has become a signature achievement of our university—an arena where high-quality engineering research is shared, challenged, and transformed into solutions that benefit society.

This year's conference again reflects both breadth and rigour. The Technical Programme spans 11 tracks and a rich slate of 11 pre-conference workshops, 5 of which were delivered by international experts. Upholding academic integrity, the double-blind review was supported by over 250 reviewers, ensuring careful assessment and constructive feedback for every submission. The resulting programme showcases outstanding work across communications and networking, AI and data-driven engineering, energy and sustainability, mechatronics and robotics, biomedical systems, the built environment, and more.

On behalf of the Faculty of Engineering, I wish to record my sincere appreciation to our leadership for their continuous guidance and encouragement: the Chancellor, the Vice-Chancellor, and the Senior Deputy Vice-Chancellor & Provost. I also thank our General Chair, Prof. D. N. K. Jayakody and the Organising Committee, Track Chairs, the Technical Programme Committee, and the many reviewers, workshop leads, volunteers, and staff whose dedication has made SICET 2025 possible. We are grateful as well to our distinguished keynote speakers and to our partners from academia, industry, and government for their collaboration.

I trust that you will find the conference, its presentations, and these proceedings valuable to your current and future research and development work. I encourage you to use SICET to exchange ideas, build new collaborations, and strengthen the bridges between universities, research institutes, industry, and society.

Wishing you a stimulating and rewarding SICET experience.

Prof. Ayantha Gomes
Dean, Faculty of Engineering, SLIIT

Acknowledgement

We are pleased to host the 4th SLIIT International Conference on Engineering and Technology (SICET 2025) in Colombo and Malabe, Sri Lanka. This multidisciplinary forum provides a valuable platform for scholarly exchange, welcoming contributions across diverse research areas including **Sustainable** Built Environment, Sustainable Consumption and Production, ICT for Societal Development, Transportation Systems, Mechanics, Robotics and Intelligent Systems, Thermal and Fluid Engineering, Energy and Renewable Energy Systems, Hydraulics and Water Resources, Communication and Networking, Electrical Power Systems, Machine Dynamics and Design, Contract and Risk Management, and Industry Connect technical activities.

SICET aims to unite researchers, academics, industry professionals, and policymakers in a collaborative environment to share insights, disseminate findings, and explore the latest advances in engineering and technology. To maintain the highest standards of quality, all submissions have undergone a rigorous double-blind peer review process conducted by distinguished local and international experts. Only papers that exemplified originality, innovation, and scholarly excellence were accepted, thereby ensuring the conference's credibility and impact.

Further, we would like to express our heartfelt appreciation to all who played a vital role in the success of this event. We are grateful to the authors and presenters for their insightful contributions, the reviewers for their meticulous evaluations, the session chair and co-chair for their valuable contributions within the sessions, and the organising committee for their unwavering commitment and hard work. We also give our fullest gratitude to the sponsors for their valuable contributions and support.

We are excited about the potential for further collaboration and knowledge creation stemming from the research presented here. We encourage your ongoing exploration in cutting-edge research areas, and we eagerly anticipate your continued engagement and contributions to advance engineering and technology through SICET 2026.

On behalf of the Organizing Committee,

Prof. Prasanna Gunawardane
Publication Chair, SICET 2025

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MECHATRONICS, ROBOTICS, AND AUTONOMOUS SYSTEMS

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Pre-Conference Workshops

Workshop 1: Building Information Modelling (BIM) for Structural Detailing
Conducted by: Eng. Udara Perera (SLIIT) and Eng. Sudara Withana (SLIIT)
Date: 21st May 2025

Building Information Modeling (BIM) represents a significant shift in the construction sector. It provides numerous benefits across various Civil Engineering sub-domains, particularly for structural engineers, who can leverage this software for structural detailing, particularly in rebar modeling and layout preparation.
Eng. Udara Perera is a Lecturer in the Faculty of Engineering at the Sri Lanka Institute of Information Technology (SLIIT), specializing in Civil Engineering. He is recognized for his expertise in Building Information Modeling (BIM) and green building technologies.
Eng. Sudara Withana is a Lecturer in the Department of Civil Engineering at SLIIT since 2025. His background combines academic and hands-on engineering expertise in water supply and construction projects.

Workshop 2: Telco Softwarization: The Road to Cloud-Native, AI-Driven, and Autonomous Networks
Conducted by: Eng. Anuradha Udunuwara (Sri Lanka Telecom)
Date: 23rd May 2025

The telecommunications industry has evolved significantly over the past 170 years, navigating numerous technological and business transitions. Today, Telcos face increasing pressure to reduce operational costs and generate new revenue streams in a rapidly transforming, hyper-connected digital economy shaped by shifting customer demands and market dynamics. Telco Softwarization—originally encompassing SDN (Software Defined Networking), NFV (Network Functions Virtualization), and Cloud—emerged as a response to these challenges. With recent advancements in cloud-native technologies, AI, and automation, the concept has matured, offering new pathways for Telcos to become more agile, efficient, and future-ready. This workshop aims to introduce the concept of Telco Softwarization, examine how it addresses current industry challenges, and explore its role in enabling next-generation, autonomous networks.
Eng. Anuradha Udunuwara is a seasoned Telecom & Technology expert with over 20 years of industry experience, currently serving as a Senior Engineer specializing in Enterprise Business Solutions at Sri Lanka Telecom. He is recognized as a thought leader and trusted advisor in telecom strategy, digital transformation, and next-generation network technologies, including SDN, NFV, cloud computing, and AI-driven networking.

Workshop 3: Intelligent High Frequency Communications- The Foundation of 6G
Conducted by: Prof. Alexandros-Apostolos (Aristotle University of Thessaloniki)
Date: 06th June 2025

Prof. Alexandros-Apostolos is an academic with a Ph.D. degree in Electrical and Computer Engineering from Aristotle University of Thessaloniki. His doctoral research focused on interference mitigation techniques in modern wireless communication systems. His research interests include wireless telecommunications, high-frequency wireless systems, and next-generation communications such as 6G. He is an active member of IEEE and contributes to both teaching and research in wireless communication technologies.

Workshop 4: GIS for civil engineers
Conducted by: Eng. Rashini Weerasinghe
Date: 05th and 31st July 2025

This session introduces the fundamentals of Geographic Information Systems (GIS) with a focus on its practical applications in civil engineering. Participants will gain insights into how spatial data and analysis tools support decision-making in urban planning, transportation, water resources, surveying, and environmental management.
Eng. Rashini Weerasinghe holds a BSc (Hons) degree in Civil Engineering along with a Diploma in Geographic Information Systems (GIS). She is motivated to contribute positively in the field of civil engineering, focusing on applications of GIS in urban planning, transportation, water management, and environmental projects.

Workshop 5: All Roads Lead to TinyML: The Rome of Efficient Machine Learning in Engineering
Conducted by: Dr. Dinuka Sahabandu (SLIIT), Dr. Nushara Wedasingha (SLIIT), Ms. Madusha Weerasooriya (SLIIT), Mr. Asiri Gawesha (SLIIT) & Mr. Sanka Mohottala (SLIIT)
Date: 20th August 2025

TinyML represents the convergence point of multiple pathways to efficient machine learning—each grounded in the practical demands of engineering systems. This workshop explores how diverse forms of efficiency—parameter, computational, energy, data, task, and connectivity—collectively enable the deployment of intelligent models on resource-constrained platforms. These efficiency pathways directly address challenges in engineering fields such as energy, civil infrastructure, healthcare, transportation, and environmental monitoring, where AI must operate under tight constraints in terms of power, memory, and latency. By aligning theoretical techniques with real-world use cases, the workshop bridges the gap between advanced ML research and its practical deployment across the engineering spectrum.
Dr. Dinuka Sahabandu is an Assistant Teaching Professor in the Department of Computer Science at SLIIT. He has extensive expertise in machine learning, game theory, and cybersecurity. His research work includes developing advanced algorithms for the security of cyber-physical systems, and his PhD research has been recognized and commercialized internationally, including by the U.S. Naval Research Laboratory.
Dr. Nushara Wedasingha: Lecturer at SLIIT, involved in teaching and research activities. She contributes to academic programs likely related to computing and technology, fostering innovation in her field.
Ms. Madusha Weerasooriya: Assistant Lecturer at SLIIT supporting teaching and academic development, possibly assisting in research and student mentoring within the faculty.
Mr. Asiri Gawesha: Research Assistant at SLIIT, engaged in supporting research projects and academic initiatives, contributing to the advancement of knowledge in his area of expertise.
Mr. Sanka Mohottala: Academic Instructor at SLIIT, focused on instruction and training, particularly in emerging fields such as TinyML and efficient machine learning applications for engineering.

Workshop 6: Strengthening Power System Stability: Techniques and Strategies for High Renewable Penetration
Conducted by: Eng. Ravi Prematilaka (BC Hydro Generation Engineering)
Date: 29th August 2025

Power system stability is a broad subject spanning to different areas of interest. "Frequency Stability" is one of the fundamental areas of concern especially in the realm of increased penetration of inverter-based resources (IBRs), renewables such as solar and wind. Although the supplemental energy seems more attractive, the non-dispatchable and non-inertia nature of these IBRs challenges the power system stability with different set of problems.
The workshop mainly focuses on frequency stability in terms of electrical power generation side of the business. The presenter's expertise in electrical power transmission side of the business is limited but an attempt will be made to answer questions on voltage stability, transient stability, FACT devices etc. which are considered as out of scope items.
Eng. Ravi Prematilaka holds a BSc Engineering degree from the University of Moratuwa, Sri Lanka, an MSc from the University of Windsor, Canada, and a PhD from the University of British Columbia, Canada. He is an expert in power system stability, focusing on frequency stability, particularly in systems with high renewable energy penetration. He has academic and engineering expertise that bridges international education and industry practices.

Workshop 7: Driving Sustainability in the Building Sector – Use of Tools for Whole Building Life Cycle Assessment, Life Cycle Costing and Building Circularity Index
Conducted by: Prof. Shiromi Karunaratne (SLIIT), Eng. Madhavi Herath (SLIIT), Eng. Madhushika Senanayake (SLIIT) & Eng. Abiru Abayapala (SLIIT)
Date: 09th September 2025

This workshop is designed for engineers, architects, and quantity surveyors focused on integrating sustainability into building practice through advanced assessment methodologies. It will provide in-depth guidance on the application of Whole Building Life Cycle Assessment (WBLCA), Life Cycle Costing (LCC) and the Building Circularity Index (BCI) as decision-support tools in design, specification, and procurement. Participants will explore how to quantify environmental impacts and circularity performance across a building's life cycle, with hands-on demonstrations, case study analysis, and discussion on aligning these tools with regulatory frameworks and green certification systems.
Prof. Shiromi Karunaratne is a Professor in Civil Engineering at SLIIT with a PhD and extensive experience in sustainability assessment in the building sector. She focuses on developing methods and tools for assessing building sustainability based on life cycle thinking. Her work emphasizes whole building life cycle assessment, life cycle costing, and building circularity to promote sustainable construction practices.
Eng. Madhavi Herath is an Instructor in the Faculty of Engineering at SLIIT, specializing in Civil Engineering. She holds a BSc Engineering (Hons) and has research interests in building sustainability and environmental engineering.
Eng. Madhushika Senanayake is a civil engineer affiliated with SLIIT's Department of Civil Engineering, contributing to academic teaching and research efforts focused on sustainable construction and civil infrastructure (based on typical departmental roles and collaborations).
Eng. Abiru Abayapala is part of the Department of Civil Engineering at SLIIT, engaged in civil engineering education and research, aiding in development of sustainable building practices and engineering solutions.

Workshop 8: Steam Engineering Applications for the industry
Conducted by: Eng. Janith Ratnaweera (Thermax Ltd, Sri Lanka)
Date: 09th September 2025

Steam engineering plays a vital role in various industries, including manufacturing, food processing, textiles, and power generation. With the increase in energy costs, efficient steam systems are essential for process heating and energy generation, contributing to cost savings and sustainability. Optimizing steam distribution and condensate recovery enhances productivity, reduces operational costs, and supports Sri Lanka's transition towards greener industrial practices. Regular system audits and maintenance help prolong equipment life, improve reliability, and maintain consistent performance.
Eng. Janith Ratnaweera is a Senior Applications Engineer at Thermax Ltd in Sri Lanka. He holds an M.Sc. and a B.Sc. (Hons) in Mechanical Engineering from the University of Moratuwa. Janith has experience in engineering applications related to energy efficiency, steam systems, and thermal energy solutions, contributing to sustainable industrial practices in sectors like manufacturing and processing.

Workshop 9: Digital Innovation: From Fashion Design to Apparel Manufacturing
Conducted by: Dr. R. K. J. De Silva (Department of Textile and Apparel Engineering,University of Moratuwa)
Date: 09th September 2025

This workshop focused on the digital technologies utilized in the fashion and apparel industry, particularly in relation to the digital product creation process. This workshop will provide participants with both theoretical insights and practical perspectives, empowering them to innovate and contribute to the digital future of the apparel sector. The session is thoughtfully designed to bridge the gap between industry expertise and software development, facilitating the creation of next-generation fashion tools. Participants will have the opportunity to explore our team's VR and AR applications and engage in a discussion with an educational consultant from a leading 3D CAD software organization.
Dr. R. K. J. De Silva is a Senior Lecturer in the Department of Textile and Apparel Engineering at the University of Moratuwa, Sri Lanka. She specializes in new product development for the apparel industry, focusing on virtual prototyping, digital transformation, and the application of virtual and augmented reality technologies in apparel design and manufacturing. Her research contributes to advancing fit precision, sustainable apparel production, and digital innovation in the textile sector, supporting academic and industrial progress in garment technology.

Workshop 10: Smart and Sustainable Technologies for Next-Generation Cities
Conducted by: Prof. Ammar Muthanna (Saint Petersburg, Russia), Dr. Ahmed Mohamed Aziz Ismail, (School of Engineering, Central Asian University) & Dr Rakesh Vaid (Department of Electronics,the University of Jammu, India)
Date: 09th September 2025

This workshop brings together cutting-edge innovations that collectively advance the vision of smart, sustainable, and resilient urban environments. The session on AI for City Verse Services Optimization explores how holography, virtual and augmented reality, and AI-driven insights can transform city planning, service delivery, and citizen engagement in next-generation urban systems. The discussion on Compressive Sensing for IoT Applications addresses critical challenges in energy efficiency, data security, and network performance, presenting novel solutions to optimize IoT-enabled smart services. Meanwhile, the talk on Triboelectric Nanogenerators highlights emerging energy-harvesting technologies that convert ambient mechanical energy into clean electricity, supporting decentralized and eco-friendly power systems. Together, these sessions emphasize the integration of digital intelligence, sustainable energy solutions, and efficient data management as key enablers of future cities. The workshop outcomes point toward cross-disciplinary collaboration, offering pathways for smarter decision-making, reduced environmental impact, and enhanced quality of life in urban settings.
Prof. Ammar Muthanna is a professor based in Saint Petersburg, Russia, known for his research and academic contributions in smart and sustainable technologies, particularly in the context of next-generation cities.
Dr. Ahmed Mohamed Aziz Ismail is the Dean of the School of Engineering at Central Asian University. He holds advanced degrees including a PhD and DSc in Computer Science, specializing in Cybersecurity and Artificial Intelligence. Dr. Aziz has over 17 years of academic and leadership experience globally and is active in research on Smart Cities, AI, IoT, and network security.
Dr. Rakesh Vaid is a professor and former head of the Department of Electronics at the University of Jammu, India, with expertise in electronics and communications, contributing significantly to research and academic leadership in his field.

Workshop 11: Smart Procurement Strategies to Mitigate Supply Chain Risks in the Built Environment
Conducted by: Ch.QS Janitha Bogamuwa (National Highways, United Kingdom), Ch.QS Majith Kodithuwakku (International Construction Consortium (Pvt) Ltd.), & Dr. Thamasha Jayanetti (SLIIT)
Date: 09th September 2025

The construction industry supply chain in Sri Lanka faces significant challenges such as dependency on imports, small-scale suppliers, fragile policies, limited technological adoption, and quality control issues. These risks directly impact project cost, timelines, and overall quality. This workshop will explore how smart procurement strategies and digital integration can address these challenges, improve efficiency, and strengthen resilience. Drawing from both local experiences and international best practice, the session will provide actionable insights into innovative procurement methods, policy interventions, and capacity-building initiatives tailored for the Sri Lankan context.
Ch.QS Janitha Bogamuwa is the Lead Commercial Manager at National Highways, United Kingdom. He is a Chartered Quantity Surveyor with extensive experience in commercial management, contract administration, and project delivery within large infrastructure projects.
Ch.QS Majith Kodithuwakku is the General Manager of Estimates and Contracts at International Construction Consortium (Pvt) Ltd., with expertise in construction project cost management, contracts, and procurement strategies.
Dr. Thamasha Jayanetti is a Senior Lecturer at Sri Lanka Institute of Information Technology, Malabe. She specializes in construction management, supply chain integration, and digital innovation in the built environment.

Keynote 01:Optimization Methods in Computational Intelligence for Joint Wireless Channel Parameter Estimation over Advanced Radio Interface Technologies

Prof. Sofiene Affes
Wireless Communications Group
Institut national de la recherche scientifique (INRS), Canada

ABSTRACT

Advanced Radio Interface Technologies (RITs) combine broadband signalling—hence multi-carrier operation and richly multipath propagation—with multi-antenna transceivers. In these regimes, joint estimation of channel parameters (angles of arrival/departure, delays, Doppler/frequency offsets, gains/phases, etc.) becomes a central yet challenging inference problem. Objective or cost functions are often nonconvex, multimodal, and simulator-defined, with scarce gradients, tight pilot budgets, and low signal-to-noise ratios (SNRs). Therefore, among computational intelligence (CI) categories that encompass 1) neural networks and 2) fuzzy systems, the third or 3) population-based and bioinspired optimization (PBO/BO) methods – such as particle swarm optimization (PSO), differential evolution (DE), genetic algorithms (GA), grey wolf optimizer (GWO), and related swarms – have gained traction as global search engines that either directly minimize maximum-likelihood (ML) or mean-square error (MSE) criteria or act as robust initializers for hybrid pipelines. In this talk, first we integrate a disciplinary taxonomy relating artificial intelligence (AI), optimization, and Monte Carlo inference to place CI and PBO/BO within a broader computational context worth contemplating. Then we survey the current state of the art on CI optimization for wireless channel parameter estimation and analyze the strengths and weaknesses of each CI subcategory versus the others and against conventional estimation methods. We synthesize algorithmic patterns, objectives, accuracy, convergence/complexity trends, and empirical findings, etc., over advanced RITs, and we discuss most recent progress and open challenges.

BIOGRAPHY

Sofiene Affes received the Engineering Diploma in Telecommunications and the Ph.D. Degree (Hons.) in Signal Processing from Telecom Paris-Tech (ENST), Paris, France, in 1992 and 1995, respectively. He has been since with INRS, Montreal, QC, Canada, as a Research Associate until 1997, an Assistant Professor until 2000, an Associate Professor until 2009, and from then on as a Full Professor. From, 2013 till 2019, he was the Director of PERWADE, a unique 4M$ research-training program on wireless in Canada involving 27 academic and industrial partners from 8 universities and 10 industrial organizations. Dr. Affes has been twice the recipient of a Discovery Accelerator Supplement Award from NSERC, from 2008 to 2011 and from 2013 to 2016. From 2003 to 2013, he held a Canada Research Chair in Wireless Communications. And from 2017 to 2022, he was the recipient of a Cyrille-Duquet Research Chair in Telecommunications. In 2008 and 2015, he received the VTC and ICUWB Chair Recognition Award and Certificate from IEEE VTS and MTT-S, respectively, for exemplary contributions as General Co-Chair to the success of both conferences held at their Fall 2006 and 2015 editions in Montreal. In 2017, he served as General Chair of IEEE PIMRC also held in Montreal. His team received Best Paper Awards at IEEE Globecom, IEEE ICASSP, and IEEE VTC. He has been or is currently an Editorial Board Member for the IEEE Transactions on Communications, Signal Processing, and Wireless Communications, for the Wiley Journal on Wireless Communications & Mobile Computing, the MDPI Sensors and Sci Journals, and the Electronics and Signal Processing Journal.

Keynote 02: Triple Play: AI, MV, and HTC

Prof A. Koucheryavy
Chaired Professor, Telecommunication Network and Data Transmission Department
The Bonch-Bruevich Saint-Petersburg State University of Telecommunications, Russia

ABSTRACT

At the beginning of the 21st century, with the convergence of communication networks, the term Triple Play, which included voice, video, and data services, became a popular term for the provision of services by next-generation networks. At that time, this approach meant the unity of the convergent network and the universality of the services provided to the user.Now, about a quarter of a century after that time, the development of communication networks is taking place in the direction of creating various kinds of universes based on artificial intelligence technologies. Even urban universes have appeared as a development of smart cities. At the same time, the design Artificial Intelligence (AI) plus Metaverse (MV) was considered quite popular for some time. At the global standardization symposium in New Delhi in October 2024 during WTSA-24, it was proposed to supplement this dual with a holographic type of communications (HTC). This was necessary because there is a fairly widespread opinion that society will become holographic by 2030. This proposal was made by the ITU-T Focus Group Leader Richard Lee in 2018 at the first meeting of the focus group. Considering the great potential of holographic universes and the development of technologies in the field of providing holographic telepresence services, it seems useful to use the triune design of AI + MV + HTC at present.

The report further discusses the development of artificial intelligence in the field of communication networks, the transformation of metauniverses into holographic network universes (HolNetVerse), work in the field of creating various terminals for holographic interactions and implementing telepresence services, the creation of holographic universities, the creation of holographic cities using the example of St. Petersburg, the development of a telepresence suit with parametric feedback, the capabilities of such telepresence suits together with a network universe for remote rehabilitation of patients using the example of recovery for children with upper limb injuries. All these applications show how effective the use of the new Triple Play AI + MV + HTC can be.

BIOGRAPHY

After graduating from Leningrad University of Telecommunications in 1974, A. Koucheryavy joined Telecommunication Research Institute LONIIS, where he worked till October 2003 (from 1986 to 2003 as the First Deputy Director). Dr. A. Koucheryavy holds Professor position at the Bonch-Bruevich St. Petersburg State University of Telecommunications (SUT) since 1998. There, in 2011 he became a Chaired Professor in “Telecommunication Networks and data transmission” department. Dr. A.Koucheryavy was an advisor of the Central Science Research Telecommunication Institute (ZNIIS) from 2003 to 2010. Co-founder of the International Teletraffic Seminar (1993, 1995, 1998, 2002); founder of the model network for digital networks at LONIIS (1997); co-founder of the model network for packet networks at ZNIIS (2004); co-founder of the Internet of Things Laboratory (2012) and Quality of Experience and IPTV Laboratory (2014) at SUT. Chair of the Scientific school on teletraffic theory in LONIIS (1990 – 2003); Founder and scientific school chair “Internet of Things and self-organizing networks” in SUT (2010 up to now); Steering committee member of IEEE technically co-sponsored series of conferences ICACT, NEW2AN and ICFNDS, Chair of ICACT 2020 International Steering Committee. SG11 ITU-T vice-chairman 2005 – 2008, 2009 – 2012. WP3/WP4 SG11 chairman 2006 – 2012, WP4 SG11 vice-chairman 2015-2016, Chairman of SG11 from 2016 up to March 2022. Co-founder of International Testing Center for new telecommunications technologies at ZNIIS under ITU-D competence. Host and technical program committee member of the “Kaleidoscope 2014” at SUT. Founder of the model network for telepresence services in SUT (2021). Honorary member of Popov’s society (2002).

AI AND DATA-DRIVEN ENGINEERING

Paper ID - 105

Machine Learning-Based Identification and Behavioral Analysis of Student Learning Styles in Online Learning Environments Using FSLSM and Clustering Techniques

Wanniarachchi W.A.A.M.[a], Maduranga M.W.P..[b], Wijayaratne W.M.S.R.B.[c], Premadasa H.K.S.[d]

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ABSTRACT

A major objective of the systematic education process is lifelong learning. Monitoring and identification of the learning styles of the learners in delivering educational content plays a significant role for improving both teaching and learning aspects. In E-learning environment, identification of the learning style plays a pivotal role as it highly impacts the module content design process for the online learning environment to improve the knowledge of the students in a precise manner. When it is considered the Moodle learning platform, a popular method used for learning style identification is considering the access frequency. But considering only the access frequency will always not predict the correct results as there may be situations where students access the course material online but not spend sufficient time with educational materials. The proposed methodology is a novel improved approach which considers both access frequency and the time spent on the learning material by applying the K-Means Clustering. In this research, Felder Silverman learning Style model (FSLSM) which is an acceptable learning style identification methodology was used as the leaning model. For the data collection process, it has been used the Moodle logs for the getting the access frequency and a deigned reusable Moodle plugin for measuring the total time spent on the activities. Then K- Means clustering was applied, which is an unsupervised machine learning algorithm to identify the learning style of the learners. The development of an application that employs these models to dynamically identify and predict student learning styles adds practical value, enabling integration into learning management systems. Finally, the research introduces a temporal analysis of learning behavior transitions, understanding of how student engagement evolves over time.

KEYWORDS: *FSLSM, Machine Learning, Clustering, Learning Styles*

Paper ID – 073

Forecasting Land Prices in Colombo District, Sri Lanka using Machine Learning and Spatial Network Analysis

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ABSTRACT

Land prices are essential indicators of economic and social development, but forecasting them presents challenges due to the multitude of factors that influence land value. This study explores the use of Machine Learning and geospatial analysis to forecast land prices in 50 key cities within the Colombo District of Sri Lanka. The dataset used comprises customer-submitted land price information provided by a real estate company 'Lanka Property Web' collected between 2018 and 2023. Geospatial data, including shapefiles, were obtained from the Survey Department of Sri Lanka and used to generate new variables, such as distances from land plots to significant infrastructure and locations, through spatial network analysis. A range of machine learning algorithms were evaluated for their performance in predicting land prices, including Linear Regression, Gradient Boosting, XGBoosting, Random Forest, and Artificial Neural Networks (ANN). Model performance was assessed based on predictive accuracy, with XGBoosting emerging as the most accurate, achieving an accuracy of 62.23%. In comparison, Linear Regression achieved 8.29%, Gradient Boosting 60.01%, Random Forest 58.54%, and ANN 48.01%. To further extend the forecast, a Seasonal Autoregressive Integrated Moving Average (SARIMA) model was applied to predict land prices up to the second quarter of 2027. The final deliverable of this research is a user-friendly dashboard designed for individual land buyers and sellers. This dashboard provides dynamic, data-driven insights into land market trends, empowering users with the information needed to make informed decisions in a rapidly changing property market. This study demonstrates the potential of machine learning and geospatial analysis in improving land price forecasting, offering valuable tools for stakeholders in the real estate sector.

KEYWORDS: *Colombo District, Land Price Forecasting, Machine Learning, Real Estate, Spatial Analysis*

Paper ID - 39

Drug Addiction Likelihood Prediction Using a Web-Based Platform: (RiskAssess)

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ABSTRACT

This paper presents RiskAssess as an early feasibility study, a comprehensive web-based platform that integrates machine learning algorithms with clinical workflow to predict drug addiction risk in the Sri Lankan context.. The platform addresses the critical gap between risk identification and intervention by providing immediate counselor assignment, appointment scheduling, and secure messaging capabilities. A multi-step questionnaire covering demographics, environment, relationships, substance use patterns, and mental health was developed and deployed in English, Sinhala, and Tamil. Eight machine learning algorithms were evaluated, with XGBoost, KNN, and ANN achieving the highest accuracy of 90.91%. A hybrid ensemble model combining Random Forest, XGBoost, and SVM was implemented for production, achieving 81.82% accuracy with superior stability and calibrated probability outputs. Feature importance analysis identified motivation to stay sober (17.5%), alcohol use (8.7%), and drug cravings (5.7%) as the most significant predictors. The platform features role-based interfaces for clients, counselors, and administrators, enabling seamless integration from assessment to intervention. Comprehensive security measures including bcrypt password hashing, role-based access control, and audit logging ensure compliance with healthcare data protection standards. The system successfully demonstrates how locally adapted machine learning models can enhance early intervention strategies for substance use disorders while maintaining clinical workflow integration. However, the results are preliminary due to the small dataset size (n=102), and the platform requires further validation before clinical deployment.

KEYWORDS: *Machine Learning, Drug Addiction Prediction, Risk Assessment, Web Platform, Sri Lanka, Ensemble Methods, Clinical Decision Support, Early Intervention*

Paper ID - 101

BiLSTM-Attention Autoencoder based Intrusion Detection System for SWIPT-Enabled IoT Systems

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ABSTRACT

Integration of simultaneous wireless information and power transfer (SWIPT) into Internet of Things (IoT) network require unique security requirements. These systems operate in energy-constrained environments, where traditional intrusion detection systems (IDS) are mostly unable to perform as expected. In SWIPT-systems, information transmission as well as energy harvesting and allocation systems are vulnerable to attacks, thereby requiring more sophisticated security systems to support continued operation. The study proposes an unsupervised bi-directional long short-term memory (BiLSTM) attention autoencoder-based IDS model designed specifically for SWIPT-enabled IoT systems operating with a sequence-to-sequence framework.

KEYWORDS: *SWIPT, IoT, unsupervised learning, BiLSTM, Intrusion Detection Systems*

Paper ID - 116

Investigating the Deep Learning Performance for Deforestation Mapping using Landsat Multispectral Data

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ABSTRACT

Deforestation is a significant threat to the sustainability of the ecosystem, leading to adverse effects such as climate change, biodiversity loss, and socio-economic consequences. Timely monitoring of forest destruction enables the effective implementation of preventive mechanisms supported by law enforcement. Advancements in remote sensing, coupled with enhanced deep learning techniques, boost efficient deforestation monitoring as these technologies support real-time analysis of complex satellite images. Thus, this study aimed to develop a classification model to identify forest areas from non-forest areas using Landsat data acquired for Wilpattu park, Sri Lanka, between 2015 to 2024. We explored model building using minimal input of two bands in satellite data, facilitating low resource needs. Seven deep learning models were explored, progressing from Convolution Neural Networks to Transformer-based models to build the classifier using a set of patches of size 100x100. The results were evaluated using standard metrics such as accuracy, precision, recall, F1 score, and Kappa index. We found that SegNet outperformed the remaining models with an overall accuracy of 96.36, F1 score of 0.97, and Kappa index of 0.92, demonstrating excellent ability to distinguish the classes. However, the efficiency of the model needs further improvement. The proposed system will contribute to deforestation detection, offering a simpler model development approach with minimum input requirements. The proposed method can be adopted to other domains where the chosen band combination supports effective detection, such as water body identification.

KEYWORDS: *Classification, CNN, Deep Learning, Deforestation, Landsat, Remote Sensing*

Paper ID - 107

Adaptive Meta-Learning with Reinforcement-Guided Task Weighting in an Enhanced Reptile Framework

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ABSTRACT

Meta-learning algorithms aim to endow models with the ability to learn new tasks rapidly from few examples. Reptile, a first order meta-learning method, achieves this by searching for an initialization that is close to many tasks. Recent work improved Reptile through multistage gradient aggregation and adaptive inner-loop learning rates, yet task weighting remained static. We propose Reinforced Reptile (R2), an enhanced Reptile variant in which a light weight reinforcement learning (RL) agent assigns dynamic weights to tasks during meta-training. The agent observes task specific performance signals and outputs continuous weights that modulate the meta-gradient. Extensive experiments on four vision benchmarks (Omniglot, mini-ImageNet, tiered-ImageNet, CIFAR-FS) and one NLP benchmark (SNLI-FewShot) show that R2 outperforms classical Reptile by up to 4.1% in 5-way 1-shot accuracy while reducing convergence time by 18%. Ablation studies confirm that RL guided task weighting accelerates learning on difficult tasks without over fitting to easy ones. R2 offers a simple, resource efficient drop-in replacement for existing Reptile pipelines.

KEYWORDS: *Meta-Learning, Few-Shot Learning, Reptile Algorithm, Reinforcement Learning, Task Weighting, Neural Networks*

Paper ID - 112

Enhancing Named Entity Recognition for Email Text using Domain-Specific Tags

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ABSTRACT

Named Entity Recognition (NER) is a fundamental task in Natural Language Processing (NLP) that identifies and classifies entities such as dates, organizations, and people. However, generic NER models often underperform in domain-specific contexts, failing to detect entities like email addresses and website links that are essential for applications such as spam detection. This study proposes an enhanced NER framework that introduces two custom domain-specific tags-EMAIL and WEBSITE-using rule-based methods. Preprocessing strategies were incorporated to resolve tokenization inconsistencies in monetary values, time expressions, and URLs. The enriched entity set, combining SpaCy's default NER output with the custom tags, was transformed into feature vectors alongside TF-IDF representations and used to train multiple machine-learning classifiers, including Multinomial Naïve Bayes, Support Vector Machine (SVM), and XGBoost. Experimental results on a public spam dataset show that the enhanced model achieved a peak accuracy of 95.99%, outperforming the TF-IDF-only baseline (91.4%). An ablation study confirmed that the custom EMAIL and WEBSITE entities contributed up to a 4.5% improvement in accuracy. Interpretability analysis using Local Interpretable Model-Agnostic Explanations (LIME) validated the influence of these domain-specific entities on classification outcomes. While results highlight measurable performance gains, limitations include reliance on a single dataset and reduced effectiveness against obfuscated entity formats. The approach is adaptable to other NLP applications such as phishing detection, fraud prevention, and customer service analytics, demonstrating that lightweight domain-specific enhancements can deliver tangible benefits in specialized contexts.

KEYWORDS: *Custom Named Entity Recognition, Domain-Specific Named Entity Recognition, Named Entity Recognition, Natural Language Processing, Spacy.*

Paper ID - 22

Diabetic Retinopathy Screening Using Image

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ABSTRACT

Diabetic retinopathy, a grave consequence of diabetes mellitus, has emerged as the leading cause of visual impairment worldwide. This ocular condition arises from the deterioration of blood vessels situated behind the retina and progresses insidiously, ultimately leading to blindness. Early detection is paramount in mitigating vision loss among afflicted individuals. In this study, we propose three distinct approaches Support Vector Machines (SVM), Convolutional Neural Networks (CNN), and Residual Networks (ResNets) for the accurate detection of diabetic retinopathy. Our aim is to determine the most effective model for this purpose, thereby improving screening efficiency. Utilizing a pre-processed dataset sourced from Kaggle, we conducted comprehensive experiments to evaluate the performance of each model. This curated dataset was instrumental in optimizing the classification algorithms. Our findings reveal notable disparities in the performance of these models. Through meticulous testing and validation, we sought to identify the model exhibiting the highest accuracy in diabetic retinopathy detection. Leveraging a dataset comprising 2750 retinal images, our experiments yielded accuracy values of 68% for SVM, 74% for CNN, and 63% for ResNet.

KEYWORDS: *Diabetic Retinopathy, Diabetes, Convolutional Neural Network, Support Vector Machine, Residual Network, Image Processing, Deep Learning.*

Paper ID - 128

Edge AI-Enabled In-Vehicle System for Comprehensive Remote Surveillance

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ABSTRACT

The system outlined here presents a novel in-vehicle system designed for continuous monitoring of a vehicle by detection of traffic violations and aggressive driving. The system integrates a range of sensing modules and data processing algorithms within the in-vehicle unit to continuously capture and process vehicle data. The system transmits data, including violation states and aggressive driving state to a remote server in real time to provide secure and immediate access to the data. The system's continuous detection and monitoring functionality is a significant improvement in remote vehicle surveillance technology.

KEYWORDS: *Remote Monitoring, Traffic Violation Detection, Aggressive Driving Detection, Deep Learning, Fleet Management, Law Enforcement*

Paper ID - 072

AI adoption in the research component of business processes: enhancing effectiveness in client acquisition for IT services organizations

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ABSTRACT

This study explores the adoption of Artificial Intelligence (AI) within the re-search component of business processes and its potential to enhance client acquisition effectiveness in IT services companies. In an environment where traditional research methods remain dominant yet inefficient, AI offers opportunities to streamline data collection, improve insight generation, and re-duce time-to-strategy. However, AI adoption across IT research teams remains inconsistent due to barriers such as data privacy concerns, skill gaps, and limited organizational readiness. The research applies a qualitative approach using semi-structured interviews with nine professionals from a global IT services organization. Thematic analysis reveals that while AI tools such as ChatGPT and Microsoft Copilot are increasingly used for summarization and trend analysis, their integration remains exploratory rather than systematic. Barriers for AI adoption include limited AI literacy, lack of structured training, leadership hesitation, and concerns about trust and compliance. Conversely, enablers such as pilot testing, internal AI platforms, peer learning, and strong leadership support are identified as critical facilitators of successful adoption. A five-phase AI Adoption Framework is then proposed, offering a practical roadmap for organizations to transition from ad-hoc AI use to structured, outcome-driven integration. The findings contribute to aca-demic literature by addressing gaps in B2B AI adoption research and offering practical implications for IT service organizations seeking to enhance re-search efficiency and client acquisition performance through AI.

KEYWORDS: *Artificial Intelligence Adoption, Business Process Research, IT Services, Client Acquisition, AI Adoption Framework*

Paper ID - 111

A new machine learning approach for in-game behavior analysis of football players based on player statistics

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ABSTRACT

This research endeavors to leverage technological innovations to enhance player evaluation and recruitment processes within football clubs. The study commenced with the acquisition of player attributes and ratings from the FIFA24 dataset, supplemented by additional statistics sourced from various reliable sources. Player performance ratings were obtained from Sofascore ratings, aim to create a unified dataset. Through data preprocessing and attribute selection the dataset was refined to include only relevant variables for analysis. The research proceeded with the development of predictive models for player performance ratings, utilizing advanced machine learning techniques. A subset of the dataset was designated for training these models, and various algorithms were explored and evaluated to identify the optimal ensemble model, resulting in voting method ensemble model predicting player performance ratings. Furthermore, player clustering based on player characteristics ratings was undertaken using the K-means clustering algorithm. The optimal number of clusters was determined through the elbow method, and distinct player clusters were identified based on their playing characteristics. A random forest model was trained with accuracy of 96% to predict player clusters, enabling the categorization of players into distinct playing styles. This research effort led to the development of a comprehensive system capable of predicting player performance ratings and clustering players based on their playing styles. This system offers valuable insights to football clubs, aiding in informed decision-making processes related to player recruitment and team composition. By using data analytics and artificial intelligence,
football clubs can gain a competitive advantage in identifying talents suitable for them, ultimately enhancing the performance and success of their teams on the field.

KEYWORDS: *Football player Analysis; Football player performance prediction; Football playing style Classification; FIFA dataset analysis*

Paper ID – 012

Evaluating the Efficacy of Machine Learning Algorithms for Customer Churn Prediction in The Insurance Industry

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ABSTRACT

In the insurance industry, large-scale data from customer transactions is generated daily, making it more cost-effective to retain existing clients than acquire new ones due to customer churn. This study aims to identify the best classification algorithm for predicting customer churn, determine the characteristics of churning customers, and model the time until churn. After data preprocessing and addressing dataset imbalance using the Synthetic Minority Oversampling Technique (SMOTE), various predictive models, including logistic regression, naive Bayes, decision trees, random forests, neural networks, extra trees, boosting algorithms, and heterogeneous ensemble learning methods, were applied. K-fold cross-validation was utilized for hyperparameter tuning and preventing overfitting. The results, evaluated using the confusion matrix and Area Under Curve (AUC), showed that Extreme Gradient Boosting (XGBoost) and Light Gradient Boosting Machine (LGBM) classifiers achieved the highest accuracy at 88.57% and 88.53%, respectively, with precision, recall, and F-score also used for assessment. Survival analysis revealed that approximately 80% of policyholders survived the first 200 months, with "having children" being the most significant predictor of customer churn. Unlike standard classification, survival analysis enables modeling of both churn likelihood and expected time-to-churn, accounting for censored observations. This provides actionable insights for intervention timing, a critical advantage in customer retention planning.

KEYWORDS: *Confusion Matrix; Customer Churn Prediction; Insurance; Machine Learning; SMOTE; Survival Analysis*

Paper ID – 146

Fine-Tuning BERT for Context-Aware Phrasal Verb Disambiguation

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ABSTRACT

Transformer-based models like BERT have significantly advanced natural language processing by enabling deep contextualized language representations. While powerful in token prediction and structural understanding, their success does not inherently imply a strong grasp of semantic meaning, particularly for ambiguous expressions. Semantic disambiguation is a core challenge, especially with phrasal verbs, whose meanings are often non-compositional and highly context-dependent, making them difficult for models trained primarily on surface-level patterns. This research addresses the gap where foundational BERT models are not optimally designed for meaning classification. We investigate whether fine-tuning BERT can improve its performance in phrasal verb meaning classification. To this end, we created a context-rich dataset focused on phrasal verb semantic interpretation, augmenting it with LLM-generated sentences for robustness. We compare a baseline Bert-base uncased model with a fine-tuned version, utilizing QLoRA for efficient training given hardware constraints. Model performance before and after fine-tuning is evaluated using a diverse set of metrics including cosine similarity, BLEU, ROUGE-L, Jaccard similarity, and METEOR. The results consistently demonstrate that fine- tuning significantly enhances the model's ability to capture the semantic intent behind phrasal verbs, confirming the effectiveness of contextual specialization through targeted training for nuanced language understanding. The code implementation can be found at: https://anonymous.4open.science/r/bert-semantic-classification

KEYWORDS: *BERT Fine-tuning; Natural Language Processing; Phrasal Verbs; QLoRA; Semantic, Disambiguation; Transformer Models.*

Paper ID – 50

Gap analysis of the implementation of Intelligent Process Automation in the industrial context in Sri Lanka – A Systematic Literature Review

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ABSTRACT

Intelligent Process Automation (IPA) represents the integration of Robotic Process Automation (RPA), Artificial Intelligence (AI), and Business Process Management (BPM) aimed at streamlining complex business processes. A Systematic Literature Review (SLR) was conducted to explore the implementation landscape of IPA within the global and Sri Lankan industrial context, a domain with limited empirical exploration. The study systematically analyzed 144 publications across Web of Science and Scopus and visualized bibliometric networks through VOS viewer and Bibliometrix, which is built into the R software package using the PRISMA protocol. Despite global advancements and growing scholarly interest, the review identifies a significant contextual, empirical, and theoretical gap in IPA research in Sri Lanka. Opportunities for industrial transformation were indicated by the emergence of two main thematic clusters that comprise intelligent process automation technologies and their strategic application. Additionally, a density visualization demonstrated the limited involvement of Sri Lankan institutions, highlighting the need for localized research. The study examines the determinants influencing IPA adoption, such as trust, transparency, and user attitudes, through the lens of the extended Unified Theory of Acceptance and Use of Technology (UTAUT). Additionally, it identifies barriers like knowledge hiding and resistance to AI-driven innovations grounded in organizational behavior theories, including the Not-Invented-Here Syndrome and knowledge-based views. The findings propose that business model innovation supported by strong governance, employee readiness, and aligned strategic vision is critical for successful IPA integration. The study highlights under-researched areas and establishes a foundation for future empirical investigations in the Sri Lankan industrial domain.

KEYWORDS: *Business Process Management, Unified Theory of Acceptance and Use of Technology, Bibliometric Analysis, Systematic Literature Review, Sri Lanka*

Paper ID – 64

Enhancing Modern Education Through an AI-Integrated Learning Management and Support System (LMSS)

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ABSTRACT

The rapid advancement of educational technologies has underscored the limitations of conventional Learning Management Systems (LMS) in effectively supporting the evolving demands of learners and educators. While traditional LMS platforms primarily focus on content delivery and administrative tasks, they often lack the capacity to foster active engagement, facilitate meaningful collaboration, and promote participation in broader learning experiences. This paper presents the design and functional implementation of a prototype for a Learning Management and Support System (LMSS), an AI-enhanced platform built to address these limitations by offering a more holistic and student-centered approach to digital education. LMSS integrates course management with interactive features that encourage student collaboration, peer-to-peer communication, and involvement in academic and extracurricular events. These capabilities are designed to support a more engaging and socially connected learning experience while also simplifying instructional workflows for educators. The system incorporates adaptive learning tools and real-time insights to better align learning processes with individual needs and institutional goals. This paper reviews the existing literature, highlights gaps in current LMS implementations, and details the development methodology, architecture, and feature set of LMSS. The system's anticipated impact is grounded in established research findings demonstrating that adaptive learning approaches can significantly enhance student engagement, AI-driven early intervention can improve retention rates among at-risk learners, and real-time analytics can reduce instructor workload related to feedback provision. By integrating these evidence-based practices into a unified platform, LMSS is designed to foster learner motivation, deepen engagement, and support teaching effectiveness. Ethical considerations such as user privacy and data governance are also addressed to ensure responsible and transparent use.

KEYWORDS: *Learning Management System, Artificial Intelligence, Personalized Learning, Real-Time Support, Educational Technology.*

Paper ID – 78

Data Driven Patternmaking: Automated Generation of Stretch-Knit Patterns for Different Fabric Stretch

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ABSTRACT

Patterns serve as the blueprint for garment production; therefore, accurate patternmaking is crucial for producing well-fitted garments with minimal trial and error. Patternmaking is time consuming and requires specialized expertise and proficiency. Current research in automated patternmaking has increasingly focused on enhancing pattern precision through computational methods. Recent developments have addressed data driven modeling and machine learning in automated pattern creation. Yet, the influence of fabric stretch on pattern adjustment has not been studied. This study examined how fabric stretch characteristics apply to garment fit and developed predictive models to create pattern shapes of womens wear upper torso stretch garments. The research objectives were to review existing data-driven approaches for automated patternmaking techniques, create CAD patterns based on the sizes and fabric stretch values, develop a machine learning model to predict pattern shapes, and validate the predicted patterns through digital fit assessments. Adopting a machine learning approach, this study applied multiple linear regression to predict pattern alterations based on size and fabric stretch values. Furthermore, the same framework is improved to automate the pattern generation with fabric stretch values and size inputs provided. The findings contribute to the development of more accurate, automated patternmaking systems that account for fabric stretch, enhancing efficiency and fit consistency in apparel production.

KEYWORDS: *Automated Patternmaking; Digital Prototyping; Machine Learning; Multiple Linear Regression Stretch knit fabrics.*

BIO MEDICAL ENGINEERING AND SMART HEALTH SYSTEMS

Paper ID - 31

Gesture-Controlled Embedded Interface for Sterile Medical Environments

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ABSTRACT

Maintaining sterility in surgical environments is critical, yet conventional input devices such as keyboards and mice pose contamination risks and are impractical during procedures. This paper presents the design and implementation of a compact, contactless gesture-controlled embedded system tailored for medical settings, enabling surgeons to interact with on-screen medical images and control connected devices without breaking sterile conditions. The system employs a Raspberry Pi Pico MCU (Microcontroller Unit) and three VL53L0X ToF (Time-of-Flight) sensors to recognize seven distinct hand gestures, including directional swipes and timed holds. Detected gestures are transmitted via USB (Universal Serial Bus) serial communication to a host computer, where a custom LabVIEW (Laboratory Virtual Instrument Engineering Workbench) interface interprets the input and executes corresponding actions such as image navigation, zoom, and device control. Visual feedback is provided through RGB (Red-Green-Blue) LEDs (Light-Emitting Diodes), enhancing usability and user confidence. In addition to software-based control, the system enables gesture-based actuation of a servo motor, demonstrating the capability to manipulate external devices directly from the embedded unit. The prototype demonstrated reliable gesture recognition, seamless integration with host applications, and precise servo motor control, validated through systematic functional testing. Achievements include accurate gesture detection, intuitive user feedback, robust communication between embedded hardware and software, and successful real-time device actuation. The project establishes a strong foundation for future enhancements, such as expanding the gesture set, improving classification algorithms, enabling wireless communication, and integrating a broader range of medical devices. Overall, this work demonstrates the feasibility and effectiveness of low-cost embedded hardware for intuitive, real-time, and hygienic user interfaces in critical medical applications, paving the way for smarter and safer surgical environments.

KEYWORDS: *Gesture Recognition, Sterile Medical Interface, Embedded System, Raspberry Pi Pico, Time-of-Flight Sensor, LabVIEW, Servo Motor Control, Contactless User Interface*

Paper ID: 118

Predictive Modeling for Personalized Cancer Therapy Using Reinforcement Learning

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ABSTRACT

Adaptive therapy is transforming cancer treatment by enabling dynamic, patient-specific interventions that adapt to tumor progression and individual variability. Unlike traditional fixed-dose regimens, adaptive therapy leverages the evolutionary dynamics of tumors to extend treatment effectiveness and delay resistance. Reinforcement Learning (RL), an area of artificial intelligence focused on sequential decision-making, offers a robust framework for optimizing these adaptive strategies. RL can learn optimal treatment policies by interacting with computational models of tumor growth and drug response, continuously adjusting regimens based on observed tumor states, resistant cell populations, and biomarkers. This approach allows for the creation of personalized therapies that maintain long-term tumor control while minimizing toxicity and the emergence of resistance. The integration of RL into predictive modeling for cancer therapy represents a paradigm shift, enabling smarter, safer, and more effective treatments that are dynamically tailored to each patient's evolving disease. This paper reviews the foundational concepts of adaptive therapy and RL discusses tumor modeling approaches, examines RL algorithms, and addresses current challenges and future directions in the field.

KEYWORDS: *Reinforcement Learning, Personalized Medicine, Cancer, Predictive Modeling.*

Paper ID - 036

Predicting Cognitive Test Performance from New Onset Behavioral and Personality Changes in Adults over 50 using Post-Selection Boosted Random Forest Classifier

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ABSTRACT

Mild Behavioral Impairment (MBI) refers to neuropsychiatric symptoms of various severity levels that might not be discovered by conventional psychiatric nosology. These symptoms should persist for more than six (06) months. MBI is typically observed in adults of age 50 and above. This study investigates the prediction of cognitive test performance of cognitive and behavioral changes in adults over 50 years of age using a post-selection boosted Random Forest (RF) Classifier. The baseline cognitive aging data of the Simple Reaction Time (SRT) metric and Mild Behavioral Impairment Checklist (MBI-C) from the ongoing PROTECT study in the United Kingdom was used to classify the participants' cognitive ability into five classes. Using the post-selected boosted RF classifier, the study obtained an accuracy of 96.26% which was an improvement compared to the 95.52% accuracy obtained by the RF classifier. These findings suggest that machine learning-based prediction models can provide valuable insights into analyzing the cognitive decline of adults of a late age.

KEYWORDS: *MBI, Cognitive Performance, Lasso Method, Deep Learning*

Paper ID - 114

Enhancing Healthcare Predictive Models Through Privacy- Preserving Synthetic Data Generation

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ABSTRACT

The advancement of healthcare predictive modeling is closely tied to the availability and quality of patient data. However, privacy regulations and ethical concerns often hinder data sharing, making it a persistent challenge. As a solution, privacy-preserving synthetic data generation has emerged, enabling the creation of artificial datasets that retain the statistical properties of real data while protecting individual privacy. This paper explores the use of such synthetic data throughout the clinical risk prediction pipeline by leveraging state-of-the-art generative models. We evaluate their utility in exploration data analysis, feature selection, model training, and deployment. Our study focuses on synthetic data generated using advanced models such as Differentially Private GANs (DPGAN), Private Aggregation of Teacher Ensembles GANs (PATEGAN), and Anonymization through Data Synthesis GANs (ADSGAN). Using these techniques, we created synthetic versions of the UK Biobank ever-smoker cohort. These synthetic datasets were shown to reproduce key statistical patterns, support effective feature selection, and enable accurate lung cancer risk prediction modeling all without using real patient data. We compare synthetic data with other privacy-enhancing technologies like federated learning and highlight a key advantage: synthetic data allows the direct use of existing analytical and machine learning tools without modification. Additionally, we examine deployment models such as "no- release" and "delayed-release," emphasizing how synthetic data can speed up research and enable broader data sharing while maintaining GDPR compliance. Overall, this study demonstrates the potential of synthetic data to transform healthcare research, software testing, education, and collaboration while carefully navigating the trade-off between privacy and utility.

KEYWORDS: *Synthetic Data, Privacy-Preserving Data Generation, Healthcare Predictive Modeling*

CIRCULAR ECONOMY AND SUSTAINABLE PRODUCTION

Paper ID - 162

Experimental Study to Investigate the Compression Responses of Concrete with Waste Tire Aggregates Under Varying Loading Conditions.

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ABSTRACT

This study explores the variation of compressive stress-strain behavior of concrete incorporating waste tire aggregates as a partial replacement for conventional coarse aggregates, addressing the global challenge of tire waste management. Concrete mixes with 0%, 10%, and 20% rubber replacement were tested under varying loading conditions after curing for 28 days. The research aims to provide insights into the trade-offs between strength and flexibility in rubberized concrete to support sustainable construction practices. Experimental results demonstrated that the control mix (0% rubber) exhibited the highest compressive strength but showed brittle behavior with minimal strain tolerance. The 10% rubber mix achieved a balance, retaining substantial strength while improving strain capacity and energy absorption, making it suitable for applications requiring both strength and ductility. The 20% rubber mix had the greatest strain tolerance and energy absorption but the lowest compressive strength, indicating its potential for impact-resistant and flexible structures. These findings align with existing literature, emphasizing the material's suitability for applications in seismic zones, noise barriers, and vibration-dampening structures. This study highlights the potential of rubberized concrete as a sustainable alternative, offering environmental benefits by reusing waste tires and reducing dependence on natural aggregates. However, challenges such as reduced strength with higher rubber content need to be addressed through optimized mix designs and pretreatment methods. Rubberized concrete provides a promising pathway for balancing sustainability with structural performance, particularly for dynamic and non-load-bearing applications.

KEYWORDS: *Rubberized concrete, waste tire aggregates, compressive strength, stress-strain behavior, sustainable construction.*

Paper ID - 66

Developing a web-based augmented reality tool For promoting sustainable fashion consumption

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ABSTRACT

This study explores the use of Augmented Reality (AR) as an intervention to promote sustainable fashion consumption among Sri Lankan consumers. It also involves developing a web-based AR tool designed to educate users about sustainable fashion and evaluating its acceptance within the target audience. This research identified that young consumers in Sri Lanka demonstrate a low level of awareness regarding sustainable fashion consumption. Therefore, this study addresses an important gap by analyzing how interactive digital tools can influence consumer education and promote green purchase behaviors. To gather requirements for developing the AR tool, a qualitative research method was employed through focus group discussions with 8 Gen Z participants representing diverse fashion preferences. For validation, the tool was further tested with 30 participants to evaluate usability, engagement, and effectiveness. Nine themes relevant to AR tool development were identified through thematic analysis, which highlighted the awareness about sustainable fashion, patterns of digital learning, and sensitivity to AR capabilities. This study revealed a strong consumer intention to engage with visually dense, socially sharable, and mobile-optimized AR applications. To address these points, a prototype web-based AR platform was designed using MyWebAR platform, alongside real time information on garment sustainability through the scanning of QR codes. The results demonstrate that AR can successfully engage consumers, increase awareness of the environmental footprint of fashion, and enable behavioral change when deployed on familiar social media platforms. The research concludes that interactive, culturally relevant AR tool experiences have strong potential to influence sustainable fashion practice among consumers.

KEYWORDS: *Augmented Reality, Consumer Behavior, Digital Technologies, Fashion Consumption, Sustainable Fashion.*

Paper ID - 048

Evaluation of the Suitability of Barley Grass and Sandalwood Reinforced PLA Composites for FDM 3D-Printing Applications

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ABSTRACT

The escalating environmental impact of petroleum-based plastics and their composites, coupled with their irreversible pollution, underscores an urgent need to transition toward biodegradable alternatives. Given the situation, natural fibre-reinforced composites have emerged as potential substitutes due to their renewability, low carbon footprint, and compatibility with circular economy principles. This study investigates the feasibility of using polylactic acid (PLA) composites reinforced with barley grass (BG) and sandalwood (SW) powders, as sustainable filaments for fused deposition modelling (FDM) 3D printing. Composites containing 5 wt.% filler were produced using a twin screw extruder and pelletizer and were processed into 1.75 ± 0.3 mm filaments. Then, a systematic evaluation of the mechanical, thermal, and sustainability properties of composites was carried out. The results revealed that the barley grass-reinforced composite (BGPLA) exhibited superior performance, including the highest Young's modulus (33.92 MPa), ultimate tensile strength (45.89 MPa), flexural modulus (29.83 MPa), and impact strength (3.99 kJ/m²) among the two materials tested. Furthermore, BGPLA demonstrated enhanced thermal stability compared to pure PLA and SW-reinforced composites (SWPLA), as evidenced by its lowest maximum weight loss rate, together with higher transition temperatures, which contribute to improved stability under thermal load. Sustainability assessment confirms that the environmental advantage of natural filler-reinforced PLA composites (BGPLA, SWPLA), showing that the life-cycle carbon emissions attributed to the filler phase are 91–93% lower than those of glass fibre–reinforced PLA composites. Given their improved mechanical, thermal, and sustainability properties, these filaments should be feasible for applications such as battery storage compartments, renewable energy system components (such as solar panel brackets and wind turbine blade inserts), and automotive interiors. These findings highlight the versatility and environmental advantages of BGPLA and SWPLA as sustainable alternatives that can reduce reliance on non-renewable resources while offering cost-effective solutions for future industrial applications.

KEYWORDS: *Sustainable polymeric composites, Fully biodegradable composites, Circular economy, Lightweight materials, Battery holder compartment, Reinforcements for composites.*

Paper ID - 174

Public Sector Role as a Key Stakeholder Towards the Circular Economy in the Built Environment in Sri Lanka

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ABSTRACT

The circular economy (CE) concept is a more appropriate approach to meet the sustainability challenges of today's construction industry, allowing construction activities to operate in a closed loop, away from the traditional linear economy model (LE). Although some CE principles are applied in Sri Lanka, they are not fully implemented. As a policy maker, the public sector should play a significant role in implementing CE in the built environment. However, limited attention has been paid to this, and no research has identified the public sector's role in this regard. The primary aim of this research is to explore the role and potential contribution of the public sector as a key stakeholder in implementing CE in Sri Lanka's built environment. To achieve this, global and local practices were examined to understand how CE principles are applied and to provide recommendations for improving CE adoption. The benefits and challenges to the public sector and private sector views on its role in CE implementation were also explored. A mixed approach was used for data collection. Expert interviews and questionnaires were developed after gaining a thorough understanding of CE principles through a comprehensive literature review. Ten expert interviews and thirty-eight questionnaire responses were analyzed. Although the public sector has initiated efforts such as green building standards and waste management, the study found a need for a stronger regulatory framework, institutional support, and collaboration with the private sector. Challenges such as limited awareness, high start-up costs, and regulatory gaps were identified. The research emphasized the importance of CE policies, financial incentives, and public-private partnerships. It also stressed the need for training and awareness programs to equip stakeholders with the knowledge required to implement CE.

KEYWORDS: *Public Sector, Stakeholder, Circular Economy, Built Environment, Sri Lanka*

Paper ID - 127

Development of Low-Cost Slipper by Using NR/EVA Blend with Recycling Materials for Reducing Environment Pollution in Footwear Industry

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ABSTRACT

This study aims to develop a low-cost slipper compound by blending low-grade natural rubber (NR), ethylene vinyl acetate (EVA), and recycled LDPE plastic granules with crumb rubber at different phr (parts per hundred rubber) amounts. Low-grade natural rubber (off-grade brown scrap) and ethylene vinyl acetate (containing 19 wt.% vinyl acetate) were used during formulation to reduce costs. During the compounding process, polymeric materials and other chemical ingredients were masticated using a kneader and two-roll mills. The mixture was then sheeted through calendaring techniques, and curing was performed using a compression molding method. Blowing agents were incorporated to create the intercellular structure of the slipper sheets. A peroxide curing system was used due to the natural rubber's blend with ethylene vinyl acetate. Different phr amounts of crumb rubber and recycled LDPE granules were blended during batch preparation. Initially, crumb rubber sheets punctured and waste scrap sheets were obtained and then converted into small particles (~30 mesh) using grinding and crushing methods. The hardness and abrasion resistance of the prepared slippers were tested. After curing, higher hardness values were observed with increasing crumb rubber phr. As particle size increased, there was a tendency for an asymmetrical distribution of compounding ingredients within the mixture, which was mitigated by the addition of processing oils that improved particle dispersion. In summary, this work identified an optimal compounding formulation with specific phr values suitable for manufacturing low-cost slipper sheets on an industrial scale.

KEYWORDS: *Footwear waste, Low-cost compounds, Ethylene-vinyl acetate, Crumb rubber.*

Paper ID - 130

Production of cost-effective recycled plastic interlock as a solution to plastic waste generated in Sri Lanka.

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ABSTRACT

This research examines the potential of producing recycled plastic interlocking bricks as a sustainable alternative to conventional concrete interlocks, with a focus on addressing the rising plastic waste problem in Sri Lanka, particularly within the Ampara District. While the study is geographically concentrated in Ampara, its findings are expected to provide valuable insights applicable across the country. The district presents appropriate research setting due to its rich biodiversity, fragile ecosystems, and expanding tourism sector, all of which are increasingly threatened by unmanaged plastic waste. Furthermore, the availability of data and the ability to collaborate with local communities enhance the practicality of conducting the study in this region. As Ampara reflects many of the national challenges such as inadequate waste management and rapid development, the solutions proposed—recycling initiatives and the production of plastic interlocks—can be scaled and adapted nationwide. Although regionally based, the outcomes of this study carry wider significance for advancing sustainable waste management practices throughout Sri Lanka. In the Ampara District of Sri Lanka, the accumulation of plastic waste continues to rise, while existing disposal practices remain limited and unsustainable. This situation threatens local biodiversity, fragile ecosystems, and the tourism industry that depends on a clean environment. At the same time, the construction sector is experiencing increasing costs for conventional materials such as concrete interlocks. These challenges create a demand for alternative solutions that address both environmental and economic concerns. The research problem, therefore, lies in the absence of an effective method to recycle plastic waste into durable and affordable interlocking bricks, along with the lack of sufficient evidence on how their performance and cost compare with standard concrete interlocks. A thorough assessment of plastic waste volume and composition was conducted using data from local authorities, including the Urban Council and Pradeshiya Sabha. High-density polyethylene (HDPE), polyethylene terephthalate (PET), and sand were selected as the primary materials, with a heating process used for manufacturing. Various compositions were tested to identify the most effective mix, followed by laboratory evaluations measuring compressive strength and water absorption. The study also included a detailed cost analysis, comparing the selected plastic interlock with traditional concrete interlocks. Results confirmed that recycled plastic interlocks are a viable and cost-effective solution, offering environmental benefits by reducing plastic pollution while promoting sustainable construction materials in the Ampara region.

KEYWORDS: *Plastic Pollution, Recycled Plastic Interlocks, Eco-friendly Bricks, Waste management, Cost analysis, Environmental Sustainability*

Paper ID - 161

Applying the Multifaceted Potential of Seaweed in Bioplastics to Advance Sustainable Development in Sri Lanka – A Review

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ABSTRACT

Plastic pollution remains a critical environmental and public health challenge. Bioplastics have emerged as a promising alternative to reduce the adverse impacts of petroleum-based plastics. Among renewable biomass sources, macroalgae, particularly seaweeds, stand out due to their high biomass yields, cost-effectiveness, and ease of cultivation. For an island nation like Sri Lanka, seaweed-based bioplastics present a unique opportunity to advance sustainability while strengthening the economy. Sri Lanka already has an established seaweed farming industry, primarily exporting dried seaweeds, which could be expanded into value-added bioplastic production. Several studies project a significant global increase in bioplastic demand by 2028, underscoring the potential market. With its year-round cultivation potential, rich marine biodiversity, and proximity to major Asian markets, Sri Lanka is well-positioned to become a competitive player in the regional bioplastics industry. This review examines bioplastic production from seaweeds, with a focus on its applicability, benefits, and strategic relevance for Sri Lanka as a developing country.

KEYWORDS: *Bioplastics, Seaweed, Economic, Sustainability, Ecology*

CLEAN AND RENEWABLE ENERGY INNOVATION

Paper ID – 175

Solar Hotspot Detection Using VHDL-Simulated Fixed-Point SVM: A Methodology Toward FPGA Realization

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ABSTRACT

The early and accurate detection of thermal hotspots in photovoltaic modules is critical to ensure the efficiency, safety, and longevity of solar power systems. This study presents a complete end-to-end methodology for implementing a fixed-point Medium Gaussian Support Vector Machine classifier using Very High-Speed Integrated Circuit - Hardware Description Language, optimized for Field Programmable Logic Array. The approach begins with feature extraction from thermal images, focusing on MPEG-7 descriptors and blue chrominance. The SVM model is trained in MATLAB and converted into a fixed-point Q1.15 format for hardware compatibility. Key parameters, including support vectors, Lagrange multipliers, bias, and kernel scale, are extracted and verified in a custom Python environment to ensure numerical alignment with MATLAB results. The validated model is then implemented in synthesizable VHDL and verified using GHDL and GNU Tool Kit waveform viewer, confirming bit-accurate hardware behavior. Results show classification accuracy exceeding 99.3% with negligible performance loss due to quantization. The design achieves deterministic latency based on FSM structure and parallel feature processing, completing classification within 2702 clock cycles for a 300-support-vector, 222-feature system. Unlike floating-point models, this approach enables low-power, real-time inference on edge platforms such as drones.

KEYWORDS: *FPGA, ML, VHDL, Solar PV, MPEG-7*

Paper ID - 177

Comparative Study on TiO_2/Graphite–PEG and Graphite/Carbon Fibre-Paraffin Shape Stabilized Phase Change Materials for Thermal Energy Storage Applications

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ABSTRACT

Shape-stabilized phase change materials (SSPCMs) are promising candidates for latent heat thermal energy storage systems due to their high energy density and ability to prevent leakage during phase transitions. This study presents a comparative analysis of two SSPCM systems: TiO_2/graphite–polyethylene glycol (PEG) and graphite/carbon fibre/graphene– paraffin composites. Both composites were prepared by vacuum-assisted infiltration of molten PCMs into porous expanded graphite networks, with the addition of functional fillers to enhance structural integrity and thermal stability. Scanning electron microscopy (SEM) revealed distinct microstructural features for each system; TiO_2 nanoparticles were uniformly dispersed within the PEG matrix and anchored onto graphite surfaces, while carbon fibres and graphene nanoplatelets formed a hierarchical interconnected network within the paraffin-based composites. Differential scanning calorimetry (DSC) demonstrated that both systems preserved high latent heat storage capacities with slight shifts in phase transition temperatures compared to pure PCMs. Thermogravimetric analysis (TGA) showed improved thermal stability of the SSPCMs relative to neat PCMs, with filler composition significantly affecting degradation onset temperatures. In TiO_2/graphite–PEG composites, DSC analysis showed melting temperatures of 61.4-62.7 °C and solidification temperatures of 53.1-54.0 °C, with latent heats of 185-210 J g^{-1} depending on TiO_2 content. Graphite/carbon fibre/graphene–paraffin composites exhibited melting temperatures of 54.8-55.6 °C and solidification temperatures of 48.9-49.7 °C, with latent heats of 140-160 J g^{-1}. Thermogravimetric analysis revealed improved degradation onset temperatures: TiO_2/graphite PEG composites showed higher thermal stability compared to pure PEG, while carbon fibre/graphene–paraffin composites exhibited enhanced thermal resistance relative to pure paraffin. The TiO_2/graphite-PEG composites exhibited higher latent heat capacities and enhanced thermal resistance, whereas the graphite/carbon fibre/graphene–paraffin composites provided superior mechanical reinforcement and phase change reliability. These findings offer insight into the design and optimization of SSPCMs tailored for specific thermal management applications.

KEYWORDS: *Phase Change Materials, Hybrid Composites, Thermal energy storage*

Paper ID - 106

Development of an AI-based model with low computational complexity for accurate solar energy forecasting

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ABSTRACT

This paper introduces a short-term solar energy forecasting model that is designed with a focus on low computational complexity and addresses the challenges posed by fluctuations in solar energy generation, which are significantly influenced by environmental factors. These fluctuations can lead to instability when solar power generation systems are integrated into national energy grids, creating difficulties in maintaining a balanced supply and demand. If solar energy generation can be accurately forecasted before fluctuations occur, potential issues can be identified in advance, allowing for better management of the energy system, including optimizing storage facilities when energy generation is high. Current solar energy forecasting systems face significant challenges due to their high computational complexity, which results in increased power consumption and lower accuracy. To address these issues, this study focuses on the development of an artificial intelligence (AI)-based forecasting model using an Artificial Neural Network (ANN). The goal is to reduce the computational complexity of the model while maintaining high accuracy. To achieve this, various data analysis and complexity reduction techniques, such as variable reduction, pruning, and quantization, were applied. The performance of the optimized AI model was evaluated by comparing the forecasted values to actual solar energy generation data. The results demonstrate that the proposed model successfully reduces computational complexity while maintaining a satisfactory level of accuracy. This optimization makes the model more suitable for real-time forecasting, particularly in resource-constrained environments, and provides a more efficient approach to solar energy management. The findings of this study suggest that AI-based forecasting models can play a critical role in enhancing the integration of solar energy into national grids, ensuring a more reliable and sustainable energy supply. Further research could explore additional optimization techniques and the introduction of generalization techniques to improve transferability of the model and applicability across diverse geographical regions. Additionally, focus on utilizing AI techniques that minimize computational complexity without compromising the accuracy of the model, aiming to maintain high forecasting precision while optimizing the efficiency of the system.

KEYWORDS: *Solar forecasting, artificial intelligence, computational complexity, simulation, optimization, machine learning.*

Paper ID - 121

Development of an AI-Based Model with Low Computational Complexity for Accurate Load Demand Forecasting

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ABSTRACT

This research addresses the challenge of short-term load demand forecasting in microgrids, where renewable energy unpredictability destabilizes power systems. Current forecasting models often suffer from high computational complexity, resulting in increased power consumption and reduced real-time applicability. To overcome these limitations, this study develops and optimizes an Artificial Neural Network (ANN)-based short-term forecasting model with significantly reduced computational demands. In this study, a model was constructed utilizing historical operational data from a microgrid system. To optimize the computational efficiency of the model, various techniques were applied to reduce its complexity. The model's performance was systematically evaluated using appropriate performance metrics. The experimental results demonstrate that the proposed approach significantly decreases the computational complexity of the final model, while preserving an acceptable level of accuracy when compared to the original, unoptimized model. The practical implications of this research include enabling real-time demand forecasting on resource-constrained microgrid controllers and edge devices, facilitating more efficient energy management in sustainable power systems. Future work will focus on enhancing the model's generalization capabilities by incorporating additional geographical and climatic factors, enabling accurate demand forecasting across diverse microgrid environments beyond the specific conditions of the initial dataset.

KEYWORDS: *Load forecasting, AI, low-complexity models, energy demand prediction, optimization, time-series analysis*

Paper ID - 041

Synergistic Charge Dynamics and Light Harvesting in TiO_2/MgO Composites for Efficiency Enhancement in CdS Quantum Dot-Sensitized Solar Cells

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ABSTRACT

Quantum dot-sensitized solar cells (QDSSCs) represent a promising advancement in renewable energy technologies, with recent improvements achieving power conversion efficiencies close to 6%. Structurally similar to dye-sensitized solar cells (DSSCs), QDSSCs employ quantum dots (QDs) as sensitizers that absorb photons and inject excited electrons into the conduction band of a wide-bandgap semiconductor electrode. while a redox electrolyte removes the generated holes, completing the circuit by regenerating them at the counter electrode. Quantum dots composed of materials such as CdS, CdSe, PbS, and InP are increasingly studied for use in QDSSCs, offering the advantage of tunable optical band gaps through particle size manipulation. This adaptability enhances QDSSCs' design potential, enabling the integration of third-generation solar cell configurations, including multiple exciton generation (MEG), to further enhance energy conversion efficiency. Despite these advancements, QDSSC performance is currently limited by issues such as reduced photovoltage and recombination losses at the TiO_2-QD-electrolyte interface. This study explores the use of magnesium oxide (MgO) coatings on TiO_2 nanoparticles to address these limitations, focusing on improving the fill factor (FF) and overall cell efficiency. MgO serves as an electron-blocking layer, effectively reducing recombination and associated energy losses. Furthermore, MgO facilitates electron transport from QDs to the TiO_2 electrode, improving charge collection. The light-scattering properties of MgO also increase the photon's path length within the cell, enhancing light absorption and consequently boosting the short-circuit current. In this study, MgO powder was incorporated in specific mass ratios with TiO_2, followed by the application of CdS quantum dots (QDs) on the TiO_2/MgO composite layer using the SILAR method. Results indicated a significant improvement in the fill factor (FF) at an optimal MgO-to-TiO_2 ratio, attributed to synergistic effects of MgO on interface stabilization, reduced recombination, and enhanced charge transport. The optimized MgO-modified TiO_2 films achieved a current density of 1.946 mA, voltage of 437 V, and power of 0.121 W, reaching an efficiency of 0.311 (18.7% higher than TiO_2/CdS QDSCs), with improved interfacial impedance, Incident Photon to Current Efficiency (IPCE), and FF of 37.4%.

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KEYWORDS: *CdS, Efficiency, Fill factor, MgO, QDSCs, SILAR, TiO_2*

Paper ID - 108

Development of an AI-Based Model with Low Computational Complexity for Accurate Wind Energy Forecasting

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ABSTRACT

Most countries primarily relay on fossil fuel for electricity generation, leading to fossil fuel depletion and environmental pollution. The countries are developed technologies for renewable energy generation. The wind energy being promoted as a superior renewable energy. However, wind energy has its challengers, particularly uncertainty that can affect overall system stability. The accurate short-term forecasting of wind energy was crucial for ensuring grid stability. Both physical and AI-based models can effectively be utilized for wind energy prediction. AI-based methodologies have shown superior effectiveness, efficiency, and accuracy when compared to traditional physical models. The lightweight AI-based forecasting model was particularly significant for processing devices, enabling faster computations and substantially more cost-effective forecasting. The research utilized simulation software to develop an Artificial Neural Network (ANN) model, initially incorporating eight meteorological parameters. Four of these parameters showed weak correlations and were subsequently removed from the model. Further optimization was achieved through pruning and quantization techniques, significantly reducing computational complexity. The optimized model demonstrates a notable reduction in both training time by 92.69% and inference time by 63.83%, while maintaining accuracy with only a marginal decrease of 3.99% compared to the initial model. These improvements were achieved with minimal loss in predictive accuracy, significantly reducing computational complexity. The study concludes that the optimized ANN model is well-suited for real-time wind power forecasting, offering a balance between accuracy and computational efficiency. This approach not only facilitates better grid management but also extends the applicability of AI-based forecasting to devices with limited processing capabilities. Future work could explore additional complexity reduction techniques and broader deployment scenarios.

KEYWORDS: *Wind Forecasting, Artificial Intelligence, Computational Efficiency, Model Optimization, Simulation, Time-Series Prediction*

Paper ID - 68

Macaranga peltata Leaf Extract Mediated Green Synthesis of Iron Nanoparticles and Their Application in Organic Dye Removal

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ABSTRACT

This study presents an eco-friendly method for synthesizing iron nanoparticles (FeNPs) using *Macaranga peltata* leaf extract, evaluating their potential in degrading the organic dye methyl orange (MO). The synthesis exploits phytochemicals in the leaf extract as natural reducing and stabilizing agents. The synthesized FeNPs were characterized using UV-Vis spectroscopy, FTIR, XRD, and SEM, confirming amorphous structure and particle sizes ranging from 34–94 nm. Catalytic activity was evaluated via MO degradation experiments, achieving 85.16% efficiency within 200 minutes. The study demonstrates a sustainable solution for wastewater treatment through green nanotechnology.

KEYWORDS: *Green synthesis, Iron nanoparticles, Macaranga peltata, Methyl Orange, Dye degradation, Wastewater treatment*

Paper ID – 11

Design, Simulation, and Optimization of a Hybrid Hydrogen Fuel Cell–Battery Energy System for Sustainable Electric Vehicle Applications Using MATLAB Simulink

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ABSTRACT

The transition to sustainable transportation demands energy systems that are both efficient and environmentally friendly. This paper presents the design, simulation, and optimization of a hybrid energy system that integrates Proton Exchange Membrane (PEM) hydrogen fuel cells with lithium capacitor batteries for electric vehicle (EV) applications. The system aims to combine the high energy density of hydrogen with the fast response and recharge capabilities of advanced battery technologies to meet varying load demands efficiently. Using MATLAB Simulink, a hybrid model was developed to evaluate dynamic power sharing between the fuel cell and battery under variable driving conditions. A boost converter regulated the fuel cell output, while a bidirectional DC-DC converter managed power flow between the battery and the load. Maximum Power Point Tracking (MPPT) was implemented to optimize hydrogen fuel cell performance, enhancing energy efficiency under transient conditions. Simulation results demonstrated improved voltage stability, reduced stress on individual sources, and efficient energy utilization. Optimization of component sizing and control strategy further enhanced system response and fuel economy. These findings highlight the hybrid system's potential for reducing EV range anxiety and promoting the use of renewable energy carriers such as hydrogen. This work contributes to ongoing research in sustainable mobility by offering a technically viable and scalable energy architecture that addresses the limitations of standalone battery and fuel cell systems. Future work will extend to hardware implementation and control refinement to accommodate real-world uncertainties and ensure robust performance.

KEYWORDS: *Hybrid Energy System; Hydrogen Fuel Cell; Lithium Capacitor Battery; Electric Vehicle Integration; MATLAB Simulink Simulation; Power Management Strategy; MPPT Algorithm; Sustainable Energy Technologies*

Paper ID – 164

A Cost-Effective Battery Retrofit for Non-Hybrid Grid-Tied PV Systems to Reduce Solar Energy Loss During Grid Outages

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ABSTRACT

Conventional grid-tied, non-hybrid photovoltaic systems disconnect from the utility grid during outages, resulting in complete solar energy loss despite continued solar generation. This paper proposes a cost-effective retrofit solution that enables energy harvesting and storage during such outages without requiring inverter replacement or voiding manufacturer warranties. The proposed retrofit integrates three blocking diodes, a two-pole DC magnetic contactor, a DC relay, a bidirectional maximum power point tracking (MPPT) DC–DC battery charger, and a microcontroller-based supervisory controller. Under normal grid-connected conditions, the retrofit remains electrically isolated to preserve the inverter's original operation. During grid outages, available solar energy is redirected to charge a battery through the bidirectional charger. At night, the stored energy is discharged via controlled current injection into one of the inverter's MPPT inputs through the diode-protected pathway, enabling up to 12 hours of energy utilization depending on local night duration. This approach mitigates solar energy loss during grid failures, eliminates the need for costly hybrid inverter upgrades, and offers a scalable retrofit pathway for residential and small-commercial PV systems.

KEYWORDS: *Non-hybrid PV systems, retrofit solution, grid-tied PV systems, solar energy loss, battery storage.*

CONSTRUCTION DYNAMICS AND DIGITALISATION

Paper ID - 109

Enhancement of Quality Management Through Lean in Sri Lankan Construction Industry

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ABSTRACT

Quality management remains a critical concern in the construction industry of developing countries, where inefficiencies, rework, and inconsistencies in quality practices negatively impact project outcomes. Although lean construction features prominently in the global literature, the rigorous integration of lean principles into quality management frameworks remains underexplored. While lean construction is widely recognised for enhancing process efficiency and value delivery, its integration with quality management, particularly through structured frameworks, has received limited attention in the Sri Lankan context. This study addresses this gap by investigating how lean can be applied to enhance quality management in Sri Lankan construction organisations. Guided by a pragmatic research philosophy, this study employed the Delphi technique involving experts with expertise in lean construction and quality management. Data was analysed using NVivo through directed content analysis. The study identified lean-related quality process areas and performance indicators based on established literature and expert judgement. The validated indicators were organised into four core process areas: continuous improvement, benchmarking, standardisation, and error detection and prevention. A total of 22 performance indicators corresponding to these areas were confirmed through expert consensus. The findings show strong alignment with established lean concepts such as Kaizen, the Plan Do Check Act cycle, standard work, and quality at source. The results also reflect local priorities such as proactive error management and regulatory alignment, emphasising the need for contextual adaptation. The study extends lean quality theory to a new geographic setting, offers a practical framework for Sri Lankan construction organisations, demonstrates the methodological value of the Delphi approach in data-limited contexts, and supports societal goals by promoting more reliable and accountable construction practices. These contributions advance understanding and implementation of lean-based quality management in emerging construction sectors.

KEYWORDS: *Construction Quality Management, Construction, Lean Construction, Construction Dynamics*

Paper ID - 37

Development of Field Instrument for Measuring Rope Slippage in Traction Elevator

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ABSTRACT

Among the various approaches to developing field equipment for measuring elevator rope slippage, this study, which utilizes contact-based motion measurement, stands out as a more practical and reliable methodology. The relative motion of the traction sheave and the rope is sensed by encoders and computed by microprocessors. Mainly, the movements of the traction sheave and the hoisting ropes are required to be measured to find the rope slippage at various dynamic movements of the elevator. Modern elevators achieve precise control through the use of motion measurement sensors. Quantitative detection of rope travel is more difficult than that of the traction sheave. Thus, the research intended to find an alternative to measure the motion of the passenger cabin. A laboratory-scale prototype was developed to investigate rope slippage behavior under varying weight ratios, simulating different load conditions in an actual elevator. The experiments revealed that increasing the weight ratio between the passenger car and the counterweight leads to a noticeable increase in rope slippage, highlighting the sensitivity of slippage to tension ratios in traction systems. The study extended to field-level experiments to examine the traction slippage behavior of an elevator traction machine under no passenger load conditions. Results indicated that, in the absence of passenger weight, the traction machine exhibits greater slippage during upward movement compared to downward travel. The experimental setup yielded promising results from both experimental tests and field measurements. Ultimately, the encoder-based motion measuring systems demonstrated potential for field applications when integrated with enhanced mechanisms.

KEYWORDS: *Rope Slippage, Encoders, Traction Sheave, Elevator*

Paper ID - 103

Construction Dynamics And Digitalization

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ABSTRACT

The construction industry is at the edge of a decisive transformation, moving away from fragmented, paper-based practices toward an era defined by intelligent digitalization. At the center of this shift is the Digital Twin- a living, data rich model that synchronizes the physical and virtual realms of construction. By Integrating Building Information modeling (BIM), Internet of Things (IoT) sensors, artificial intelligence, and cloud computing, Digital Twins enable Projects to move from reactive monitoring to proactive, predictive control. This paper examines their influence on Construction dynamics, demonstrating how 4D scheduling with Primavera P6 and intuitive dashboards guided by PMBOK-7 principles elevate visibility, collaboration, and decision making. A case study of the Maldives International Airport new terminal illustrates tangible outcomes: real-time clash detection, optimized sequencing, energy efficient design, and measurable carbon emission reductions. Beyond showcasing benefits, the study outlines a pragmatic roadmap for Sri Lanka, stressing the importance of regulatory reform, academia-industry partnerships, and pilot implementations. The findings suggest that Digital Twins are not distant aspirations but present-day necessities for sustainable, data driven construction.

KEYWORDS: *Digital Twin, Construction Dynamics, BIM, Digitalization, PMBOK-7, 4D scheduling, sustainability.*

Paper ID - 133

Adaptation of a Circular Economy Framework in The Design Phase of The Refurbishment Project

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ABSTRACT

Sustainable development in the built environment depends on minimizing environmental impact and conserving resources. In refurbishment projects, integrating circular economy (CE) principles during the design stage can significantly reduce waste and enhance resource efficiency. This study presents a tailored CE framework based on the 2D3R model, which emphasizes Design for Disassembly, Design for Adaptability, and the strategies of Reduce, Reuse, and Recycle. The framework was developed through a combination of literature review, expert interviews, and survey analysis to identify drivers and barriers to CE adoption in refurbishment. Key findings highlight the role of digital technologies particularly Building Information Modeling (BIM) in improving material traceability and facilitating lifecycle assessments. These tools support the implementation of circular strategies by enabling better planning and design decisions early in the project. The study concludes that applying the 2D3R approach in initial design phases enhances sustainability, reduces costs, and improves the adaptability and longevity of refurbished buildings.

KEYWORDS: *Circular Economy, 2D3R method, Sustainable construction, Building Information Modeling, Resource efficiency*

Paper ID – 134

The Adoption of Virtual Reality (VR) in Different Stages of Construction Project

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ABSTRACT

This research investigates the integration of VR technology within the construction industry, a sector notably lagging in digital adoption despite VR's transformative impact in others. The study aims to investigate the potentials of VR across different stages of construction projects, specifically aligned with the RIBA Plan of Work. The study initially confirmed low VR adoption rates and a significant gap between awareness and practical implementation among professionals. It then identified a comprehensive array of barriers, including prevalent technical skill shortages, high implementation costs, integration difficulties, and resistance to change. Building on these findings, the research proposes actionable strategies for overcoming these challenges, promoting for phased VR implementation, targeted workforce training, and the strategic selection of compatible technologies. While offering crucial insights, the study acknowledges limitations such as a regionally focused sample and perception-based data. Future research should pursue in-depth, longitudinal case studies and explore the impact of specific VR tools on project outcomes to further accelerate the construction industry's digital transformation.

KEYWORDS: *VR Technology ,Construction Industry ,VR Adoption ,RIBA Plan of work ,Challenges & Solutions*

Paper ID – 136

Circular Economy Practice in Road Rehabitation and Development in Sri Lanka

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ABSTRACT

The integration of Circular Economy principles into road rehabilitation and development offers a sustainable alternative to traditional linear construction practices. In Sri Lanka, where road infrastructure is crucial to economic growth and connectivity, the Circular Economy offers opportunities to reduce reliance on virgin materials, minimise environmental impact, and enhance long-term cost efficiency. This study explored applicable Circular Economy strategies, assessed current implementation practices, identified key challenges, and proposed viable solutions to support Circular Economy adoption in the Sri Lankan Road sector. A mixed-methods approach was employed, combining a comprehensive literature review with data from semi-structured expert interviews and a questionnaire survey of construction professionals. The findings indicate that while awareness of the Circular Economy is growing, its practical application remains limited due to barriers such as the absence of standardised technical guidelines, insufficient government incentives, limited stakeholder knowledge, logistical challenges in material sourcing and storage, and reluctance to shift from traditional methods. Data also highlights substantial potential benefits, including cost savings, reduced construction waste, increased material efficiency, and environmental improvements. Participants emphasised the importance of pilot projects, training programs, and policy support in promoting Circular Economy practices. To overcome existing barriers, the study recommends the development of clear Circular Economy specifications, financial incentives, capacity-building initiatives, and the establishment of centralised recycling infrastructure. These strategic actions can facilitate the transition toward a more circular and sustainable approach in Sri Lanka's Road construction and maintenance sectors.

KEYWORDS: *Circular Economy, Road Construction, Road Rehabilitation, Sustainable Infrastructure, Recycled Materials*

Paper ID – 150

Impacts of COVID-19 on Sri Lankan Road Projects: Multi-Class Delay and Resilience Analysis

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ABSTRACT

Road infrastructure delivery in lower-middle-income economies was severely tested by the COVID-19 pandemic, yet whether impacts differ across road classes and governance roles remains unclear. This paper investigates 55 Sri Lankan Road projects—Classes A, B, C, expressway and rural—active during the peak disruption window (Q4 2020–Q3 2021). A paired-response survey generated 110 matched client- and contractor-side questionnaires, supplemented by semi-structured interviews. Detrended Correspondence Analysis, independent-samples t-tests, one-way ANOVA and Pearson correlations mapped latent impact clusters and quantified stakeholder divergence. Mean schedule slippage ranged from 14 % to 27 % with no significant road-class effect ($p > 0.5$). Contractors reported markedly higher health risk (56 % vs 36 %), deeper cash-flow stress (43.8 % vs 29.2 %) and only 6 % remote-work capability compared with clients' 44 %. Labour attrition (14–27 %) and material shortages (< 5 %) were lower than published benchmarks for the UK (≈ 40–60 %) and Nepal (≈ 35 %), indicating that finance and workforce health—rather than inputs—were the principal bottlenecks. Adaptive measures such as precast adoption (45 %), staggered shifts and digital progress certification correlated moderately with shorter delays ($r = 0.52–0.63$). The study contributes (i) a stakeholder–road-class impact matrix to prioritise contingency support, (ii) a crisis-optimised rapid-survey protocol applicable in data-scarce settings, and (iii) policy guidance embedding pandemic-specific force-majeure clauses and real-time payment certification to hard-wire resilience. Findings extend project-resilience theory and inform emergency-financing frameworks for future systemic shocks.

KEYWORDS: *Pandemic Disruption; Schedule Overrun; Labour Attrition; Cash-Flow Stress; Governance Divergence; Lower-Middle-Income Context*

Paper ID – 151

Benchmarking Machine-Learning Models for Weekly River-Sand Price Floor Prediction

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ABSTRACT

River-sand price volatility in Sri Lanka forces sub-optimal procurement and erodes margins. We benchmark seven machine-learning families for next-week floor-price forecasting across six depots and test whether sparse linear regularization outperforms non-linear alternatives under small-sample conditions. We assemble the first VAT- and transport-neutral weekly panel of river-sand quotes from six Kalutara depots (3 June 2018–23 February 2020), sourced from invoices, quotations, and ledger scans and harmonized into a continuous series. A feature-rich time-series pipeline creates lagged minima (1–4 weeks), rolling minima (7, 14, 30 days), and harmonic calendar encodings. Seven algorithms—ElasticNet, Ridge, Random Forest, HistGradientBoosting, Gradient Boosting, K-Nearest Neighbors, and Support Vector Regression—plus a naïve persistence baseline are evaluated using expanding-window cross-validation to mirror real-world information flow. Within this benchmark, ElasticNet yields the lowest hold-out MAE (LKR 4.50; 99.2% below the baseline MAE of LKR 563) and $R^2 \approx 0.99996$, relying on just three predictors: the previous week's minimum, the 14-day rolling low, and a post-budget flag. This meets pre-stated parsimony and stability criteria for deployment at scale. Non-linear ensembles and instance-based learners underperform, often failing to beat the trivial baseline, highlighting small-n overfitting risk in frontier markets. For practitioners, a simple "buy when spot ≤ forecast + 0.2%" rule converts model outputs into average savings of LKR 600–800 per cube in historical back-tests. Overall, aligning model complexity with data reality delivers interpretable forecasts and tangible cost savings in practice.

KEYWORDS: *Sparse regularization; Commodity forecasting; Small-sample datasets; Construction supply chain; Data-driven purchasing*

Paper ID – 141

The Influence Of Project Managers' Decision-Making Styles On Schedule Variance In Building Construction Projects

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ABSTRACT

This research focus to assess the relationship between project managers decision making styles and schedule variance in building construction projects in Sri Lanka. Timely completion of construction projects is one of the major performance indicators, yet delays are a long-standing issue in Sri Lankan construction projects. Though there are many causal factors, decision-making styles of project managers have not been studied yet, creating a significant knowledge gap with regard to their influence on project schedule variance. This study attempts to analyze the relationship between project managers' decision-making styles: directive, analytical, conceptual, and behavioural and schedule variance in Sri Lankan building construction projects. A mixed-methods research approach was adopted. Primary data were gathered by holding semi-structured interviews with nine industry practitioners and a questionnaire survey of 50 respondents covering key project roles. To analyze the data code based content analysis and descriptive statistical tools (percentage count, mean, weighted average etc.) were used and to examine the relationship between decision-making styles and schedule variance Pearson correlation was conducted. Results revealed that decision making styles play a significant role in influencing project schedules. However, it was found that directive and behavioural styles are most prevalent and successful styles in the Sri Lankan context. The data revealed both positive and negative influences of managerial decision-making styles on schedule performance. These results contribute to the link between leadership and project performance and make a theoretical and practical contribution by revealing decision-making as a key influence to minimize schedule variance.

KEYWORDS: *Project Manager, Decision Making styles, Schedule Variance, Building Construction Projects, Correlation analysis, Behavioural and directive styles.*

ICT FOR SOCIETAL DEVELOPMENT AND DIGITAL INCLUSION

Paper ID - 125

Mobile applications usage and awareness among Sri Lankan small business owners

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ABSTRACT

Many Sri Lankan small business owners (SBO) today use mobile applications in managing their businesses. The relatedness of the purpose of the mobile applications that the SBO communities commonly use to the objectives and nature of their business (i.e. specifically designed for small businesses), the awareness among the SBOs in finding applications that can serve their business purposes, or their awareness of the importance of using dedicated applications for small business' purposes is an area that has not been investigated. This paper presents the findings of a pilot study on the current trends and nature of mobile application usage among Sri Lankan small business owners to understand the level of awareness they have on choosing mobile applications tailored for small businesses, and their expectations on features in mobile applications tailored to serve SBOs. It also investigates the demand among SBOs for integrated, SBO-specific mobile solutions. The findings shows that Sri Lankan SBO community has either not taken these facts into consideration in their mobile applications usage or they find it difficult to manage their businesses using existing mobile applications because those applications are not designed to cater their specific needs. This paper also summarizes the nature of mobile application usage among SBOs in several perspectives that gives meaningful insights to mobile application developers about this competitive community of users.

KEYWORDS: *Mobile Application, Small Business Management, User Experience (UX) Enhancement, Integrated Business Solutions, SBO-specific mobile applications*

Paper ID - 20

Nitrogen Management in Sri Lankan Rice Cultivation Using UAV-Based Multispectral Imagery and Machine Learning

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ABSTRACT

In Sri Lanka, paddy farming is a crucial livelihood and farmers are often struggle with applying right amount of fertilizers to their paddy fields. Nitrogen(N) is one of the most essential nutrients for plant growth, the quality and the quantity of the yield. Farmers are still using traditional methods to estimate the fertilizer requirement. As a results soil plant analysis development (SPAD) meter encountered and it gives correct digital value of chlorophyll level of the leaf which indirectly indicates the N concentration. However, it requires lot of workforces if the paddy field is too large. Besides, the high cost and limited availability of SPAD equipment, unnamed aerial vehicle(UAV) based imagery provides practical and affordable alternative for monitoring N levels in crops. This study evaluates the use of UAV-based multispectral imagery to estimate the N status of rice crops and compares ten vegetation indices (VI) with SPAD readings. The image dataset was captured at the rice research and development institute (RRDI), Bathalagoda, using a DJI Mavic 3M drone mounted multispectral camera with two different altitudes. The research focused two rice varieties (BG300, BG360) during the 2023 intermediate cultivation season. Six Machine Learning Models were used to analyze the correlation with SPAD values. RFR model performs high accuracy (0.7122) with lowest RMSE (4.5415). The results revealed that NDRE exhibited the highest correlation (0.00823) with SPAD values, outperforming the other indices. This indicates that NDRE also a reliable vegetation index for assessing the nitrogen status of rice crops. The findings suggest that UAV-based multispectral imagery, particularly NDRE, could serve as a valuable index for improving fertilizer management practices, optimizing nitrogen use, and enhancing crop yield prediction. This approach can be offers a cost-effective solution for Sri Lanka's rice farming sector, aiding farmers in making more informed decisions to reduce fertilizer use and mitigate environmental impacts.

KEYWORDS: *UAV, Multispectral imagery, Vegetation indices, Nitrogen status, Machine Learning.*

Paper ID - 54

Enhancing Web Accessibility for People with Impairments: A Tool to Guide Web Developers

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ABSTRACT

This research addresses one of the most prevalent challenges of implementing web accessibility standards, particularly in higher education related websites used by undergraduates with impairments. Despite the existence of the Web Content Accessibility Guidelines (WCAG) developed by the World Wide Web Consortium (W3C), many websites are still inaccessible due to low awareness or poor implementation by web developers. This study introduces a simple tool specifically designed to assist web developers in producing WCAG-compliant websites by detecting accessibility violations such as poor color contrast, lack of alternative text, and inappropriate heading structures. Also, by integrating machine learning, this tool offers several actionable recommendations for color palette improvements for visibility. The tool was evaluated by industry experts with an accuracy of 86.66% when matched with human evaluation. However, there are several limitations of the tool in dynamic content analysis as well as in mobile accessibility testing. This research emphasizes the importance of inclusive web design, and offers a practical solution promoting digital accessibility, especially within higher education institutions.

KEYWORDS: *Accessibility Awareness; Enhancement; Web Accessibility; WCAG (Web Content Accessibility Guidelines; Web Developers*

Paper ID - 23

A Data-Driven Approach to Predicting Ischemic Heart Disease Risk in Monaragala: Integrating Lifestyle and Symptom Factors with Machine Learning

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ABSTRACT

Ischemic Heart Disease (IHD) remains a leading cause of mortality worldwide and presents a critical challenge in underserved rural areas such as Monaragala, Sri Lanka. Traditional IHD prediction methods predominantly depend on clinical diagnostics like ECGs and blood tests, which are often unavailable or inaccessible in such regions. This study aims to bridge this gap by developing a machine learning-based prediction model that utilizes only lifestyle and symptom-related data, eliminating the need for invasive clinical procedures. A dataset comprising lifestyle habits (e.g., diet, smoking, alcohol use, exercise) and symptom indicators (e.g., chest pain, fatigue, dizziness) was collected via surveys. Feature selection using Logistic Regression identified the top eight most relevant predictors. Five machine learning algorithms, Logistic Regression, K-Nearest Neighbors, Support Vector Machine, Decision Tree, and Random Forest, were trained and evaluated. Among them, the Random Forest model achieved the highest performance with an accuracy of 83.5%, precision of 0.86, recall of 0.78, and F1-score of 0.81, demonstrating strong predictive capability based solely on non-clinical features. In addition, a web-based self-assessment tool was developed to make the model accessible to the public, particularly targeting individuals in rural areas with limited healthcare access. The tool enables users to input basic lifestyle and symptom information and receive a real-time risk assessment. The findings confirm that the model leveraging lifestyle and symptom data can effectively identify individuals at risk of IHD. This approach supports the development of scalable, low-cost, and user-friendly screening tools that can enhance early detection and preventive care, especially in rural and resource-constrained settings.

KEYWORDS: *Ischemic Heart Disease, Machine Learning, Lifestyle Factors, Rural Health, Monaragala, Risk Prediction, Symptoms, Web-Based Tool*

Paper ID - 122

Towards Safer Elderly Care: A Convolutional Neural Network Solution for Fall Detection

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ABSTRACT

As modern life becomes increasingly busy, computer vision-based monitoring systems have become essential, particularly in elderly care. This paper presents the development of a robust fall detection system using deep learning techniques, specifically a convolutional neural network (CNN) that processes RGB images to accurately distinguish between fall and non-fall events. The model is trained and validated on a dataset categorized into two classes: fall and non-fall. By utilizing convolutional and pooling layers, CNN effectively learns hierarchical representations of the input data, capturing both low-level and high-level features crucial for accurate fall detection. The key stages of this approach include data acquisition, pre-processing, and model training. The model's performance is evaluated using precision, recall, and F1-score metrics, demonstrating high accuracy, which is further enhanced through data augmentation, pre-processing, and cross-validation techniques. A confusion matrix analysis confirms the model's effectiveness in correctly classifying instances across both classes. The system also extends its capabilities to video analysis by extracting frames at 30-second intervals, ensuring continuous and comprehensive monitoring. This research highlights the potential of deep learning to enhance safety and care for the elderly, offering a reliable solution for real-time fall detection. The findings underscore the importance of integrating advanced technologies into healthcare, paving the way for future innovations in monitoring and assistance systems.

KEYWORDS: *Fall detection, Elderly care, Computer Vision, Deep Learning, Convolutional Neural network-(CNN), Data preprocessing*

Paper ID – 102

Feature Analysis of Blood Spatter Patterns with Image Processing

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ABSTRACT

Bloodstain Pattern Analysis (BPA) is a vital component in forensic investigations that aids in reconstructing the sequence of events at a crime scene. It is centralized in and revolves around the categorization of the patterns based on their features, as this is the most significant and critical stage of BPA. Therefore, a preliminary measure of BPA is via the thorough evaluation of images photographed of the crime scene to collect evidence as much as possible to arrive at the correct conclusion and to deduce the relevant details accurately. However, currently existing BPA methods are vulnerable to subjectivity, hence which can lead to pre-assumptions, without thoroughly and completely observing the crime scene, and consequently cause the arrival of incorrect conclusions and discrepancies in BP feature classification. Additionally, other flaws such as unintentional crime scene contamination and evidence tampering exist in these current methods as well. Henceforth, it is imperative that a novel method is constructed to eliminate these issues and arrive at the correct conclusions. This study introduces a robust image-processing-based methodology for extracting and quantifying bloodstain pattern features, thereby enhancing objectivity and reducing human error. The proposed technique encompasses critical stages: image acquisition, preprocessing, segmentation, feature extraction, and analysis. Through the use of image enhancement and segmentation algorithms, essential attributes such as impact angles, tail-to-body ratios, shape irregularities, and distribution densities are computed. The results were validated against original findings and show close agreement in feature values such as convergence area and circularity. The approach demonstrates the potential to integrate with existing BPA tools, facilitating automated, accurate, and reproducible forensic analysis.

KEYWORDS: *Image processing; Forensic science; Bloodstain pattern analysis; Feature extraction; Classification algorithm; Impact angle*

Paper ID – 44

Digital Marketplace and Community Hub for the Tailoring Industry in Sri Lanka

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ABSTRACT

This paper describes the design, implementation, and evaluation of needle360°—an integrated digital marketplace and community hub for optimizing operational workflows in the Sri Lankan tailoring industry. Small and Medium-sized Businesses (SMBs) in this sector are significantly behind in their digital transformation, relying instead on labor-intensive manual operations for order processing, inventory tracking, and communicating with customers. This research narrows the gap of traditional operations to modern technology solutions through a careful engineering process using Design Science Research Methodology (DSRM). This research involved 15 tailors and 50 customers of Kahathuduwa and Homagama as active participants including a needs assessment, co-design of the solution and iterative identification of features. This platform was developed by utilizing the MERN stack architecture (MongoDB, Express.js, React.js, Node.js) and deployed on the AWS cloud with Docker containers. Unique and innovative aspects of the platform include a 3D design tool, multi-vendor marketplace architecture, and more customer tailor interactions. A systematic evaluation through pre/post implementation surveys, system performance, and user testing produced significant improvements: order accuracy increased 85%, customer communication increased 72%, and the average time to execute daily tasks decreased by 60%. Performance metrics for the system averaged 1.2 seconds response time and 99.5% uptime throughout the evaluation process. The research provides both a practical digital solution and a methodological approach explaining how structured, participatory design approaches can be effectively used to bridge the digitalization gap, while maintaining cultural context and accounting for infrastructure limitations in developing countries.

KEYWORDS: *Digital Marketplace; Community Hub; Small and Medium-sized Businesses; Tailoring Industry; Sri Lanka; Digital Transformation; Design Science Research Methodology*

MECHATRONICS, ROBOTICS, AND AUTONOMOUS SYSTEMS

Paper ID - 29

A Reconfigurable Fire Detection Platform with Live Monitoring and Automated Actuation Based on Sensor Data Analytics

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ABSTRACT

This paper presents a robust, intelligent fire detection and response system employing a multi-sensor configuration comprising DHT11, MQ-2, and LDR sensors with dynamically tunable thresholds controlled via a LabVIEW-based GUI. Unlike conventional fire alarm systems with static thresholds prone to false positives from environmental variability, the proposed design enables real-time threshold reconfiguration without firmware updates. Sensor data from an Arduino microcontroller is processed in LabVIEW, which triggers a serial command to activate a buzzer, LED indicators, an exhaust fan, a real-time camera, and a servo-operated emergency exit. A human-in-the-loop camera feed and hardware override ensure safe manual reset in false alarms. In non-critical applications, an ultrasonic sensor enables automated touchless opening of doors. Experimental performances have an average response time of 2.4 s with a standard deviation of 0.2–0.5 s under various ambient conditions, confirming quick and consistent performance. Such flexible architecture also lessens spurious triggering and enhances safety, rendering it applicable to dynamic industrial and smart building environments.

KEYWORDS: *Intelligent Fire Detection and Response System; Multi-Sensor Configuration; LabVIEW; Real-Time Threshold Reconfiguration; Arduino Microcontroller; Industrial Safety; Smart Building Automation.*

Paper ID - 28

Improving Post-Harvest Rice Drying Efficiency through a Low-Cost Halogen Dryer Design for Rural Communities

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ABSTRACT

Small-scale rice farmers in Sri Lanka often depend on traditional sun-drying methods, which are inefficient, weather-dependent, and contribute to significant post-harvest losses. This research focuses on the conceptual design and evaluation of a low-cost wet rice dryer using halogen lamps as the heat source, aimed at improving drying efficiency prior to milling. Field surveys were conducted to identify the common challenges faced by rural farmers, such as uneven drying, weather interruptions, and grain rejection by millers due to high moisture content. Based on the survey results, key user requirements were identified, including low operating cost, simple structure, and potential for multi-crop drying. A conceptual design was developed accordingly, with a drying chamber and tray system optimized for 1 cm thick rice layers. The full assembly was modelled in 3D using CAD software, allowing for virtual evaluation of airflow, heat source positioning, and accessibility. Finite Element Analysis (FEA) was applied to simulate the mechanical response of the tray under typical loads, confirming its structural soundness. Preliminary thermal experiments were conducted using a controlled test box setup to evaluate the heating performance of a 1000W halogen lamp. The system successfully achieved drying temperatures up to 82°C, suitable for surface moisture reduction. Temperature trends were recorded over time, and manual quality checks showed promising results for further development. These findings indicate the technical feasibility of the design and its potential to improve post-harvest efficiency in rural settings. The study provides a foundation for future stages of prototype fabrication, sensor integration, and field validation.

KEYWORDS: *Halogen lamp dryer, Low-cost design, Post-harvest technology, Prototype development, Rice moisture reduction, Small-scale rice processing, Wet rice drying*

Paper ID - 30

Low Cost and Portable Battery Tester for Hybrid and Electric Vehicle

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ABSTRACT

Hybrid and electric vehicles (EVs) have become increasingly popular due to reduced gasoline consumption and significant environmental benefits. The majority of the functions of these vehicles rely on the battery power and batteries tend to degrade over time. Testing and maintenance of the batteries of these vehicles are essential. Thus, hybrid vehicle battery testers are utilized for this purpose. These testers are often expensive and come as a set of gadgets. In particular, the battery testers depend on, computers or mobile devices to display the results when needed. Therefore, the battery testers are getting expensive, and having several types of equipment makes the use of a tester a hassle. To solve these shortcomings, we developed a low-cost, portable hybrid vehicle tester that is custom-made for the Sri Lankan context, focusing on its ease of use and practicality. Our device can successfully detect weak cells present in hybrid and electric vehicle batteries by carefully calculating the discharging time of each of the cells. In addition to being compatible with a variety of hybrid and electric vehicle batteries, this lightweight tester is an inexpensive, self-supporting test tool that complies with sustainable vehicle maintenance processes. This paper discusses the current practice and the methods for hybrid electric vehicle (HEV) battery testing and their disadvantages. Furthermore, the development of the low-cost and portable battery tester as well as the main functions of the device are presented in detail. Finally, the results used for the verification of the developed device are presented and discussed.

KEYWORDS: *Battery tester, hybrid electric vehicle (HEV), Arduino, Hybrid battery*

Paper ID – 84

A Systematic Review on Edge Computing for Smart Agriculture: Practical Applications and their Future Directions

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ABSTRACT

Edge computing is revolutionizing smart agriculture by enabling real-time data processing closer to the source of information, leading to faster responses and optimized farming practices. Instead of relying solely on centralized cloud computing, edge devices analyze data locally, allowing for quicker decisions on issues such as irrigation, fertilization, and pest control. This leads to increased efficiency, reduced latency, and improved resource management in farming operations. As a result, edge computing transforms smart agriculture into a decentralized, responsive ecosystem where farmers can monitor, adapt, and react to environmental changes and crop health issues very quickly. The integration of edge computing into smart agriculture is rapidly transforming the industry. From this review, we will discuss the essence of edge computing towards sustainable agriculture by explaining how edge-related techniques help to speed the sensor controls and data communication, how edge-powered hardware/firmware boost the information accessibility and how modern developments in edge technology improve overall performance in smart agriculture. This review also covers the key modern developments in sensing and automation, Edge-AI frameworks, on-device computational power, and connectivity innovations that are collectively propelling this agricultural revolution.

KEYWORDS: *Artificial Intelligence; Edge computing; Internet of Things; Smart sensors; Smart agriculture*

Paper ID – 38

Bottle Identification and Positioning System of PET Bottle Collecting Robot for Trashed Bottles on the Ground

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ABSTRACT

Trashed PET bottles scattered on the floor create an environmental problem that needs an automatic system for identification and spatial measurement to enable efficient collection. The research develops such a system using Machine Learning for object detection and stereo vision for 3D coordinate estimation. The detection model is trained on a custom dataset to optimize accuracy while maintaining speed, ensuring that detection performance remains reliable even in cluttered environments. Stereo vision with calibrated cameras estimates the depth and determines accurate X, Y, and Z coordinates of detected bottles. It integrates techniques for image preprocessing, depth estimation, and real-time processing to enhance performance. Optimizing detection accuracy, refining the depth estimation, and ensuring computational efficiency with limited hardware resources remain some of the key challenges. It was evaluated based on the correctness of the detected bottles, their spatial precision, and the speed of processing. This research will contribute to intelligent waste management and robotic collection with an efficient and scalable solution for the localization of PET bottles. The proposed system can be further improved by using advanced models of neural networks and optimized algorithms of stereo vision, making it more applicable to a wide variety of automated waste sorting, environmental cleanup, and robotic collection systems. The success rate of overall accuracy was 87.23%. Results confirm that deep learning and stereo vision can effectively automate bottle identification and positioning.

KEYWORDS: *Real-time Object Detection; Object Identification; Object Positioning; Depth Estimation; Stereo Vision*

Paper ID – 166

High – Speed Path Tracking of a Small Mobile Robot Using PD and ADRC Controllers with Experimental Validation

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ABSTRACT

This paper presents the development, modeling, and validation of a compact ground-based mobile robot designed for high-speed trajectory tracking with low-cost hardware and advanced control strategies. Originally designed for micromouse competitions, the platform was upgraded with a vacuum-assisted friction enhancement mechanism and a lightweight sensor fusion system comprising Time-of-Flight (ToF) sensors, infrared (IR) proximity sensors, a 6-axis IMU, and wheel encoders. Due to the lack of manufacturer-provided system parameters, a data-driven system identification approach was employed to derive a MIMO state-space model representing the robot's dynamics. Two control strategies, Proportional-Derivative (PD) and Active Disturbance Rejection Control (ADRC) were implemented and evaluated through both numerical simulations and real-world experiments across three benchmark trajectories: straight-line, 90° smooth turn, and figure-eight. The results show that both controllers achieved trajectory tracking within 5% RMSE, with ADRC offering improved heading accuracy and energy efficiency. Experimental observations indicate that ADRC reduces battery current fluctuations, although current modeling was not included in the control design. The proposed platform and methodology offer a cost-effective and robust solution for mobile robot control in constrained environments, with future work focusing on energy-aware control integration.

KEYWORDS: *Mobile Robot, System Identification, PD Controller, ADRC, Sensor Fusion, Vacuum Traction*

NEXT GENERATION COMMUNICATIONS AND NETWORKING

Paper ID - 137

Penetratingz the Defenses: An Investigation into the Achilles' Heel of HTTP and SSH

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ABSTRACT

As the cyber threat increases, it becomes necessary for organizations to start securing their digital valuables and infrastructures. This research is mainly about analyzing the weaknesses lying in the vulnerabilities of the HTTP and SSH protocols. Investigation here is into how the intruder can escalate his privileges and illegally access computers. Under open-source tools like Netcat and Gobuster, the article examines the vulnerability-assessment methodologies culminating in root access to the target machine. This paper emphasizes the need for proactive security measures and gives recommendations on improving defences against future attacks. The study, as bright as the findings may be, awaits empirical dimensions to affirm the proposed measures.

KEYWORDS: *Cybersecurity, HTTP vulnerabilities, SSH vulnerabilities, privilege escalation, reverse shell, penetration testing.*

Paper ID -047

Enhancing Military Communication Security Using Hybrid Cryptography and Steganography

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ABSTRACT

The increasing threat of military communication interception emphasizes the critical need for secure data transmission methods to safeguard highly sensitive information. This research investigates ways to enhance communication security in Sri Lanka's military by employing a hybrid system that integrates Advanced Encryption Standard (AES), Rivest Shamir Adleman (RSA), and Least Significant Bit (LSB) steganography. The aim of this study is to devise, implement, and evaluate a hybrid cryptographic system that utilizes AES-256 for encryption, RSA-2048 for key exchange, and LSB steganography, focusing on improving the security and operational efficiency of military communications. The system was developed with the NetBeans Integrated Development Environment (IDE) and Java Cryptography Architecture (JCA), using AES-256 for symmetric encryption, RSA-2048 for managing asymmetric keys, and LSB steganography to embed the encrypted data in digital images. A performance evaluation was conducted to measure the execution times of encryption, decryption, and steganography processes, as well as the precision of data extraction, and the system's resilience against potential security threats. The results indicated that AES encryption provided fast and efficient data protection, RSA managed secure key exchanges efficiently, and LSB steganography successfully concealed the encrypted information in images without causing noticeable visual differences. These findings confirm that the system offers a robust and secure approach to military communications, although the encoding time for steganography increased with larger image sizes. A proof of concept was developed to demonstrate and assess the proposed solution, incorporating only the vital elements needed to effectively showcase each phase of the secure communication process. This study enhances the current understanding by illustrating how hybrid cryptography and steganography can work together to meet the specific security requirements of military communications. This paper presents a feasible solution to reduce interception risks and has important implications for secure communication systems in the military sectors.

KEYWORDS: *Hybrid cryptographic system, Military communication security, AES-256 encryption, RSA-2048 Key exchange, LSB steganography*

Paper ID - 155

Duty Cycle-aware Energy-Efficient MAC Protocol for Single-Layer Hierarchal UAV-WSN

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ABSTRACT

Optimizing energy consumption is critical for extending network lifetime and ensuring reliable data collection in UAV-assisted wireless sensor networks (WSNs). In the proposed work, an enhanced MAC protocol is developed, i.e., Duty-Cycle-Aware Bit-Mapped (DCABM). The pro- posed method estimates the active nodes per communication cycle based on their duty cycles and assigns transmission slots using a bit-mapping approach. The protocol is evaluated using the IEEE 802.15.4 standard with CC2420 radio parameters, considering varying network sizes, event occurrence probabilities, and packet sizes. The comparative analysis of the proposed method is compared with conventional U AV EBM A and U AV ET DM A methods. The results demonstrate that DCABM significantly reduces energy consumption. Specifically, DCABM achieves up to 42% energy savings compared to U AV ET DM A and approximately 31% reduction compared to U AV EBM A under high event occurrence conditions. Additionally, across increasing node densities and packet sizes, DCABM consistently maintains superior energy efficiency, making it suitable for scalable and event-driven WSN applications with UAV support

KEYWORDS: *UAV-assisted wireless sensor networks, duty cycle estimation, bit-mapping, slot scheduling, event-driven communication, wireless communication protocols*

Paper ID - 70

Analysis of the Receiver Architectures of the SLIPT Based Communication

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ABSTRACT

This study is based on the Simultaneous Lightwave Information and Power Transfer (SLIPT) system. Today, it has a high demand for the research community as well as new trends in Visible Light Communication (VLC). Here, we discussed two main receiver architectures, namely Power Splitting (PS)-SLIPT technology, which functions in the power domain and Time Splitting (TS)-SLIPT architecture, which functions in the time domain. In addition, we analyzed and compared both system architectures. Information decoding (ID) and energy harvesting (EH) are analyzed in both architectures. In addition, we discussed the existing mathematical model for the TS-SLIPT architecture, and the mathematical model developed for the PS-SLIPT system. Finally, we discuss the enhancement of Quality of Service (QoS) in both systems using numerical values.

KEYWORDS: *Power Splitting (PS), Time Splitting (TS), Simultaneous Lightwave Information and Power Transfer (SLIPT), Visible Light Communication (VLC).*

Paper ID – 129

The Evolution of the Internet of Things (IoT) and Smart Networks: From Inception to Intelligent Edge Computing

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ABSTRACT

Today, the Internet of Things (IoT) is used in different fields like healthcare, agriculture, transportation, etc. Alongside, it investigates the Software-Defined-Networking (SDN), 5G/6G, edge computing, and other novel technologies and their impact on smart networks in terms of the performance, scalability, and operational intelligence of IoT systems. Therefore, this paper presents a timeline of milestones in history, beginning with early-stage Machine-to-Machine (M2M) communication and tracing the evolution to sophisticated edge Artificial Intelligence (AI) and technological growth related to IoT and smart networks. A discussion of the data processing architecture of IoT with sensor technology, challenges faced in modern applications, the analysis of current gaps in research related to smart developments, emerging trends in IoT, and future directions is also explored in this study.

KEYWORDS: *Internet Of Things; Smart Networks; Edge Computing; 5G/6G; Artificial Intelligence; Software Defined Networking*

Paper ID – 87

Robust Dual-Hop Distributed Beamforming for Operation of WSANs with Nominally Rectangular Layouts

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ABSTRACT

We present a robust distributed collaborative beamforming (RDCB) framework for wireless sensor and actuator networks (WSANs) nominally placed over rectangular grids in dual hop transmission settings under highly scattered (polychromatic) environments. The proposed polychromatic-monochromatic PM-RDCB method exploits deterministic node placement and asymptotic approximations to design beamforming weights that are robust to placement errors and phase jitter. We derive closed-form expressions and demonstrate how our solution generalizes previous solutions to new design errors. Numerical evaluations confirm the accuracy and robustness of the proposed approach, showing its suitability for large-scale WSANs in practical 5G/6G applications

Paper ID – 89

Joint Time and Frequency Synchronization for Beamforming in a Relay System Using Population-Based Algorithms Enhanced with Importance Sampling

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ABSTRACT

In this paper, we tackle the problem of joint time and frequency synchronization for decode and-forward (DF) relay systems. We present a new data-aided (DA) maximum likelihood (ML) algorithm based on improved population-based algorithms through the importance sampling (IS) concept. In this work, we consider three such algorithms: 1) Particle swarm optimization (PSO) based on swarm intelligence: 2) Grey wolf optimization (GWO) inspired by nature and motivated by the socio-hierarchical behaviour of grey wolves and their special characteristic of hunting in a pack: and 3) Differential evolution (DE) based on metaheuristic evolutionary process. These traditional techniques suffer from slow convergence, limited solution accuracy, and susceptibility to getting trapped in local optima. To tackle their shortcomings, we combine them with IS. The resulting improved hybrid solutions IS-PSO (freshly proposed here), IS-GWO or GWOEIS (GWO embedding IS) and IS-DE (applied recently to other sets of parameters) rely on pseudo-pdfs for easier generation of particles, wolves, and individuals for PSO, GWO, and DE, respectively. These pseudo-pdfs boost the estimation accuracy by faster and better zeroing in on the right carrier frequency offset (CFO) and time delay (TD) values. The effectiveness of the proposed approach is validated by simulations both in delay and CFO estimation performance.

KEYWORDS: *Particle Swarm Optimization (PSO), Grey Wolf Optimization (GWO), Differential Evolution (DE), Time Delay (TD), Carrier Frequency Offset (CFO), Relay Systems, Cooperative Systems.*

Paper ID – 169

Highly Efficient 3D Object Transmission System for HTC Services in 6G Networks

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ABSTRACT

In recent years, advancements in technology have brought forth a new frontier in visual communication. Holography is a technique that captures and reproduces three-dimensional (3D) images with an unprecedented level of realism and depth, has emerged as a groundbreaking method for conveying visual information. Unlike traditional images and videos, holography recreates scenes with full parallax, enabling viewers to perceive objects from various angles. The transmission of holographic images presents both exciting possibilities and unique challenges. To this end, this article conducts a comparative analysis of a previously developed application system for transmitting dynamic 3D human movements with a ready-made solution for transmitting 2D video streams in order to provide conference calling services. The network characteristics of the systems were collected and compared. The opportunities that programs currently provide and will provide in the future are examined.

KEYWORDS: *Telepresence, Comparative Analysis, MVP, TrueConf, HTC, 6G, Teleconference, 3D images, Conferencing*

Paper ID – 170

Task Scheduling Problem in Fog Computing Environment with Improved Memetic algorithm

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ABSTRACT

The task scheduling problem in fog computing is one of the key challenges in the development of fog computing within next-generation communication networks. Addressing this challenge requires balancing processing performance with resource constraints while meeting network conditions. Given the distributed and heterogeneous nature, as well as the dynamic topology, optimally allocating tasks to fog nodes is a complex issue. To contribute to solving this problem, we propose a task scheduling method based on an improved Memetic algorithm. The proposed method leverages the strengths of evolutionary algorithms and local search, while incorporating a task restructuring mechanism, to enhance allocation efficiency and task processing in the fog computing environment. Simulation experiments demonstrate that the proposed method outperforms genetic algorithms, Round-Robin, Greedy methods, and the Ant Colony Optimization algorithm in terms of efficiency. This study provides a fresh, simpler approach that aligns with network conditions while still achieving the desired performance.

KEYWORDS: *6G, Fog Computing, Task Allocation, Memetic Algorithm, Task Restructuring Mechanism, Next-Generation Networks.*

Paper ID – 171

Analysis And Optimization Of OLSR And AODV Routing Protocols For Highly Mobile Autonomous Aerial Vehicle Networks: Experimental Performance Evaluation In Various Application Scenarios

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ABSTRACT

Driven by the rapid evolution of Autonomous Aerial Vehicle (AAV) technology, ad-hoc AAV networks are becoming increasingly significant in diverse domains such as telecommunications, security surveillance, search-and-rescue operations, emergency management, precision agriculture, and cargo transportation. Owing to their flexible deployment and tight coordination capabilities, AAVs enable real-time data exchange, unlocking considerable potential for tasks that demand high accuracy and swift response. Nevertheless, their three-dimensional mobility and continuously changing topology impose substantial challenges on the design of suitable routing solutions, because conventional protocols originally developed for Mobile Ad-hoc Networks (MANETs) are seldom optimized for aerial characteristics. This discrepancy underscores the necessity for a comprehensive analysis and optimal configuration that satisfy the stringent requirements of low latency, high throughput, and reliability in mission-critical AAV applications. Against this backdrop, the present study focuses on the analysis and modelling of two widely adopted routing protocols—Optimized Link State Routing (OLSR) and Ad hoc On-Demand Distance Vector (AODV)—in various deployment contexts of ad-hoc AAV networks. By evaluating the performance of these protocols, we identify their advantages, limitations, and possible enhancement directions, and subsequently propose configuration guidelines that deliver improved link quality.

Paper ID – 172

Fog Computing Power For Telepresence Suit As User Terminal For Metaverse

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ABSTRACT

Fog computing represents an emerging paradigm in information and communication technologies that is becoming pivotal for meeting the growing performance requirements of modern computing systems, particularly in the context of the Internet of Things (IoT) and real-time services. One of the most promising 2030-network service classes enabled by fog is telepresence. This paper investigates both the theoretical and practical aspects of deploying fog-computing solutions in telepresence networks to minimize latency and enhance overall system performance. The study combines analytical modelling with discrete-event simulations carried out in Any Logic.

NEXT-GEN TRANSPORTATION AND MOBILITY SOLUTIONS

Paper ID – 75

Quantitative Risk Assessment of Pedestrians- Train Accidents in the Colombo Division Railway Network

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ABSTRACT

Rail transportation stands as a critical mode for both passenger and freight movement in Sri Lanka, acting as a major catalyst for economic activity while linking different regions across the country. Train accidents cause tragic loss of life, injuries, and lead to noteworthy financial and social disturbances. Unfortunately, there has been a lack of comprehensive studies on railway accidents in Sri Lanka, likely due to restricted data accessibility. Therefore, advancing research in this area and gaining a deeper understanding of the underlying causes and patterns of train accidents is essential. The main objective of this study is to quantify pedestrian–train accident risk across the Colombo Division railway network and to determine the risk status of each line segment of the network. The Colombo division comprises 5 railway lines and includes 194 stations. Through segmentation of each railway line based on stations, a numerical assessment of risk is conducted for each segment. Statistical techniques, including bootstrapping and K-means clustering, are employed to classify the calculated risk scores into three categories: high, medium, and low. The reliability of these risk categories is validated using Kruskal-Wallis rank sum test and Dunn's test with Bonferroni correction. The results indicate that, out of the total 194 segments, 165 are classified as low risk, 10 as medium risk, and 19 as high risk segments. Among these, the Coastal line has the highest count of high risk segments. Although, the Northern line and Kelani Valley line exhibit no high risk segments, Puttalam line has 1, while the Main line shows 7 high risk segments. These findings offer valuable insights to relevant authorities for identifying railway line segments that are highly vulnerable to accidents and for guiding government efforts in implementing safety measures for railway operations in Sri Lanka. Future research could enhance this study by including analyses of train accidents involving vehicles, animals, and other properties.

KEYWORDS: *Bonferroni Correction, Bootstrapping, Dunn's Test, K-means Clustering, Kruskal-Wallis Rank Sum Test*

SUSTAINABLE BUILT ENVIRONMENT, SMART CITIES AND NATURAL ECOSYSTEMS

Paper ID - 104

Machine Learning-Based Early Warning Systems for Urban Floods: A Case Study in Nilwala Basin

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ABSTRACT

This study pioneers the integration of Graph Neural Networks (GNN) into flood forecasting systems, extending the predictive horizon from short-term forecasts to 7 days by effectively capturing spatial dependencies between rainfall stations. Focusing on the flood-prone regions of Matara and Galle districts within the Nilwala Basin, the research addresses the limitations of conventional forecasting methods by leveraging historical hydrological data, including daily rainfall records from six key stations and flow data from Pitabeddara. A hybrid machine learning framework combining Random Forest (RF) and K-Nearest Neighbors (KNN) models was developed to predict river discharge based on rainfall data, overcoming challenges posed by limited water level information. The inclusion of GNN introduces a novel approach to modeling complex spatial relationships, enabling improved accuracy for long-term flood prediction, particularly during extreme events. The proposed system demonstrates significant advancements in predictive reliability, offering a timely and accurate early warning tool to enhance disaster preparedness and risk management in the Nilwala Basin. This research underscores the transformative potential of data-driven methodologies in addressing the challenges of flood-prone regions.

KEYWORDS: *Floods, Flood early warning systems, Nilwala basin, Machine Learning*

Paper ID - 019

3D Electro-Geometric Approach and Advanced Lightning Protection Modeling for Anuradhapura's Sacred Sites

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ABSTRACT

The Eight Sacred Places in Anuradhapura, Sri Lanka. Jaya Sri Maha Bodhiya, Ruwanwelisaya, Thuparamaya, Lovamahapaya, Abhayagiri Dagaba, Jetavanarama, Mirisaveti Stupa, and Lankarama are significant Buddhist pilgrimage sites associated with the life of Lord Buddha, representing an invaluable part of the world's cultural heritage. Due to their towering structures, which symbolize spiritual and historical triumph, these monuments are highly susceptible to lightning strikes, a natural phenomenon capable of causing irreversible damage to ancient architectural marvels. Although conventional Lightning Protection Systems (LPS) have been implemented, their effectiveness is challenged by variations in lightning stroke currents, exacerbated by climate change and the complex geographical topography of the region. To address these challenges, this research focuses on three primary objectives: first, conducting a comparative analysis of LPS methodologies, namely the Protection Angle Method (PAM) and the Rolling Sphere Method (RSM), utilizing advanced 3D geometric modeling and electrostatic simulations through COMSOL Multi-Physics® software to evaluate step and touch voltages, thereby providing site-specific recommendations for enhanced protection; second, assessing the influence of varying protection levels and striking distance criteria on optimal air terminal placement to maximize safety; and third, performing a cross-validation study to determine the adequacy of proposed LPS designs while identifying vulnerable zones through shielding failure analysis. Additionally, the study introduces an innovative lightning counting technique to establish a data-driven risk assessment framework, facilitating the integration of advanced protective measures. By combining computational modeling with empirical validation, this research aims to deliver scientifically robust solutions for safeguarding these sacred monuments, ensuring their preservation against lightning-induced threats for future generations.

KEYWORDS: *Protection angle method (PAM), rolling sphere method (RSM), lightning risk assessment, lightning protection system (LPS), step and touch voltage, finite element modeling.*

Paper ID - 4

FreshSight: An Accessibility-Focused Approach to Produce Freshness and Shelf-Life Detection for Food Safety and Waste Reduction

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ABSTRACT

Colour-blind individuals encounter daily challenges, particularly in distinguishing colour-based indicators of food spoilage. This limitation significantly impacts their ability to assess the freshness and safety of fruits and vegetables accurately. Concurrently, global concerns regarding food spoilage have intensified, with millions worldwide affected by foodborne illnesses each year. The modern lifestyle, characterized by its rapid pace and time constraints, exacerbates this issue, often leading to unnoticed spoilage and substantial waste. The resulting annual waste, estimated at one-third of all edible food, imposes significant societal and environmental burdens, underscoring the urgency for effective solutions. FreshSight enables users, including those with colour vision deficiencies, to assess the condition of fruits and vegetables through a Convolutional Neural Network (CNN)-based real-time image analysis engine and an intuitive interface. This system provides immediate visual feedback to help users make informed decisions and avoid the consumption of spoiled produce. It also offers inclusive design features that support individuals with visual impairments. Beyond individual benefits, FreshSight promotes responsible food handling and contributes to the broader goal of sustainable food systems. By combining advanced technology with user-centered design, the solution enhances both safety and accessibility in everyday food-related decisions. In addressing the critical challenges of food safety, inclusivity, and waste reduction, FreshSight aims to support healthier lifestyles and contribute positively to environmental and societal well-being in the modern world.

KEYWORDS: *Colour vision deficiency, Food spoilage, Image analysis, Food safety, Responsible consumption, Accessibility, Sustainability*

Paper ID - 117

Advancing Transit Oriented Developments (TOD); Strategic Urban Framework for Sustainable Built Environments for Mirigama

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ABSTRACT

Mirigama is rapidly evolving into an industrial and transit hub due to its convenient position at the center of Sri Lanka's main national transportation lines. Although there has been a lot of development in this desirable area, most of it has been unplanned, which has resulted in environmental deterioration, land-use disputes, and traffic congestion. These circumstances offer Mirigama a chance to steer its transition to a sustainable built environment as well as a challenge. The main challenge is striking a balance between the town's growing transit-related activity and social well-being, economic vitality, and ecological sensitivity. Without a well-thought-out plan, Mirigama runs the risk of becoming a dispersed, automobile-dependent community, compromising its long-term viability and livability. A Transit-Oriented Development (TOD) framework is suggested in this study to promote sustainability in Mirigama. The framework is tailored to Sri Lanka's planning context and in line with national development agendas and is based on international TOD principles, especially emphasis on walkability and support for mixed-use vibrancy. Stakeholder interviews, policy analysis, site visits, and geographical mapping were all incorporated into the mixed-method approach. This made it possible to critically evaluate the socioeconomic circumstances, transportation networks, and urban shape of Mirigama, pinpointing key areas in need of reform. It places a strong emphasis on applying global best practices to local circumstances in a context-sensitive manner, guaranteeing environmental stewardship, cultural relevance, and community acceptance. For small to mid-sized Sri Lankan communities undergoing transit-induced growth, the study provides a repeatable TOD model, demonstrating how locally based but internationally informed design solutions can promote sustainable urban transformation.

KEYWORDS: *Mirigama, Transit- Oriented Development, Sustainable, Built Environment.*

Paper ID - 139

Spatially Integrated Water and Wastewater Management: A Model Design for Fish Markets in Sri Lanka

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ABSTRACT

Fish markets in Sri Lanka, vital to the national economy, lack essential hygiene facilities such as washable floors, dedicated fish cutting and gutting stations, and enclosed drainage systems. These deficiencies, coupled with poor wastewater handling, have created severe impacts on surrounding urban environments, ecosystems, and public health. In most markets, waste management relies heavily on a simple collect-and-dump approach, while wastewater often flows through clogged and foul-smelling open drains, compounding hygiene and environmental issues. These conditions highlight the urgent need for a spatially integrated and smart water management strategy that not only addresses overall market operations but also adapts to the specific requirements of each functional zone. This research develops a cost-effective and scalable framework for water and wastewater management in Sri Lankan fish markets. The study draws on case studies of the Sydney Fish Market as a global best practice and the Peliyagoda Fish Market as a local practice, adapting international standards to the Sri Lankan context. Insights from stakeholder engagement and field assessments revealed critical gaps, including the absence of greywater separation, inadequate drainage, poor solid waste filtering, limited reuse systems, and a lack of smart monitoring. The proposed framework suggests dedicated zones for specific market functions such as washing and sorting areas, wholesale and retail sections, fish cutting bays, and loading and service spaces, while integrating water supply and wastewater management systems within each zone to ensure spatial organization, hygiene, and environmental sustainability. The framework also recommends sustainable interventions such as the use of seawater ice for storage and freshness, rainwater harvesting for non-potable applications, bunded wash zones with enclosed drainage systems, biofiltration units for effective wastewater treatment, and affordable smart technologies for monitoring drainage outputs. This systematic organization provides a replicable framework to upgrade Sri Lankan fish markets into hygienic, resource-efficient, and environmentally responsible urban facilities.

KEYWORDS: *Coastal Fish Markets, Smart Water Management, Wastewater Treatment, Spatial Zoning, Sustainable Market Design, Sri Lanka*

Paper ID - 60

Piezoelectric Energy Harvesting in Interactive Environments: A Case Study Using a Playpen-Based Prototype

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ABSTRACT

As modern cities evolve towards sustainable and efficient infrastructure, implementation of micro-energy harnessing technologies caught the attention of researchers. This is mostly because non-renewable energy sources are being depleted, and the consequences of them are also marginal to the world. Piezoelectric materials are known for their conversion ability of mechanical stress, such as motion, vibrations, pressure, to electrical energy. This study provides a piezoelectric mechanism-based prototype that demonstrates the suitability of converting mechanical energy to electricity, especially footsteps from people, while being low maintenance and cleaner. In this design, 70 PZT piezoelectric disks are implemented beneath a playpen floor, suspended by a spring mechanism and further suspension components. Output voltages of 9.2V to 11.4V could be observed from this demonstration, with the help of 2-5kg loads applied. 76 LEDs were used to visualize this power in real-time, which also offers interactive feedback for children. The output analysis shows a low-current and somewhat non-linear power output. These results validate the possible outcome of deploying a piezoelectric system in high footfall infrastructure and recreational spaces. Even though it is low powered, such systems can enhance built environment functionality, and further improvements in the design can increase the output of such designs. This project represents a small-scale demonstration of this unpopular yet effective technology.

KEYWORDS: *footstep energy, interactive environments, kinetic-to-electrical conversion, low-power applications, piezoelectric energy harnessing, PZT (Lead Zirconate Titanate), smart cities, sustainable infrastructure*

Paper ID - 81

Performance Verification of the Leachate Treatment Plant: A Dilution-Based Engineering Approach

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ABSTRACT

Leachate treatment is a critical component of municipal solid waste management due to the complex and variable nature of leachate composition. This study investigates a dilution-based strategy to address insufficient leachate volume during a mandated 21-day reliability test at the Kelaniya Transfer Station leachate treatment plant, part of the Metro Colombo Solid Waste Management Project. The primary objective was to evaluate the plant's capacity to treat leachate under continuous operational conditions at its design flow rate of 160 m^3/day, despite a limited leachate supply caused by non-functional compactors. A dilution ratio of 50–60% was applied to available leachate to meet volume requirements, with the underlying assumption that such dilution would not significantly alter leachate variability. Baseline and incoming leachate samples were analyzed for key parameters, chemical oxygen demand (COD), ammonia nitrogen (NH_4–N), total nitrogen (TN), and total suspended solids (TSS). Statistical tests, including two-sample t-tests and Levene's tests, were conducted to assess variability before and after dilution. The results revealed significant variation between undiluted samples from the same source, confirming the inherent variability of leachate. However, Levene's tests showed no statistically significant differences in variance for NH_4–N, TN and TSS before and after dilution, indicating that the dilution process preserved the natural variability of leachate characteristics. The findings support the use of controlled dilution as a valid strategy for leachate volume supplementation during performance testing, without compromising the reliability of treatment plant assessment. Nevertheless, dilution reduces nutrient loading, particularly carbon input, and may not reflect peak loading scenarios. To address this, a supplementary a separate testing phase was conducted using undiluted leachate with high-strength characteristics over a period, specifically to evaluate the treatment plant's capacity to handle peak loading scenarios.

KEYWORDS: *Leachate treatment, dilution, volumetric mixing, reliability test, variability, TN, NH_4–N, TSS, municipal solid waste*

Paper ID - 173

Three Types of Buildings, Three Tools: Why Does Building Life Cycle Assessment Need Standardization?

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ABSTRACT

The growth of global construction necessitates robust environmental impact assessment methods. Yet inconsistencies in life cycle assessment (LCA) tools limit benchmarking, particularly in Asian regions. This study addresses this need by conducting a comprehensive evaluation of three widely used life cycle assessment (LCA) tools: Athena IE, One Click LCA, and eTool LCD applied to Sri Lanka's most common building types: office, apartment, and residential buildings. Furthermore, through a comparative analysis, it identifies software-specific limitations and establishes performance rankings for the three tools based on five published evaluation themes. The study focuses on four critical impact categories: global warming potential (GWP), acidification potential (AP), and eutrophication potential (EP). The analysis revealed tool-dependent variations of up to 15% in GWP values (office: 13.4-22; apartment: 25.3-35.2; residential: 9.7-12.6 kg CO_2-eq/m^2/year), primarily resulting from differences in regional databases and calculation methodologies. Consistent with established literature, the use stage (B1–B7) emerged as the dominant contributor (>75%) to GWP among the selected building types, followed by the product stage (A1–A3). The systematic evaluation ranked One Click LCA highest (90%), with eTool LCD (75%) and Athena IE (62%) demonstrating specific limitations in regional applicability. These findings highlight the importance of tool selection in emission assessments. Also, it underscores the urgent need for standardized LCA protocols in tropical developing regions. For practitioners, this study provides guidance for selecting LCA tools.

KEYWORDS: *Whole building life cycle assessment tools, sustainable building, building emissions, global warming potential, Athena IE, One Click LCA, eTool LCD*

Paper ID – 93

Multifactorial Drivers of Chronic Kidney Disease of Unknown Etiology (CKDu): A Review of Cadmium Exposure, Ultraviolet B B Radiation, and the Potential Role of Vitamin D Toxicity

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ABSTRACT

There are many research studies conducted to determine the cause/origin of CKDu for preventing this increasingly occurring disease, particularly among poor farmers. The disease is known to be multifactorial with heat stress enduring period > 3 months, but there is difficulty in distinguishing between harsher environments than endemic locations. This study identified that the likely cause is UVB actuating Vitamin D Toxicity (VDT), thus affecting the kidneys. Hence, a focused literature review was undertaken to find the links between cadmium (Cd), calcium, fluoride, enzymes, inhibitions, and the like. Moreover, 2nd law of thermodynamics was applied to determine the entropy differences between cold and hot source. The mean values of climate models were obtained from one publication on radiative forcing (RF) in the tropopause of 1.28 Wm-2 and climate feedback (CF) 0.25 Wm-2K-1. The energy of RF was used to determine entropy value $SRF(UVB)$at $T2$=230K as mean atmospheric temperature and the maximum temperature, $T1$ at locations. It was then equated to the energy value of UVB, $QCF(UVB)$ to be found between 1/273 and 1/$T1$. It was also validated using CF. The endemic location resulted 3.697 Wm-2 at 303K, and low RH compared to 3.239 Wm-2 at 311 K high RH. Although there is much comfort in endemic location, the chances of VDT or heat stress are higher more so with Cd inhibition of enzyme 7-dehydrocholesterol reductase (DHCR7), which is crucial for cholesterol synthesis. Instead, 7-dehydrocholesterol in excess switches more to form VDT, causing symptomatic hypercalcemia. Cadmium can disrupt vitamin D metabolism, contributing to osteomalacia and osteoporosis, actuating hypercalciuria, an indirect marker of low-level cadmium exposure. The kidneys, already compromised due to cadmium (Cd) accumulation and reabsorption during systemic distribution, ultimately eliminate Cd via the urine. Notably, no significant Cd accumulation is observed in end-stage renal tissues. Further basic research is required to elucidate the VDT in response to UVB exposure.

KEYWORDS: *Cadmium, CKDu, Climate Feedback, hypercalcemia, Vitamin D toxicity (VDT), UVB, Radiative Forcing, 7-dehydrocholesterol reductase (DHCR7)*

Paper ID – 94

Evaluation of the Knowledge Base in Agriculture and Food to Reduce and Prevent Chronic Kidney Disease of Unknown Etiology (CKDu)

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ABSTRACT

Kidney disease is a growing global problem, more so in tropical regions. The cause of CKDu is multifactorial and influenced by heavy metal (HM) contamination, inhibiting essential enzymatic reactions. Fertilizers and water contamination are believed to cause the disease. This study aimed to review the existing knowledge base, focusing on a transitional approach to advanced technologies with the least HMs and to use justifiable scientific reasoning supported by published data, to used to demonstrate the movement of Cadmium (Cd) at both low and high concentrations from applied fertilizer through the soil to grain and rice. The quantity of fertilizer applied per ha with the given Cd levels was equated to Cd concentrations in the harvested grain and rice per ha, considering positive or negative contributions from the soil. Weekly consumption levels of rice at the threshold limits by an average Sri Lankan were determined for low and high Cd levels in rice using the tolerance limits of two international standards. It is best to characterize watersheds and determine the movement of nutrients and HM in ferruginous soils. Hinderance to phosphate immobility in these soils can be overcome by applying biochar biofertilizer with possible enrichment of biofilm biofertilizers to replace totally inorganic fertilizers contaminated with HMs. Cd levels of 836.25 and 393.75 of the two publications equate to the assumed harvest: lowest 21.22, average 385.13, and the highest 1246.10 mg Cd ha-1. Allowable standards indicate that the weekly limit of a Sri Lankan to consume rice is 300 g, containing a high concentration of 0.2618 mg Cd kg-1 and 1kg or 604 g, having 0.1339 mg Cd kg-1 for an average harvest of 4350 kg.ha-1. Water contains HM, particularly arsenic from fertilizer and pesticides. Recommended researching while implementing phytoremediation, mechanized farming, preventing UVB, Integrated Pest Management (IPM), and organic agriculture with supporting technologies of watershed resource management.

KEYWORDS: *Biochar, Biofertilizer, Biofilm, Cadmium, CKDu, Heavy metals, Organic pollutants, Soil*

Paper ID – 95

Preserving Built Heritage in Sri Lanka through Digital Twin Technology: Opportunities and Implications

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ABSTRACT

The "digital twin" concept has gained prominence in architecture and construction for maintaining accurate digital representations of physical structures. There is no generalized digital twin system which can be applicable for all purposes; thus, the digital twin development is context and site specific. Building Information Modeling proves invaluable for performance modeling, behavior analysis, and preventive maintenance of historic sites, yet its implementation complexities demand customized approaches. In Sri Lanka, digital twin adoption lags due to uncertainties in construction, operation, utility, and limited research on their cultural heritage impacts. Modernization threatens colonial street architecture, intensifying conservation urgencies. Digital twins offer detailed virtual models capturing architectural nuances and historical contexts, crucial for UNESCO World Heritage sites facing modernization and climate change threats. The UN's 2030 Sustainable Development Goals prioritize cultural and environmental sustainability, underscoring the need for effective conservation strategies. This study integrates a literature review, two case studies with a detailed algorithm for the creation of a digital twin, and professional interviews for identifying challenges and strategies for digital twin implementation. Case studies of the De Soysa building and Rangiri Dambulla Caves illustrate their potential respectively: the former preserving legacy amid urban development, the latter optimizing preservation through microclimatic analysis. Project-specific digital twins are pivotal for safeguarding cultural identity and managing heritage properties. Challenges in digital twin use for heritage preservation include data capture, costs, integration, and ethical considerations. Solutions entail advanced technologies, funding strategies, standard data formats, cloud storage, and ethical data handling to enhance management and preservation.

KEYWORDS: *Digital Twins, Historical Cultural Heritage, Conservation.*

Paper ID - 153

Flammability Characteristics of Waste-Based Fibre-Reinforced Composite Using Palmyra Fibre and Waste Polythene

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ABSTRACT

This study investigates the flammability characteristics of composites developed from waste materials, notably integrating Palmyra fibre and waste Law Density Polyethylene (LDPE). The research systematically assessed the flammability properties of Palmyra Fibre-Reinforced Composites (PFRCs) across seventeen distinct variations. PFRCs were synthesized employing a variety of techniques, including the hot-press method, the cold-press method, and the hand lay-up method. The analysis spanned various dimensions such as the treatment condition of the fibres, fibre lengths, volume fractions, and orientation, aiming to evaluate their impact on the composite's flammability properties comprehensively. Among the variations considered, 40 mm length alkali-treated fibre with 20% (w/w) inclusion in random orientation provided the best overall density and flammability characteristics. The results highlight the capability of Palmyra fibre to serve as an effective alternative for reinforcing composite sheets. The research indicates that these materials demonstrate not only favourable density and improved resistance to fire but also add to the overall durability and wider usage possibilities of the composites. Together, these findings emphasise the field of sustainable and alternative materials research, emphasizing the practicality of utilizing waste-derived composites in a range of applications.

KEYWORDS: *Flammability, Palmyra Fibre, Waste Polythene, Waste-Based Fibre-Reinforced Composite*

THERMAL & FLUID ENGINEERING

Paper ID - 085

Li-ion Battery Cooling - A Computational Study of Different Phase Change Material Configurations

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ABSTRACT

Overheating of Li-ion batteries in Electric Vehicles (EVs) degrades performance and reduces lifespan. Hence, energy-efficient and reliable Battery Thermal Management Systems (BTMS) are required. This paper investigates the use of Phase Change Materials (PCMs), a passive cooling method with high heat storage capacity, for the thermal management of prismatic Li-ion battery cells in EVs. This computational study models the influence of buoyancy-driven convective flow on the PCM cooling performance, compared against thermal conduction-only models. In addition, this study investigates how convective flow influences the cooling performance with variations in cell orientation between vertical and horizontal alignments. n-Octadecane is used as the PCM, and Computational Fluid Dynamics (CFD) simulations were conducted with the Solidification and Melting model in ANSYS Fluent. A 12 mm PCM layer placed around the cell periphery reduced the centre temperature after 1800 s by 2.7 K in the vertical orientation and 3.7 K in the horizontal orientation compared to air-cooling. The effect of natural convection was more pronounced in the horizontal orientation, providing superior cooling performance relative to the vertical case. When the same PCM volume was used to fully enclose the cell, the cooling effect was further enhanced, achieving a maximum temperature reduction of 8.3 K within the first 1800 s. These findings demonstrate that natural convection significantly enhances the PCM-based cooling effectiveness, particularly in horizontally oriented cells, while thinner PCM layers with increased heat transfer area promote faster melting and improved cooling performance.

KEYWORDS: *Battery Thermal Management (BTMS), Phase Change Materials (PCMs), Natural Convection, Computational Fluid Dynamics (CFD), Prismatic Li-ion Cells*

Paper ID - 55

A Numerical Investigation of the Potential of Dimpled Surface Configurations to Improve Aerodynamic and Aeroacoustic Performance of Airfoils

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ABSTRACT

This study investigated the potential of dimpled surface configurations to enhance the aerodynamic and aeroacoustic performance of airfoils. Computational Fluid Dynamics (CFD) simulations were carried out on a NACA 0012 airfoil featuring surface dimples, under flow conditions relevant to low-speed aerodynamic applications such as unmanned aerial vehicles (UAVs), light aircraft, and small-scale wind turbines. The simulations were conducted at a Reynolds number of 700,000 and a Mach number of 0.21, representing typical subsonic operating conditions. Two angle of attack, 5° and 10°, were examined to represent attached flow and near-stall behavior, respectively. Aerodynamic performance was evaluated through lift and drag coefficients, while aeroacoustic characteristics were analyzed using Overall Sound Pressure Level (OASPL) with directivity plots and frequency spectrum analysis based on the Ffowcs Williams–Hawkings (FW-H) acoustic analogy. Key findings indicate that the dimpled configuration enhances flow behavior by increasing lift and reducing drag at a 10° Angle of Attack (AoA), primarily through delayed separation and modified stall onset characteristics. Aeroacoustic analysis showed a noise reduction of 2–7 dB at various receiver positions at a 10° AoA, with reductions varying by observer angle and frequency, confirming the directional sensitivity of noise emissions. These insights contribute to the understanding of passive flow control mechanisms and their dual impact on aerodynamic performance and noise reduction in airfoil design.

KEYWORDS: *Dimpled Airfoil, Aerodynamics, Aeroacoustics, CFD, NACA 0012, Detached Eddy Simulations (DES), Passive Flow Control*

Paper ID - 120

Analysis of Thermal Performance of Shell and Tube Heat Exchangers: A Correlation and CFD Based Approach

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ABSTRACT

Shell and tube heat exchangers are devices which are widely adopted in thermal systems for the transfer of thermal energy due to both performance and reliability factors. Given their application in systems that are energy intensive, the design and sizing of these devices have become a widely growing field. Traditionally, empirical correlations which were based on experimental results were used for thermal sizing and design. This was replaced by computational fluid dynamics (CFD) modelling given its ability to model and visualize flow expanding the horizon of possibilities for design and performance optimization. As of recent, CFD has been combined with numerical methods such as non-linear least squares regression to develop correlations which can predict the thermal performance based on the input design parameters. However, the application of this integrated method for shell and tube heat exchangers is limited. This study will model a single pass TEMA E-type shell and tube heat exchanger using ANSYS Fluent ®. CFD simulations are used to explore the effect of turbulence on thermal performance by varying both the inlet mass flow rate and the central baffle spacing. As steady state simulations are conducted for four models of six, eight, ten and twelve baffles. The results of CFD modelling are then combined with non-linear least squares regression in the MATLAB Curve Fitter Toolbox ® to develop four sets of correlation in the form of $Nu = C.Re^{a}.Pr^{b}$. Reasonably confident results were obtained in the final fitted data, however, relatively high 95% confidence interval widths were evident for certain fitted coefficients leaving space for improvement in the model. The study highlights that combining CFD with tools such as nonlinear least squares regression aids both engineers and designers in the thermal design process of shell and tube heat exchangers eliminating the need to limit design based on empirical correlations.

KEYWORDS: *Shell and tube heat exchangers, thermal optimization, non-linear least squares regression, central baffle spacing, turbulence, mass flow rate*

Paper ID - 17

1D and 3D numerical analysis on Francis hydro turbine model to improve the performance for flexible operating range

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ABSTRACT

The performance enhancement of Francis hydro turbines is essential for maximizing efficiency and adaptability in modern hydroelectric power generation. This study employs a dual approach, utilizing 1D and 3D numerical analysis to refine turbine operations within a flexible range. 1D simulations provide a fundamental overview of flow behavior, pressure dynamics, and energy distribution, enabling rapid assessment of system-wide performance trends. Meanwhile, 3D computational fluid dynamics (CFD) simulations offer an in-depth examination of intricate fluid interactions, turbulence effects, and vortex formation—key factors influencing hydraulic efficiency. By integrating these methodologies, this research identifies performance-critical parameters, reduces energy dissipation, and enhances the operational flexibility of Francis turbines under variable load conditions. The findings contribute to the advancement of sustainable hydroelectric technology, optimizing turbine design for improved reliability and efficiency in renewable energy applications.

KEYWORDS: *Francis hydro turbine, Vortex rope, 1D analysis, CFD analysis, Flexible operating range.*

Paper ID - 65

Numerical Investigation of Valve Timing and Intake Pressure Effects on Performance and Emissions in a Hydrogen Port Fuel Injection Engine

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ABSTRACT

Hydrogen internal combustion engines (H2ICEs) offer a viable low-emission alternative for decarbonizing transport, especially where full electrification is not practical. Among fueling strategies, port fuel injection (PFI) is particularly attractive due to its compatibility with existing engine platforms and simplicity compared to direct injection (DI). Performance and emissions in hydrogen PFI engines are strongly influenced by valve timing and intake boosting strategies. This study presents a computational framework to investigate the coupled effects of valve timing and intake pressure on the performance, thermal efficiency, and NOx emissions of a hydrogen PFI engine under fuel-lean conditions (ϕ = 0.59). A modified Sandia optical engine geometry was simulated using CONVERGE CFD v4.1, employing detailed chemistry and adaptive mesh refinement. Latin Hypercube Sampling (LHS) was employed to generate 373 design cases that span a wide parametric space. Results show that intake boosting significantly improves performance, achieving a 220% increase in indicated power (up to 43.55 kW) and an 11% improvement in thermal efficiency (up to 48.7%) over the baseline configuration. However, these gains are accompanied by elevated NOx emissions, particularly at higher valve overlaps. Conversely, the configuration that achieved the lowest NOx emissions reduced them by 76% compared to the baseline, albeit at the expense of lower power and efficiency. The three configurations representing the most favorable outcomes for power, efficiency, and emissions within the studied parameter space highlight the inherent trade-offs among these objectives. These results provide practical guidance for calibrating hydrogen PFI engines and establish a solid foundation for future studies incorporating formal optimization methods.

KEYWORDS: *Hydrogen, Performance, Emissions*

Paper ID – 21

Investigation on a Flue Gas Flow Rate Measuring Method for Draft Regulation on Boiler Operation

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ABSTRACT

The present research targeted the measurement of flue gas flow rates in industrial boiler applications, to improve boiler efficiency in Sri Lanka. This study discussed three methodologies for flow measurement and placed significant emphasis on the benefits of thermal mass flow meters, given their accuracy and reliability, especially within low flow rates. A thorough literature review was conducted to pinpoint critical parameters involved in the generation of boiler performance: flue gas composition and draft regulation. This research spotlights the deficiency in the current measurement practices, hence, a systematic approach to develop, a cost-effective and regionally adaptable solution is presented for the flue gas flow measurement. The investigation validates the proposed measurement techniques by using a combination of theoretical analysis and CFD simulations and demonstrates that the simulated flow rates are close to calculated values, with minimum differences of 0.000461 kg/s. results imply that the optimization of flue gas flow measurement can result in significant enhancements in combustion efficiency. The research ultimately contributes to the betterment of boiler operation practices in Sri Lanka by providing recommendations for future studies and practical implementations to enhance resource management and environmental sustainability within the industrial sector.

KEYWORDS: *Boiler, Flue Gas, Draft, Mass Flux, Flowmeter, Simulation*