International Conference on

EMERGING CONCEPTS AND RESEARCH IN INTEGRATED SUSTAINABLE ADAPTATION

TECHNOLOGICAL SYNERGIES FOR A SUSTAINABLE SRI LANKA

ABSTRACT PROCEEDINGS

ECRISA 2026

Organized by the **Arthur C. Clarke Institute for Modern Technologies**

January **29** & **30** 2026

ABSTRACT PROCEEDINGS

INTERNATIONAL CONFERENCE ON

"EMERGING CONCEPTS AND RESEARCH IN INTEGRATED SUSTAINABLE ADAPTATION"

ECRISA 2026

"TECHNOLOGICAL SYNERGIES FOR A SUSTAINABLE SRI LANKA"

29 & 30 JANUARY 2026

Arthur C Clarke Institute for Modern Technologies, Katubedda, Moratuwa, Sri Lanka.

VISION

To position ECRISA as a national flagship forum advancing technology-driven sustainable development in Sri Lanka.

MISSION

To connect scientific research with industry and national priorities by fostering dialogue, showcasing innovation, and enabling knowledge transfer and capacity building across key technological fields

PREFACE

The Arthur C. Clarke Institute for Modern Technologies (ACCIMT) is pleased to present the proceedings of the ECRISA 2026 International Research Conference, themed "Emerging Concepts and Research in Integrated Sustainable Adaptation." This conference brings together researchers, academics, industry professionals, policy makers, and innovators to collectively explore technological advancements and adaptive research pathways that support sustainable socio-economic development.

The rapid transformation of technological landscapes, driven by shifts in geopolitics, global market dynamics, and increasing digitalization, calls for nations to adopt context-specific yet globally aligned approaches to research, development, and innovation. In this setting, ECRISA provides a timely and meaningful platform for discourse, collaboration, and knowledge exchange across key domains including electronics, telecommunications, space technology and its applications, information technology, and astronomy.

ECRISA 2026 serves not only as a forum for presenting research outcomes, but also as a mechanism for fostering dialogue among institutions and facilitating the translation of research findings into practical, impactful solutions. The works presented in these proceedings highlight diverse and emerging perspectives, ranging from theoretical advancements to applied research and implementation-oriented studies.

We extend our sincere appreciation to all contributing authors, reviewers, keynote speakers, and session chairs whose efforts have shaped the technical and academic quality of this conference. Special thanks are also due to the members of the Editorial, Scientific and Organising Committees, as well as our partner institutions, for their dedication and support in realizing this event.

It is our hope that the insights shared through these proceedings will stimulate further research, strengthen collaborative networks, and contribute meaningfully to the advancement of technology-driven sustainable development within Sri Lanka and beyond.

MESSAGE FROM THE HON. MINISTER OF SCIENCE AND TECHNOLOGY

I am pleased to extend my warmest greetings to the Arthur C. Clarke Institute for Modern Technologies on the occasion of hosting the International Conference on "Emerging Concepts and Research in Integrated Sustainable Adaptation" (ECRISA 2026).

Conceptualisation, research, and development within integrated, country-specific environments, together with the sustainable adaptation of research outputs have become more critical than ever in today's rapidly evolving technological landscape. This landscape is characterised by unprecedented global and domestic challenges. Through well-designed sector-specific research and development, knowledge acquisition and sharing, we as a nation can navigate these complexities and build a more resilient and sustainable future.

ECRISA 2026 provides a unique platform for academics, the research community, industry professionals, and policymakers to jointly explore advancements in electronics, communication, space technology and its applications, and astronomy. By fostering collaboration and dialogue, innovative solutions to pressing global and local challenges can be realised, ultimately contributing to national growth and development.

I commend the Arthur C. Clarke Institute for Modern Technologies for their dedication and timely efforts in organising this important event. I am confident that ECRISA 2026 will generate sustainable research and development solutions, thought-provoking discussions, and productive partnerships.

I wish all participants a successful, engaging, and impactful conference.

Prof. Crishantha Abeysena
Hon. Minister of Science and Technology

MESSAGE FROM THE SECRETARY TO THE MINISTRY OF SCIENCE AND TECHNOLOGY

It gives me great pleasure to convey my best wishes to the Arthur C. Clarke Institute for Modern Technologies (ACCIMT) on the occasion of the International Research Conference "Emerging Concepts and Research in Integrated Sustainable Adaptation – ECRISA 2026."

Advancements in science, technology, and innovation increasingly determine a nation's ability to respond to emerging challenges and seize new opportunities. Integrating research outcomes into productive sectors of the economy, strengthening knowledge networks, and enhancing the commercialization of innovation are vital steps in positioning Sri Lanka for future growth.

ECRISA 2026 brings together an important convergence of expertise across research institutions, universities, industry, and government. The focus on electronics, communication, space applications, and allied disciplines aligns well with the country's strategic aspirations and offers a pathway for advancing innovation-led development.

I acknowledge and appreciate ACCIMT's continuous commitment to promoting scientific research, nurturing talent, and building capacity within the national science and technology ecosystem. Conferences such as ECRISA provide a meaningful platform for collaboration among all the key stakeholders, while creating momentum for long-term progress.

I extend my sincere wishes for a successful and impactful event and trust that the deliberations will generate new insights, partnerships, and outcomes of national significance.

Mr. Y. L. M. Navavi
Secretory
Ministry of Science and Technology

MESSAGE FROM THE CHAIRMAN OF THE ARTHUR C CLARKE INSTITUTE FOR MODERN TECHNOLOGIES

It is with great pride and pleasure that I extend my warmest greetings to all participants of the 1st International Research Conference organized by the Arthur C. Clarke Institute for Modern Technologies (ACCIMT) - ECRISA 2026.

The Arthur C. Clarke Institute for Modern Technologies is a premier government institute operating under the purview of the Ministry of Science and Technology of Sri Lanka. Established through the generous donation of prize money received by Sir Arthur C. Clarke from the Marconi Award in 1984, supplemented by government funding, ACCIMT has, for over four decades, stood as a national beacon for scientific advancement, innovation, and technological excellence.

This inaugural international research conference marks a significant milestone in the Institute's 42-year journey of fostering cutting-edge research and nurturing innovation in disciplines critical to Sri Lanka's technological and socio-economic development. It is our firm intention to establish ECRISA as an annual flagship event, providing a sustained platform for scholarly exchange, collaboration, and knowledge dissemination.

ECRISA 2026 reflects ACCIMT's unwavering commitment to advancing research in key technology domains, including Space Technologies and their Applications, Robotics, Electronics, Information and Communication Technology, and Astronomy. More importantly, it underscores our conviction that research must transcend academic boundaries to create tangible impact— strengthening industry, empowering communities, and contributing meaningfully to a sustainable and resilient future.

I sincerely commend all researchers, academics, and collaborators whose valuable contributions are featured in this conference. I also encourage the continuation and expansion of partnerships that align scientific inquiry with national aspirations, ensuring that science and technology remain powerful drivers of progress for Sri Lanka and beyond.

I wish ECRISA 2026 every success and trust that it will serve as an inspiring forum for innovation, dialogue, and discovery.

Snr. Prof. K. P. S. Chandana Jayaratne
Chairman
Arthur C. Clarke Institute for Modern Technologies

MESSAGE FROM THE DIRECTOR GENERAL/CEO OF THE ARTHUR C CLARKE INSTITUTE FOR MODERN TECHNOLOGIES

As Director General and CEO of the Arthur C. Clarke Institute for Modern Technologies (ACCIMT), it is my great pleasure to warmly welcome all distinguished stakeholders, academics, researchers, industry professionals, policy makers, presenters, and participants, to the International Research Conference *"Emerging Concepts and Research in Integrated Sustainable Adaptation – ECRISA 2026."*

ECRISA 2026 brings together key subject domains that have long been central to ACCIMT's mandate, including electronics, communication technology, space technology and its applications, information technology, and astronomy. The convergence of these domains has the potential to serve as a powerful catalyst for research-driven innovation and for the development of technology solutions tailored to contemporary socio-economic challenges. In light of the rapidly evolving global environment and the shifting geopolitical and economic landscape, Sri Lanka faces an imperative to adopt a context-sensitive yet globally integrated approach to research, innovation, and technology adaptation. Strengthening our national capacity for R&D, fostering collaboration, and accelerating the translation of research outputs into practical socio-economic benefits remain essential to advancing national development priorities.

The Arthur C. Clarke Institute for Modern Technologies stands as the nation's premier institution in these fields, with a legacy of more than four decades of sustained contribution to national development and capacity building. Throughout this period, ACCIMT has engaged in pioneering research, technological development, and knowledge dissemination that have supported key national sectors. As we move forward, the Institute remains committed to an ambitious and progressive vision, one that embraces emerging technologies, strengthens scientific and industrial partnerships, and responds proactively to national needs despite numerous institutional and environmental challenges.

I extend my sincere appreciation to all contributors, presenters, reviewers, partners, and collaborators who have made ECRISA 2026 a reality. I am confident that this conference will stimulate insightful dialogue, foster enduring partnerships, and inspire impactful research outcomes that support a technologically empowered and sustainable future for Sri Lanka.

Mrs. Kumari Meegahakotuwa
Director General / CEO

MESSAGE FROM THE DEPUTY DIRECTOR GENERAL (TECHNICAL OPERATIONS) OF THE ARTHUR C CLARKE INSTITUTE FOR MODERN TECHNOLOGIES

Sri Lanka stands at a critical juncture where scientific research and technological innovation must move decisively beyond academic publication towards delivering tangible solutions to national challenges. The theme of ECRISA 2026, *"Emerging Concepts and Research in Integrated Sustainable Adaptation Technological Synergies for a Sustainable Sri Lanka,"* strongly resonates with this national imperative.

At the Arthur C. Clarke Institute for Modern Technologies, our mandate spans electronics, communications, information technology, space technology and its applications, robotics, and astronomy domains that are increasingly interconnected and vital for sustainable development. We firmly believe that research must be driven by real-world problems: enhancing productivity in agriculture, plantations and fisheries, strengthening climate resilience, improving healthcare delivery, optimizing energy systems, advancing disaster preparedness, enabling smart infrastructure, industrial automation & robotics and supporting evidence-based decision making, policymaking through data and space-derived insights.

The future of Sri Lanka's research ecosystem lies in **integrated, application-focused innovation,** where multidisciplinary teams collaborate closely with industry, communities, and public institutions. Technologies such as AI-driven decision systems, satellite-based monitoring, robotics for hazardous and repetitive tasks, advanced communication networks, and indigenous technology development must be adapted to local contexts, affordability constraints, and societal needs.

ECRISA 2026 provides an important platform to promote research that translates into deployable technologies, scalable solutions, startups, policy tools, and improved livelihoods. We encourage researchers especially early-career scientists and engineers to orient their work towards national requirements, industry partnerships, and technology transfer pathways that create measurable socio-economic impact.

Sustainable adaptation is not a theoretical construct; it is a responsibility. By aligning research excellence with national priorities and community needs, Sri Lanka can harness technological synergies to build resilience, self-reliance, and inclusive growth for generations to come.

Eng. Kavindra Jayawardene
Deputy Director General (Technical Operations)

MESSAGE FROM THE CONFERENCE CHAIR ECRISA 2026

It is my great pleasure, as Conference Chair, to welcome you to ECRISA 2026 – the International Research Conference on Emerging Concepts and Research in Integrated Sustainable Adaptation, hosted by the Arthur C. Clarke Institute for Modern Technologies (ACCIMT).

ECRISA 2026 serves as an interdisciplinary forum that brings together researchers, industry experts, policymakers, and practitioners working across key domains aligned with ACCIMT's mandate.

The conference offers an opportunity for participants to present their latest research findings, explore new ideas, and build professional networks that contribute to both academic growth and industrial development. We are proud to see a diverse range of submissions reflecting current trends, practical solutions, and future directions in research and innovation.

The success of ECRISA 2026 is the result of the collective efforts of many individuals. I would like to sincerely thank the authors for their valuable contributions and for choosing ECRISA 2026 as the forum to present their work. I also extend my appreciation to the reviewers for their time, expertise, and constructive feedback, which ensured the quality of the accepted papers. My gratitude further extends to the Director General and Chief Executive Officer of ACCIMT, organizing committee, scientific committee, editorial committee, session chairs, co-chairs, sponsors, and volunteers for their dedication and commitment in making this conference Success.

I am confident that this conference will generate meaningful discussions, lasting collaborations, and impactful research outcomes. I wish all participants a productive and rewarding conference experience.

Kaveendra Sampath
Research Engineer

ABSTRACT OF THE KEYNOTE SPEECH

LEVERAGING EARTH OBSERVATION AND DIGITAL INNOVATION FOR RESILIENT WATER MANAGEMENT IN ASIA AND BEYOND

Water management is at the heart of agricultural productivity, food security, and sustainable livelihoods. Yet across Asia and Africa, persistent gaps in water data, knowledge, and institutional capacity continue to hinder effective planning and equitable allocation of this vital resource with growing competition between human needs and environmental demands.

Recent advances in Earth Observation (EO) technologies and digital innovation are transforming this landscape. The International Water Management Institute (IWMI) is addressing this challenge through integrated solutions that combine EO data, hydrologic modeling, and field-based measurements across multiple spatial scales—from irrigation schemes and farm level through river basins, to national and continental levels. These innovations are being co-developed with governments, research institutions, and community stakeholders to ensure practical uptake and long-term sustainability.

In Sri Lanka, satellite-based monitoring of water productivity assessments provides high-resolution insights into crop water use efficiency, while citizen science initiatives in the Jaffna Peninsula is empowering communities to track groundwater salinity and water levels using various digital tools. Digital platforms such as HydroSecure and AWARE are linking early warning signals of floods and droughts with mechanisms for Early Action and Early Finance in several countries in Africa and Asia, enabling proactive responses to climate risks. Hydrologic modeling is being combined with emerging tools including Digital Twins and Water Copilot to offer actionable intelligence for diverse water management domains, bridging the gap between data and decision-making.

Together, these EO-enabled solutions illustrate how innovation and multi-stakeholder collaboration can overcome data, knowledge and capacity barriers for strengthening resilience in water management systems across Asia and Africa that can be replicated in other similar regions.

Dr. Mansoor Leh
Researcher at International Water Management Institute

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ABSTRACT INDEX

SESSION M_01

Observational Astronomy, Instrumentation and Space Data Analytics

CHAIR - PROF. ALOY PERERA

CO-CHAIR - MR. SARAJ GUNESEKARA

SESSION M_01
SESSION CHAIR'S ADDRESS

Prof. P. A. Aloy Perera
Senior Professor,
Department of Physics and Electronics,
University of Kelaniya.

ASTRONOMY FOR SCIENTIFIC CURIOSITY AND EXPLORATION

It is a fact that astronomical observations done in the early stages of human civilizations have laid the foundation for the scientific method as we identify it today. Many advances achieved in the fields of natural sciences have come through careful observations, recording and analysis of various celestial phenomena over very long periods of time. One classic example is the development of theories to explain gravity, which is one of the four fundamental forces in Nature. Verification and prediction of the level of accuracy of Newtonian theory of gravity and the development of general theory of relativity by Einstein, which is built upon a completely different interpretation of space and time were facilitated by collective contributions made by many astronomers and astrophysicists over a very long period. On the other hand, research done in astronomy and astrophysics has also contributed immensely to the advancement of multitude of technologies such as GPS, medical imaging and CCDs. These kinds of advancements, both in theoretical side and in technology, have become possible simply because of the natural curiosity possessed by human beings to understand the phenomena that happen in the universe and to derive pleasure in such understandings. Some of the major contributions of astronomy for the advancement of science in general will be briefly reviewed in this session.

ECRISA035

CALIBRATION OF A LOCALLY MADE MIRROR GRINDING MACHINE FOR FABRICATING COMMERCIAL-GRADE TELESCOPE PRIMARY MIRRORS

K.D.K.M. Dharmasiri[1], K.G. Samararathna[1], K.V.S. Prasadh[2], K.A.S. Lakshan[1] and G.D.K. Mahanama[1,*]

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Abstract

Newtonian telescopes are the most widely available and commercially demanded type of reflector telescopes, with the quality of the primary mirror being the decisive factor in determining optical performance. Recognizing the limitations of manual hand-grinding methods identified in previous explorations, this study presents the calibration of a newly developed grinding machine to enable the reliable fabrication of thin primary mirrors on an industrial scale. The investigation focused on mirrors with an aperture of 0.2032 m and a focal length of 1.2192 m. At the initial stage, a series of grinding tools was fabricated from ceramic tiles and Plaster of Paris, and their quality was verified using simulation tests in SOLIDWORKS Computer-Aided Design software. Several tests used in early studies were repeated to ensure the suitability of glass substrates for fabricating primary mirrors. A variety of grinding strokes were tested by varying stroke patterns, amplitudes, and tool and turntable speeds, while employing Silicon Carbide and Aluminium Oxide abrasives. Pencil tests, flatness tests, and sagitta measurements were systematically performed to ensure smooth grinding and accurate focal length, while Ronchi and knife-edge tests were used to verify the final surface profile. The results demonstrated that a 4-inch grinding tool, combined with optimized stroke patterns, yielded the best configuration for producing the targeted mirror specifications. The study ultimately confirmed that the calibrated machine enables the cost-effective fabrication of high-quality primary mirrors at approximately 10,000 LKR each, providing a scalable pathway for commercial-grade primary mirror production and offering significant potential to advance local telescope manufacturing capabilities.

Keywords: Commercial-grade mirrors, Mirror grinding machine, Optical testing, Telescope mirror fabrication, Thin telescope mirrors

AN INVESTIGATION OF 7 NON-ECLIPSING SU UMA SYSTEMS USING TESS DATA

Theekshana Piyadasa[1,2,*], D.N. Jayawardana[1], and N. I. Medagangoda[2]

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Abstract

We present a study of seven non-eclipsing SU Ursae Majoris type dwarf novae based on high resolution photometric data obtained from the Transiting Exoplanet Survey Satellite (TESS). Our analysis focuses on the evolution of superhump periods during superoutbursts, which are key to understanding the tidal instability and accretion dynamics in these cataclysmic variable systems. By identifying and analyzing the characteristic stages A, B, and C of superhump evolution through the O-C method, we estimated the superhump periods for each system during the superoutburst. The stage A superhump period, which cor responds to the initial growing phase of the superhumps, was used to estimate the mass ratio $q = m1/m2$ for each system using the method proposed by Kato and Osaki. Our results show that the mass ratios for these systems span a range from $q \approx 0.07$ to $q \approx 0.23$, consistent with theoretical expectations for SU UMa-type systems.

Keywords: Cataclysmic Variable, Mass ratio, SU UMa, TESS.

ECRISA036

CLASSICAL CEPHEID CANDIDATES IN THE GLOBULAR CLUSTER NGC 121: A MULTI-MISSION STUDY WITH HST AND TESS

R.M.B.M.B. Alawathugoda[1], N.I. Medagangoda[2,*], S. Gunasekara[2], S. Kandeepan[1] and M.L.C. Attygalle[1]

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Abstract

Classical Cepheids are set of Pulsating Stars (PSs) with high luminosity. They are crucial standard candles for measuring cosmic distances because of their precise Period-Luminosity (P-L) relation. While they are a staple in cosmology, their presence in ancient, metal-poor environments like Globular Clusters (GCs) is rare and pro vides a unique opportunity to test the universality of the P-L relation. This paper de scribes a focused search for Classical Cepheid candidates within the ancient globular cluster NGC 121. The methodology employed a multi-mission approach, combining high-resolution photometry from the Hubble Space Telescope (HST) with time-series data from the Transiting Exoplanet Survey Satellite (TESS). Point Spread Function (PSF) photometry was used to identify individual stars from HST photometry FITS (Flexible Image Transport System) images and to create comprehensive stellar catalogues. The identified stars were plotted in a Colour - Magnitude Diagram (CMD) and the instability strip was identified on the CMD. Then a variability analysis was per formed using the Lomb-Scargle periodogram on their TESS light curves to confirm their pulsation. This process successfully identified five stars recognized as candidates for Classical Cepheids, a significant discovery given the cluster's advanced age and low metallicity. The existence of these candidates provides crucial data for investigating the reliability of the P-L relation in non-traditional stellar environments for Classical Cepheids. These findings highlight the critical importance of combining high-quality spatial and temporal data to ensure accurate identification and classification in challenging astronomical settings. This work not only contributes a new catalogue of rare candidates but also reinforces the ongoing effort to refine the cosmic distance scale.

Keywords: Classical Cepheids, Globular Cluster, Hubbel Space Telescope, Pul sating Stars, Transiting Exoplanet Survey Satellite.

Proceedings of International Conference on Emerging Concepts and Research in Integrated Sustainable Adaptation (ECRISA 2026)

ECRISA04

BLACK HOLES AS ENERGY-ABSORBING REACTORS: A FRAMEWORK FOR ELEMENT FORMATION AND THE THERMODYNAMICS OF COSMIC EVOLUTION

P.A. Liyanage[1], J. Adassuriya[1], K.P.S.C. Jayaratne[1] and M.B. Rathnayake[1]

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Abstract

A major challenge in cosmology and astrophysics is explaining the origin of elements. This study addresses nucleosynthesis in the early universe using the Geant4 simulation toolkit, particularly the Hadron Physics package, to model nuclear processes underlying Big Bang Nucleosynthesis (BBN). The study examines the nuclear reactions responsible for element formation, focusing on initiation energy, initiation temperature, and Q-values. Emitted particles were treated as sources for further interactions, with alpha particles colliding with Galactic material to trigger nucleosynthesis reactions. Newly synthesized nuclei were incorporated into the surrounding medium, where additional alpha particle interactions enabled successive stages of element formation. The investigation detected nucleosynthesis of elements up to Z=238. Results show that initiation energy and temperature increase steadily with atomic number up to Z=108, then transition to exponential growth between Z=108 and Z=238. This trend explains the observed elemental limit at Z=118. Nuclear synthesis reactions display negative Q-values, and Such reactions generate the energy-absorbing characteristics of black holes, suggesting a potential mechanism for element generation in these environments. The study further proposes that relativistic jets from quasars and AGN may carry detectable signatures of these newly synthesized elements, offering new insight into cosmic element formation. Overall, the relationship between negative-Q-value nuclear synthesis, jet-driven luminosity, and black-hole environments offers new insight into the of black holes in cosmic element formation, broadening the current understanding of nucleosynthesis beyond traditional stellar nucleosynthesis. The study discusses how energy-to-matter conversion contributes to universal expansion, while matter-to energy conversion underpins compression, linking Q-values to cosmological dynamics. The roles of stars as energy-releasing fusion reactors and generating compression force and black holes as energy-absorbing synthesis reactors and generating expansion force are central in shaping the universe's thermodynamic and structural evolution. This clearly explained how the Inflationary expansion occurs and then how it was dropped to normal expansion in an extremely short period of time. These insights provide a novel interpretation of the Universe's evolution through phases of Inflation, Expansion, Steady State, Compression and eventual Collapse, governed by the thermodynamics of nuclear reactions.

Keywords: Relativistic Jets, Black Holes, Physics of the Cosmos

ECRISA010

SUPER NYQUIST ANALYSIS OF COMBINED QUARTERS OF KEPLER LIGHT CURVES: KIC 8264492

J.A.D.M. Dharmathilaka[1], J. Adassuriya[2], K.P.S.C. Jayaratne[2] and Jordi L. Gutiérrez[3[

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Abstract
Generally, Nyquist frequency (fNy) is the upper limit of probing the pulsation frequencies of Long Cadence (LC) data of Kepler targets. Infrequent, the fundamental frequency of some targets appeared above the Nyquist frequency limit which can be detected only in super Nyquist frequency analysis. These Nyquist aliases occur due to the barycentric time corrections of the Kepler observations and they are split into multiplets. The main focus of this study is the investigation of the Nyquist aliases to distinguish the real fundamental frequency from aliases and to identify the alias patterns by their multiplet structures. The four quarters of the LC data of KIC 8264492, a binary system with Delta (δ) Scuti component, were analyzed in this study. To combine the four quarters of data, the inter and intra quarter offsets were corrected by median aligned approach and then normalized. The super Nyquist analysis was applied extending the analysis up to eight times fNy using Period04 software. In the combined light curve, the alias multiplet were resolved and identified that the mulitplets are separated ap proximately by the Kepler spacecraft orbital frequency (~0.0027 d-1). The presence of the number of alias multiplet of KIC 8264492 can be denoted by the theoretical relationship 2n + 1, where n denotes the alias order. This super Nyquist analysis confirmed that the real fundamental frequency of KIC 8264492 is 31.292208 ± 0.000016 d-1 which is above the Nyquist frequency 24.469 d-1 of the Kepler LC data. Furthermore, the mirrored aliases produced a triplet, quin tuplet, septuplet and nonuplet structures when n = 1,2,3, and 4, respectively. The observational results of KIC 8264492 concluded the importance of super Nyquist analysis to distinguish real fundamental frequency from Nyquist aliases. Further more, this study noted that combined dataset of at least four quarters of Kepler data is essential to accurately investigate the Nyquist alias.

Keywords: Asteroseismology, KIC 8264492, Multiplet, Nyquist alias, Super Nyquist frequency

ECRISA031

MACHINE LEARNING APPROACHES FOR EXOPLANET DETECTION AND CLASSIFICATION: A COMPARATIVE STUDY OF TRADITIONAL AND DEEP LEARNING MODELS WITH EXPLAINABLE AI

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Abstract

The exponential surge in stellar photometric data from missions like Kepler and TESS has created a bottleneck in exoplanet discovery; while manual vetting is unscalable, automated systems must prioritize scientific reliability over raw accuracy. Deep Learning (DL) models are often proposed as universal solutions, yet their "black box" nature and tendency to fail on rare events pose significant risks for astrophysical discovery. This research presents a novel comparative analysis of domain-informed classical machine learning versus end-to-end deep learning, specifically targeting the challenge of extreme class imbalance (136:1). We evaluate an XGBoost classifier with 12 engineered statistical features against a 1D-CNN trained on raw light curves, utilizing Grad-CAM and SHAP for interpretability. Using a curated dataset of 5,087 Kepler Objects of Interest, results revealed a critical "accuracy paradox." While CNNs achieved a higher overall accuracy of 96.15%, they catastrophically failed to detect the minority class (1.71% precision for confirmed planets). Conversely, XGBoost demonstrated superior scientific utility with 87% precision and 0.87 F1-score. Explainability analysis exposed that CNNs frequently overfit to background noise, whereas XGBoost relied on physically meaningful features like transit skewness. These findings underscore that domain knowledge remains superior to algorithmic complexity for rare-event detection, offering a robust framework for future automated vetting in large-scale astronomical surveys.

Keywords: Exoplanet detection, Machine learning, Deep learning, Explainable AI

SESSION M_02

Geospatial Analytics, Remote Sensing, and Environmental Intelligence for Climate-Resilient Planning

CHAIR - PROF. (MRS.) R BANDARA

CO-CHAIR - DR. S. P. CHAMINDA

SESSION M_02
SESSION CHAIR'S ADDRESS

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EARTH OBSERVATION AND GEOSPATIAL INTELLIGENCE

Earth Observation (EO) is defined as "*gathering data about Earth's physical, chemical, and biological systems using remote sensing and ground sensors*", while Geospatial Intelligence (GEOINT) is "*the analysis and visualization of location-based data to create understanding and actionable intelligence*". Climate change is another phrase that is thrown about every day to explain all mishaps faced by humanity, and it can be termed as *the long-term shift in Earth's average weather patterns and temperatures*. The importance of understanding climate change in all its facets is because of the extreme weather, ecosystem disruption, rising sea level, and the subsequent threat to food security and sovereignty of any nation. The million-dollar question is, how are EO, GEOINT and everyday problems linked? Let us take the cyclonic storm "*Ditwa*" that occurred in late November of 2025 as an example. EO has the capacity to collect data from space-borne and air-borne sensors which can be utilized for observing, detecting, and monitoring Earth's systems, even under conditions where ground observations are not possible. Hence, it was possible to use EO data to detect the atmospheric changes that would later on lead to the development of a full-scale cyclonic storm. The use of GEOINT in tandem with artificial intelligence (AI), have the capacity to automate pattern recognition, damage assessment, land-cover classification, and transform petabytes of satellite data into actionable insights within minutes. From this, it would be possible to track the potential pathways of the cyclonic storm, model the impacts and identify potential vulnerable areas, and perform various scenario modelling using different software and models available to researchers and scientists. The continuous updating of the models by real-time EO data became a reality decades ago, ensuring that the outputs are a reflectance of the reality and not an abstract. The true value of these technologies lies not in the satellites/sensors themselves, but in how we use their insights, especially to anticipate disasters, to regenerate ecosystems, and to ensure that the planet's natural systems can sustain future generations.

CAN GIS AND REMOTE SENSING TECHNIQUES REVEAL THE IMPACT OF OPEN LANDFILLS ON AIR QUALITY?: A CASE STUDY OF COLOMBO, SRI LANKA

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Abstract

Rapid urbanization and continuous population growth in Sri Lanka have led to increasing waste generation, with open landfills becoming a significant environmental concern. Air quality indices, where available, show moderately high values and there is no feasible method to monitor the overall urban air quality in Sri Lanka, mainly due to financial constraints. Hence, this study investigates the impact of open landfills in the Colombo district on urban air quality using GIS and Remote Sensing techniques. Super vised image classification identified the open landfills, and Sentinel-5P Satellite data were used to extract Methane (CH_4) and Carbon Monoxide (CO) concentration through Google Earth Engine. Pearson correlation was performed to assess the relationship between the pollutant levels and the proximity to the open landfills, while multivariate linear regression analysis was performed to assess the in-fluence of wind speed and distance from open landfills. The results revealed an increase of open landfill areas as a result of population growth and poor waste management. Spatial trends in CH_4 were not detectable due to data limitations in Sentinel-5P, while seasonal effects were evident in CO distributions. Weak Pearson correlations were observed due to the low spatial resolution satellite data while multivariate linear regression analysis highlighted the influence of wind speed on pollutant concentration. The study recommends downscaling satellite data to enhance the spatial and statistical analyses accuracy.

Keywords: Air Quality, Colombo-Sri Lanka, Open Landfills, Sentinel-5P

IDENTIFICATION OF SITES FOR SOLAR POWER PLANTS IN SRI LANKA USING SOLAR RADIATION AND CLOUD COVER ANALYSIS

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Abstract

With the increasing of energy demand in Sri Lanka, the most appropriate locations for the installation of solar power plants were identified integrating Remote Sensing and GIS, and the Analytical Hierarchy Process (AHP). The key contributing parameters are taken as solar radiation, cloud cover, slope, land cover, proximity to main roads, grid connectors, transmission lines and rivers. Cloud cover is emphasized as a critical but often overlooked factor in solar energy potential evaluation, contributing a significant improvement to previous methodologies. MODIS, Sentinel-5P, Sentinel-2, SRTM DEM, Open Street Map, Ceylon Electricity Board (CEB) and Sri Lanka Sustainable Energy Authority (SLSEA) datasets were processed to derive the key findings, which highlight the Northern, North-Central and Eastern provinces prospects for high solar energy. The pairwise comparisons were aided by feedback from around 30 professionals such as doctoral candidates, senior lecturers, electrical superintendents, engineers, and site engineers from the CEB and various solar companies and universities. The resulting map was classified on the basis of Highly Suitable, Suitable, and Moderately Suitable regions. The overlay analysis with weights confirmed that the most suitable sites for solar energy generation overlap with high solar radiation, low cloud cover, and flat or gentle slopes. Validation of solar radiation was conducted by comparing Global Solar Atlas data for the year 2018 due to unavailability of recent dataset, which resulted in a correlation coefficient (r) of 0.9715, R^2 of 0.9438, and Root Mean Squared Error (RMSE) of 30.72 W/m². Cloud cover validation was conducted through the comparison of the Global Data Set and Sentinel-5P, which resulted in a correlation coefficient (r) of 0.8523, R^2 of 0.7282, and Root Mean Squared Error (RMSE) of 0.04. Land cover was validated with ground truth using Google Earth Pro and an accuracy assessment using Arcmap, where it achieved 81% overall accuracy and 0.74 kappa coefficient value. These results enhance the validity of the final suitability assessment.

Keywords: Solar Radiation and Cloud Cover Analysis; Solar Power Plants; Satellite Images; Remote Sensing; Multi Criteria Decision Making

ASSESSING THERMAL DISCOMFORT TRENDS IN COLOMBO: A 30 YEAR PERSPECTIVE

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Abstract

Urbanization significantly alters the local climatic conditions and boosts heat stress in tropical cities. Bioclimatic quantification involves assessing and understanding the climate-related factors that influence ecosystems and living things. Studying long-term time series analysis on urban climate, these quantifications play a major part. The Relative Strain Index (RSI) is a reliable thermal comfort index that reflects the net effect of air temperature and vapor pressure on human heat stress. This study examines the temporal patterns and climatic drivers of RSI over 30 years (1988–2018) in Colombo, Sri Lanka, using long-term meteorological data from the National Oceanic and Atmospheric Administration (NOAA) and the Department of Meteorology, Sri Lanka. RSI data were also determined independently for the annual mean for both daytime and night conditions and analyzed for linear analysis (R^2 values) to evaluate correlations between air temperature and relative humidity. RSI values exhibited statistically significant ($p < 0.001$) increase in both daytime and night-time at a rate of 0.0023 and 0.0024 per year, respectively. There were strong positive correlations between RSI and air temperature ($R^2 > 0.93$), while relative humidity was moderate during nighttime ($R^2 = 0.35$). Notably, daytime RSI was generally in excess of the discomfort threshold of 0.2 post-2000, reflecting heightened exposure to thermal stress. The findings point towards a rising risk of heat-related discomfort and health implications, particularly for vulnerable groups. The study calls for incorporating RSI into urban heat hazard mapping and advocates climate-resilient urban planning approaches to develop resilience to rising heat stress situations.

Keywords: Bioclimatic Quantifications, Relative Strain Index, Thermal Comfort, Heat Stress

A NOVEL LIDAR-INTEGRATED FLOOD SIMULATION MODEL FOR ENHANCED FLOOD HAZARD-EXPOSURE MAPPING

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Abstract

Flooding is a major natural hazard that causes significant risks to communities worldwide, particularly within the Kelani River basin in Sri Lanka, one of the country's most flood-prone regions. Effective flood risk management requires accurate flood simulation modeling supported by advanced technologies such as Light Detection and Ranging (LiDAR), which provides high-resolution elevation data. However, disconnected depressions and the unrealistic spreading of water across unconnected terrain continue to limit the accuracy of conventional flood simulation approaches. The study introduces a LiDAR-integrated flood simulation approach that incorporates a connectivity-constrained inundation algorithm to overcome identified limitations. A high-resolution LiDAR-derived Digital Elevation Model (DEM) and gauge records were integrated within a Python-based simulation framework. The model employed a connected component analysis to ensure realistic flood propagation by linking inundated areas to the river system. Results demonstrated that the model effectively excluded non-vulnerable areas and disconnected depressions, increasing its accuracy. The findings confirm the potential of LiDAR data and advanced image processing techniques for reliable flood risk modeling.

Keywords: Flood Simulation Model, DEM, LiDAR, Flood Hazard-Exposure Mapping, Connected Component

PRIORITIZING URBAN HEAT MITIGATION IN COLOMBO: A LUCIS-BASED APPROACH TO BALANCING COMPETING LAND-USE GOALS

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Abstract

Rapid urbanization in tropical cities like Colombo, Sri Lanka, intensifies the Urban Heat Island (UHI) effect, posing significant threats to public health, energy security and ecological integrity. While UHI mapping is common, a critical gap remains in providing systematic, data-driven framework that balances UHI mitigation with competing land-use goals like development and ecological conservation. To address this, we apply the Land-Use Conflict Identification Strategy (LUCIS), a multi-criteria decision-making (MCDM) framework within Google Earth Engine (GEE) to prioritize heat mitigation interventions across the Colombo district (CMB) during the 2020 warm season. Using remote-sensing data from sources like Landsat 8/9, the Global Human Settlement Layer (GHSL), and WorldPop, we processed and standardized a suite of datasets. We applied a scenario-based Analytical Hierarchy Process (AHP) to simulate three distinct policy interventions: a baseline, a population-focused, and a UHI-focused mandate. This approach allows for a systematic evaluation of how varying planning priorities spatially reorder mitigation urgency. Our validation showed that satellite-derived land surface temperature (LST) captured temporal variation with a root-mean-square error (RMSE) of 1.8 °C. The results demonstrate that policy choices significantly re-order mitigation priorities. The baseline scenario identified 25.6 km^2 of high priority mitigation areas, while the population-focused scenario shifted 47% of these areas toward densely inhabited neighborhoods. Conversely, a UHI-focused weighting concentrated interventions in commercial and industrial districts. Overlay analysis revealed 12.3 km^2 of "win-win" zones where mitigation and conservation goals align, and 9.7 km^2 of "trade-off" zones, where mitigation conflicts with development. Moran's, I tests confirmed significant spatial clustering of priority areas (I = 0.36, p < 0.01), and Monte-Carlo simulations confirmed the framework's robustness by showing the top priority area varied by only ±2.5 km^2 under plausible weight perturbations. In conclusion, this research offers a transparent, novel, replicable, and data-driven decision-support tool for urban planners, demonstrating that effective UHI mitigation requires a structured approach to balancing competing land-use objectives. This framework provides a scalable model for other rapidly urbanizing cities.

Keywords: Colombo, Urban Heat Island, Land-Use Conflict Identification Strategy, Monte-Carlo Simulation, Land Surface Temperature.

LANDSLIDE MITIGATION IN SRI LANKA USING A REMOTE SENSING BASED MULTISENSORY FRAMEWORK WITH LIDAR, SAR, AND LULC DATA

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Abstract

Landslides are one of the major natural disasters of Sri Lanka, and they can potentially impact human life, infrastructure, and the environment, particularly in hilly and mountainous regions. Precise identification of landslide vulnerability zones is critical for risk reduction during disasters and land use planning. This research integrates multi-source remote sensing and terrain analysis for enhanced characterization and prediction of landslide susceptibility in Passara and Lunugala DSDs. High-resolution Airborne LiDAR data from known landslide sites capture fine-scale slope variations and are compared with coarser-resolution SRTM DEM data to quantify geometric changes in the terrain. The results show significant slope alteration due to displacement and accumulation of material. Backscatter intensity and GLCM-based texture changes before and after the landslide events were analyzed using Sentinel-1 Synthetic Aperture Radar (SAR) imagery. The overall results indicate that urban features have relatively consistent backscattering, while rural features show strong variation, hence showing significant alterations in surface roughness and scattering properties after the events. Additionally, LULC classification from Sentinel-2 imagery revealed that bare land and low vegetation areas on steep slopes are highly prone to landslides, while built-up areas though generally located on flatter surfaces show high variability in slope conditions and are therefore also susceptible to landslide hazards. Interferometric SAR (InSAR) analysis effectively captures spatial deformation patterns, supporting the identification of slope instability in both rural and urban landslide zones. In the proposed methodology, slope conditions derived from the locations of actual landslides are used to produce a landslide susceptibility map. A kernel-based terrain analysis is presented that incorporates a landslide specific slope kernel aligned with the local slope direction to better detect the areas with slope patterns similar to past landslides, increasing detection accuracy. This study integrates LiDAR, SAR, InSAR displacement capability, and optical LULC data to provide a comprehensive assessment of landslide affected terrain that improves the accuracy in hazard mapping and aids appropriate mitigation planning.

Keywords: Sri Lanka, Landslide Susceptibility, LiDAR, InSAR, SAR Texture Analysis, Sentinel-1, Sentinel-2, LULC Classification, Slope Analysis

NON-LINEAR MODELING OF CHLOROPHYLL-A DYNAMICS IN THE INDIAN OCEAN AROUND WESTERN SRI LANKA

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Abstract

The study investigates a multi-decadal examination of phytoplankton biomass patterns in tropical waters adjacent to Sri Lanka's western coastline, utilizing satellite-derived ocean color measurements spanning January 2002 through May 2025. Our research domain (78.75°E-80.5°E, 5.5°N-10°N) encompasses the biologically productive Sri Lanka Dome upwelling feature, where seasonal wind patterns drive significant nutrient enrichment events that sustain regional fisheries. Given the complex non-monotonic nature of biological-physical interactions in this monsoon-influenced region, we employed Generalized Additive Models (GAMs) with thin-plate regression splines to capture non-linear relationships between phytoplankton biomass and environmental drivers. Our analytical framework examined how ocean temperature, atmospheric moisture delivery, and biogenic carbonate concentrations influence chlorophyll-a standing stocks. Photosynthetic pigment concentrations varied between 0.42 and 5.97 mg m⁻³ across seasonal cycles. The modeling approach successfully characterized these patterns through flexible functional relationships, where thermal variables accounted for 45% of observed pigment variance through curved response functions, while moisture input contributed an additional 23% through interactive effects. Calcium carbonate signatures showed secondary yet notable associations (12% variance contribution) with phytoplankton spatial distributions, particularly during elevated biological activity periods. Harmonic decomposition identified dual annual productivity maxima coinciding with monsoon transition periods, when vertical water column processes and nutrient conditions favour phytoplankton accumulation. The southwest monsoon season demonstrated amplified productivity stemming from intensified vertical advection processes, whereas northeast monsoon conditions generated more vertically structured water columns with diminished surface-layer productivity. Cross-validation procedures confirmed robust model performance (adjusted $R^2 = 0.70$, root mean square error = 0.34 mg m⁻³, cross-validation $R^2 = 0.76$), underscoring the value of flexible statistical frameworks for characterizing marine ecosystem behaviour in equatorial ocean regions. These results advance our mechanistic understanding of phytoplankton drivers in the western tropical Indian Ocean while establishing practical approaches for ecosystem assessment, fisheries resource management, and climate adaptation planning in this ecologically vital marine province.

Keywords: Chlorophyll-a, Generalized additive models, Western Indian Ocean, Non-linear modeling, Marine productivity, Oceanographic modelling

SESSION M_03

Data Science for Environment and Sustainability

CHAIR - DR. R. WELIKANNA

CO-CHAIR - DR. SANDUN M. DASSANAYAKE

SESSION M_03
SESSION CHAIR'S ADDRESS

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THE SYNERGY OF INTELLIGENCE AND EARTH OBSERVATION

The session, "Machine Learning and Data Science for Environment and Sustainability," serves important for exploring how computational intelligence can adopt to the complexities of our changing planet. In an era defined by rapid climate shifts and resource depletion, the integration of Spatial Data and Big Data analytics is a fundamental requirement for accepting a harmonic living with our environment. The data and action gap remains a critical need of focus, in a time where the traditional methods of environmental monitoring are being transformed by an unprecedented influx of information. We are equipped with real-time Earth Observation (EO), where satellites, IoT sensors, and aerial platforms generate petabytes of high-velocity data. The challenge is more or less concentrated in data-to-discovery, where Machine Learning (ML) acts as the essential association. With the utilization of advanced algorithms, from deep neural networks to reinforcement learning it is possible to lead into high-frequency spatial-temporal analysis to predict environmental disasters, seamless data fusion models that combine contrasting datasets into actionable intelligence, near automatic identification of land-cover changes and biodiversity health, decisive planning in engineering, agriculture, health and education leading to better living at home. With the development of the technologies, policymakers and scientists are moved from reactive mitigation to proactive sustainability. Beyond the technical results, the core value of this session at ECRISA 2026 lies in the propagation of science. These research sessions serve as a collaborative incubator, where cross-disciplinary ideas from Earth Observation Science, Spatial Science, Computer Science, and Environmental Engineering intersect. By sharing advanced methodologies like transition from static GIS models to dynamic, Advance probabilistic data mining, AI-driven digital twins on ecosystems. Etc., it could be expected the next generation of researchers are equipped with the tools to solve global challenges. It is our collective responsibility to ensure that the innovations discussed here do not remain within the confines of academia but are translated into sustainable practices that protect our Earth for centuries to come. I look forward to the ever-important insights the presenters of the session will bring to this vital dialogue. The session will bring tools of the future (ML) to save the heritage of the past.

REAL-TIME CLOUD TYPE CLASSIFICATION FROM GROUND-BASED IMAGES USING A CONVOLUTIONAL NEURAL NETWORK

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Abstract

Accurate cloud classification is essential for meteorology, aviation safety, and weather-dependent industries. Traditional manual cloud observation methods are prone to human errors and inconsistencies. Recent developments in Machine Learning and Deep Learning offers a great opportunity to automate real-time cloud classification with higher precision. This study presents a lightweight convolutional neural network (CNN) for classifying three major cloud genera: Cirrus, Cumulus, and Stratus, representing high-level, convective, and layered cloud formations, respectively. These visually distinct and frequently occurring genera were selected to ensure reliable model training using a manageable dataset. A curated subset of 300 images from the (Cirrus, Cumulus, Stratus, Nimbus) CCSN dataset was preprocessed through grayscale conversion, normalization, and data augmentation. The CNN architecture consisted of four convolutional layers (32-256 filters), 3×3 kernels with ReLU activation, MaxPooling2D, and Dropout layers, followed by a dense layer and a softmax output. Hyperparameter optimization was performed using grid search to explore batch sizes, convolutional depths, dataset splits, and training epochs, with Early Stopping to prevent overfitting. The best-performing model trained for 35 epochs with a 70:20:10 split and achieved a validation accuracy of 75.56% with F1-scores of 0.78, 0.74, and 0.74 for Ci, Cu, and St, respectively. Evaluations included precision, recall, F1-score, confusion matrices, and ROC curves. For real-time deployment, a 1080p HD webcam was integrated with a 90% confidence threshold to capture and save classified frames. The system demonstrates a practical and scalable solution for automated real-time ground-based cloud monitoring. Future work will expand the dataset and explore automated neural architectures to optimize network structures.

Keywords: Convolutional Neural Network (CNN), Ground-based cloud imaging, Meteorological observation systems, Real-time cloud monitoring, CCSN dataset.

ANALYSIS OF THE MV X-PRESS PEARL DISASTER AND ITS IMPACT ON COASTAL AND OCEAN WATERS USING REMOTE SENSING

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Abstract

The X-Press Pearl container ship disaster off the coast of Colombo (7°04′57″N, 79°46′39″E), Sri Lanka, in May–June 2021 released large volumes of hazardous cargo, oil, and plastics into the marine environment, causing one of the most severe shipping related environmental crises in the Indian Ocean. This study assessed the ecological and oceanographic impacts of the incident using remote sensing to compare pre-incident (07 May 2021) and post-incident (14 October 2021) Landsat 8–9 OLI/TIRS imagery. Using ILWIS 3.3 Academic software and indices including NDVI, NDTI, NDWI, and GBR composites with land–water masking, the research quantified biological, physical, and optical changes in affected waters. Results showed significant changes across all indices. NDVI increased (0.02 to 0.04) in localized regions due to nutrient enrichment from chemical cargo stimulating phytoplankton blooms, while other zones showed stress from toxicity. NDTI values increased (–0.02 to –0.01), reflecting deposition of soot, nurdles and debris altering surface reflectance. NDWI decreased (0.00 to –0.02), indicating reduced water clarity and higher turbidity from oil films, suspended particulates, and debris. GBR composites confirmed widespread discoloration and optical modification of the water surface. The disaster caused long-lasting environmental disturbances in Sri Lanka's western coastal waters, with impacts visible months later. The study demonstrates the value of multispectral remote sensing for accident monitoring and highlights the need for stronger protection of sensitive, economically important marine ecosystems. A gap remains in applying multiple multispectral indices (NDVI, NDTI, NDWI, GBR) to assess the ecological and optical impacts of the X-Press Pearl incident.

Keywords: X-Press Pearl; Remote Sensing; Ecological Impacts; Satellite Indices; Marine Pollution

SPATIAL AND TEMPORAL VARIATION OF HUMAN MOBILITY INTENSITY IN COLOMBO DISTRICT: INSIGHTS FROM META MOVEMENT DATA (MARCH 2024–APRIL 2025)

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Abstract

Human mobility, the way people move through and between urban spaces is central to managing congestion, ensuring equitable access to services, and building resilience to disruptions in an increasingly urbanised world. Digital traces from mobile phones and GPS are widely used for this purpose, but Face book's Meta Movement Data remains under-explored, particularly in Global South contexts such as Sri Lanka. This study addresses that gap by analysing spatial and temporal patterns of human mobility in Colombo District using the Meta "Movement Distribution" dataset. We use 13 months (March 2024–April 2025) of daily records covering 11 Divisional Secretariat divisions and operationalise human mobility as population movements aggregated into three distance bands: low (0 km), medium (10–100 km), and high (>100 km). Data are processed and visualised in Python (Google Colab) using Facet Grids, heat maps and donut charts to compare administrative units, mobility categories and temporal variations. Results show systematic differences in movement intensity, with the highest levels in densely urbanised divisions and along major transport corridors, while medium-range travel dominates overall patterns. The study demonstrates that Meta movement data can capture fine-scale urban dynamics in Colombo and can be used to identify movement hotspots, inform public transport planning, and support resilience-oriented policy in Sri Lanka.

Keywords: Facebook metadata, Human mobility, Movement patterns, Spatial analysis, Urban dynamics, Urban planning

TOWARDS CLIMATE – SMART AGRICULTURE: A BIG DATA AND CLUSTERING APPROACH FOR CROP RISK AND YIELD PREDICTION USING INDIAN AGRICULTURAL DATA

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Abstract

Agriculture in South Asia is highly vulnerable to climate variability, soil degradation, and resource inefficiencies. To address these challenges, this study develops a big data framework integrating unsupervised clustering and supervised machine learning models for crop yield and risk prediction using Indian agricultural data spanning 15 years (2000–2014). The dataset comprises 246,092 records across 29 states and 600+ districts, including crop types, cultivated area, production, soil nutrients (N, P, K), soil type, and climatic variables. Clustering methods (K-Means, Hierarchical, DBSCAN) identified crop-soil-climate groupings, while predictive models (Ridge, Lasso, Random Forest, Gradient Boosting) were used to estimate yields. Specifically, four distinct agro-climatic zones were identified, representing unique crop-soil-climate groupings derived from the integrated dataset. Results show Random Forest achieved the best performance (R^2 up to 0.88). Cluster-specific models further improved accuracy, highlighting strong interactions between soil, climate, and crop features. The framework provides decision-support insights for farmers (crop prioritization), insurers (risk-based premiums), and policymakers (fertilizer subsidy targeting). These insights aim to optimize resource allocation, guiding stakeholders in selecting crops, designing insurance premiums, and targeting subsidies efficiently. Limitations include a restricted data scope due to missing irrigation and pest incidence data, as well as the exclusion of post-2014 climate variability; future work will integrate satellite and IoT data for real-time climate-smart agriculture.

Keywords: Climate-smart agriculture, big data, clustering, crop yield prediction, machine learning, Random Forest.

INTELLIGENT ECOETL: AN ENERGY-AWARE FRAMEWORK FOR SUSTAINABLE EXTRACT-TRANSFORM-LOAD OPERATIONS IN BIG DATA PROCESSING

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Abstract

In the rapidly expanding domain of big data processing, traditional Extract-Transform-Load (ETL) pipelines impose substantial energy demands on computing infrastructure, contributing to increased carbon emissions and operational costs in data centers. This paper introduces EcoETL, a novel intelligent energy aware ETL framework designed to investigate adaptive resource optimization strategies for sustainable data processing. Built on Python using pandas and psutil libraries, EcoETL features adaptive decision logic that dynamically assesses system constraints file size, estimated row count, memory usage, and available memory to switch between eco mode and speed mode processing approaches. The framework incorporates three innovations: an Energy Monitor module with high frequency sampling for real time resource tracking, an Operation Optimizer that reorders ETL pipelines to prioritize data reducing operations, and comprehensive validation mechanisms for processing integrity. Experimental evaluation using NYC Taxi datasets reveals significant insights into the relationship between dataset characteristics and optimization effectiveness. The framework demonstrates competitive performance for large datasets exceeding 400MB under memory constrained conditions, while smaller datasets experience substantial optimization overhead outweighing energy efficiency benefits. Statis tical validation across multiple test runs confirms measurement reliability and identifies critical performance boundaries determining framework applicability. The Energy Monitor achieved high accuracy in resource tracking, while the Operation Optimizer contributed measurable improvements when processing conditions aligned with framework strengths. The research contributes empirical evidence regarding scale dependent ETL optimization, validates adaptive monitoring strategies for energy aware computing, and identifies infrastructure dependencies influencing sustainable data processing. Results indicate optimization benefits scale with data complexity while framework overhead remains constant, suggesting algorithmic refinements could enhance deployment viability. This work advances understanding of energy aware data processing challenges while establishing performance boundaries for sustainable ETL implementation in re source constrained environments, providing foundation for energy efficient solutions aligned with sustainable computing objectives.

Keywords: ETL Framework, Energy Efficiency, Sustainable Data Processing, Big Data, Resource Optimization, Green Computing

INFLUENCE OF LUNAR PHASE ON THE CALVING AND ARTIFICIAL INSEMINATION IN DAIRY COWS

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Abstract

Reproductive efficiency is a key determinant of cow productivity, yet several environmental and physiological parameters influence its outcomes. Among them, the lunar cycle has been hypothesised to affect reproductive events in mammals through hormonal regulation and behavioural changes. This study examined the impact of lunar phases on calving patterns and the success rate of artificial insemination (AI) in dairy cows in the Mid-Country Intermediate Zone of Sri Lanka. A total of 13 cows (n=13) were selected, belonging to the Jersey and Jersey-Friesian breeds. Data were obtained retrospectively from existing farm records. A total of 26 calvings were observed, while 43 AI occurrences were recruited into the study during the period from January 1, 2018, to July 31, 2025. As part of the descriptive analysis, the highest number of calvings was recorded during the new moon, accounting for 25.6% of recorded calving occurrences. There was no significant relationship (p>0.05) observed between the birthweight of calves with either lunar phase, or distance to the Moon. Even the influence of the distance to the moon on the AI success rate has no significant relationship, the relation between the lunar phases and the AI success rate is significant (p<0.05). Calves' sex ratio was not affected by the Lunar phase or the distance to the moon. In conclusion, it is noteworthy that this study is the first of its kind in Sri Lanka; the lunar phase has a significant influence on the success rate of artificial insemination during the new moon phase.

Keywords: Artificial Insemination, Birth weight, Calving, Conception rate, Lunar Phase.

SESSION H_01

Intelligent Systems for Personalized Wellbeing and Sustainable National Digital Infrastructure

CHAIR - DR. NIROSHA WEDASINGHE

CO-CHAIR - DR. ASANKA SAYAKKARA

SESSION H_01
SESSION CHAIR'S ADDRESS

Dr. (Mrs.) Nirosha Wedasinghe,
Senior Lecturer,
Department of Information Technology,
General Sir John Kothalawela Defence University.

AI VS HUMAN INTELLIGENCE: MYTHS AND REALITIES

The accelerating development of Artificial Intelligence (AI) has generated widespread debate regarding its relationship with human intelligence, often accompanied by exaggerated expectations and persistent misconceptions. This conference speech, titled *"AI vs Human Intelligence: Myths and Realities,"* offers a critical and accessible exploration of how artificial and human intelligence differ, intersect, and can productively coexist in academic, professional, and societal contexts. The speech begins by examining the concept of intelligence as a multifaceted construct encompassing learning, reasoning, adaptability, creativity, emotional awareness, and ethical judgment. While human intelligence is deeply grounded in consciousness, lived experience, empathy, and moral reasoning, artificial intelligence is presented as a data-driven computational capability designed to simulate specific cognitive functions. A brief overview of AI's historical evolution is provided, highlighting key milestones from early theoretical foundations to contemporary applications such as advanced machine learning systems and generative AI tools. Central to the speech is the critical examination of common myths surrounding AI, including the beliefs that AI thinks like humans, possesses emotions, is always accurate, will fully replace human professionals, or undermines human creativity. The discussion clarifies that current AI systems operate through pattern recognition and probabilistic inference rather than genuine understanding or self-awareness, and that their outputs are inherently shaped by the quality and bias of training data. The speech further contrasts the respective strengths of AI and human intelligence, emphasizing AI's efficiency in processing large datasets alongside human superiority in ethical reasoning, contextual judgment, creativity, and social intelligence. Through illustrative examples from healthcare, education, and the creative industries, the speech underscores the importance of human–AI collaboration. The presentation concludes by advocating for a human-centred approach to AI adoption, arguing that the future of intelligence lies not in competition, but in a responsible partnership where AI amplifies human potential while humans provide ethical guidance and meaningful

A HYBRID MACHINE LEARNING FRAMEWORK FOR BIOMARKER DISCOVERY IN CHRONIC INFLAMMATORY DISEASES: BEYOND ATOPIC DERMATITIS

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Abstract

Atopic Dermatitis (AD) is a chronic, inflammatory skin condition marked by immune dysregulation and impaired epidermal barrier function. Although its clinical burden is substantial, the underlying molecular mechanisms remain incompletely understood, and reliable biomarkers for diagnosis and treatment are still lacking. This study introduces a hybrid statistical framework for robust biomarker discovery using gene expression data from the GSE116486 dataset, covering 18,523 mapped genes. A combination of parametric (Two-sample T-test, Welch's T-test) and non-parametric (Wilcoxon Mann–Whitney test, Significance Analysis of Microarrays) methods was employed to minimize method-specific bias and identify a reproducible set of 1,000 common genes. These genes served as input for classification models, with Support Vector Machine achieving strong internal validation performance (accuracy 0.98, AUC 1.00) in distinguishing AD from control samples. Linear Discriminant Analysis also performed well (accuracy 0.94, AUC 1.00), though with slightly reduced specificity. Biological validation of the top predictive genes revealed strong associations with AD pathophysiology, neurodegeneration, and immune signaling. Genes such as RNF34, PLA2G2D, FMR1, LINC00298, and POLR3F were prioritized for their combined statistical significance and biological relevance, while additional uncharacterized candidates were retained for exploratory investigation. Functional enrichment analysis confirmed immune-related pathways, including viral response processes, reinforcing mechanistic plausibility. The findings underscore the interpretability and translational potential of the selected gene set. Limitations include reliance on a single dataset and reduced transferability in external validation, highlighting the need for harmonized preprocessing and multi-cohort testing. Future directions involve pathway-level replication, comparative benchmarking, and experimental validation to enhance reproducibility.

Keywords: Atopic dermatitis, Biomarker discovery, Gene selection, Machine learning, Biological validation, High-dimensional data

SYSTEMATIC REVIEW OF AI APPLICATIONS IN ORTHODONTIC SURGERY AND TREATMENT PLANNING: DIAGNOSTIC PERFORMANCE AND EXPLAINABILITY TOOLS

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Abstract

Artificial Intelligence (AI) has emerged as a valuable tool in orthodontic surgery planning, offering solutions to the limitations of manual diagnosis, including subjectivity, inter-observer variability, and errors in image interpretation. This systematic literature review, conducted in accordance with PRISMA 2020 guidelines and examined 14 peer-reviewed studies published between 2020 and 2025. The included studies show that AI models frequently achieved high diagnostic performance, with several studies reporting classification accuracies above 90% for identifying the need for orthognathic surgery. For postoperative outcome prediction, mean facial morphology errors ranged from approximately 0.69 to 0.94 mm. In three-dimensional maxillofacial segmentation tasks, deep learning models reported Dice similarity coefficients between 93% and 99%. AI assisted cephalometric analysis reduced assessment time in datasets of up to 1500 cephalograms while maintaining clinically acceptable agreement with manual tracings, although variability between platforms and limited external validation were observed. Explainability methods such as Grad CAM heatmaps, attention mechanisms, three-dimensional shape-based explanations, and SHAP style feature attributions improved interpretability by highlighting relevant anatomical regions and influential features. However, these techniques were inconsistently integrated and rarely evaluated for their effect on clinician trust or automation bias. Overall, the evidence indicates that AI improves efficiency and local diagnostic performance but does not consistently outperform conventional approaches for complex global outcome prediction. Future research should focus on large multicenter datasets, standardized evaluation metrics, and hybrid workflows that combine AI support with clinician oversight to enable safe clinical adoption.

Keywords: Artificial Intelligence, Orthodontics, Orthognathic Surgery, Explainable AI, Diagnostic Tools, Treatment Planning

ENHANCED CNN ARCHITECTURE FOR MULTI-LABEL SKIN CONDITION CLASSIFICATION FOR PERSONALIZED SKINCARE RECOMMENDATIONS

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Abstract

Skin condition classification is a critical component in developing AI driven personalized skincare systems. This paper presents a custom convolutional neural network (CNN) based on ResNet50, augmented with attention mechanisms, for multi-label classification of five skin conditions: acne, wrinkles, dry skin, oily skin, and normal skin. The model was trained on a dataset of 880 dermatological facial images, employing condition-specific preprocessing techniques such as Contrast Limited Adaptive Histogram Equalization (CLAHE) and Gaussian smoothing to enhance image quality. Data augmentation strategies were applied to address class imbalance and increase dataset diversity. Using five-fold stratified multi-label cross-validation, the model achieved an average accuracy of 97.25%, precision of 94.44%, recall of 94.72%, F1-score of 94.58%, and AUC of 99.02%. The classification outputs are integrated with a rule-based recommendation engine that incorporates user profiling via a 10-question questionnaire, blending modern dermatology and Ayurvedic practices. This frame work demonstrates high performance compared to existing benchmarks, offering a foundation for accessible skincare solutions in diverse populations.

Keywords: Convolutional Neural Networks, Multi-Label Classification, Skin Condition Analysis, Deep Learning, Attention Mechanism

ECRISA070

A CONCEPTUAL FRAMEWORK FOR A GOVERNMENT-LED DIGITAL MARKETPLACE TO ENABLE SRI LANKA'S TECHNOLOGICAL DEVELOPMENT AND CONNECT LOCAL IT TALENT WITH NATIONAL AND INTERNATIONAL PROJECTS

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Abstract

This paper presents a conceptual framework for a government-led dig-ital marketplace aimed at enhancing Sri Lanka's technological development by connecting local IT talent with national and international projects. The proposed platform addresses the limitations of existing global freelance marketplaces by introducing government-assisted verification, transparent project allocation, and support for new entrants, such as undergraduates and entry level freelancers. Through verified participation, mentorship, and opportunities to build portfolios, the platform promotes skill development, workforce empowerment, and socio-economic growth. It also allows the government to increase transparency in project execution, monitor workforce trends, and support SMEs and startups through affordable access to qualified service providers. Furthermore, the platform promotes industry–academia synergy, bridging the gap between education and practical experience. Key implementation considerations including platform architecture, security, scalability, and governance mechanisms are discussed to secure long-term viability. The framework shows Sri Lanka as a potential model for nations seeking to take part in digital talent development with national policy goals in a transparent, broad, and scalable manner.

Keywords: Government-led platform, digital marketplace, socio-economic development, workforce development, e-governance, industry–academia synergy, verified portfolio, technological growth.

ANALYSIS OF LONG DISTANCE PUBLIC TRANSPORT DRIVING BEHAVIOUR USING GPS DATA

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Abstract

Aggressive driving is a major contributor to traffic accidents, yet identifying such behavior remains challenging, especially when relying on high-cost or intrusive sensory technologies. Long-distance public transport routes further complicate continuous monitoring due to varying road conditions and limited data avail ability, highlighting the need for scalable and objective identification methods. To address this problem, this study develops a low-cost, large-scale GPS-based framework for detecting aggressive driving behavior using non-intrusive data collected from long-distance buses. In the initial stage, a dataset of 5.9 million GPS records was cleaned and segmented into one-minute intervals while deriving eight descriptive measures, including speed, acceleration, and time spent above speed thresholds. This pre-processing addresses feature granularity and class imbalance caused by predominantly neutral driving. Resampling techniques were applied to improve the representation of aggressive patterns. The proposed frame work adopts a hybrid unsupervised learning approach combining an Autoencoder and a Self-Organizing Map (AESOM). The Autoencoder compresses correlated features into a latent space, while the Self-Organizing Map clusters distinct behavioural patterns. Four behavioral categories emerged: Smooth/Neutral, Passive, Defensive, and Aggressive. These clusters were validated through statistical analysis and visualizations such as spatial heatmaps, scatter plots, and feature distribution curves. Segment-level results are aggregated into a Driving Behaviour Index (DBI), providing a quantifiable trip-level measure of aggressive ness using weighted segment-level classifications. Visualizations and statistical summaries confirm consistency between DBI scores and observed driving dynamics: aggressive trips exhibit high acceleration variability and strong braking, while 1 conservative trips remain stable. Overall, the framework offers a low-cost, scal able, non-intrusive and interpretable solution for monitoring driver behaviour, with potential to enhance fleet management, road safety, and policy interventions.

Keywords: Driver Behaviour, GPS data, Auto-encoder, SOM, Aggressiveness Index

A COMPREHENSIVE ANALYSIS OF NEED FOR AN AUTOMATED SOLID WASTE SEGREGATION AND MANAGEMENT SYSTEM FOR THE PORT OF COLOMBO, SRI LANKA

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Abstract

The Port of Colombo faces significant challenges in managing industrial solid waste generated from container terminal operations, with current manual segregation processes resulting in inconsistent sorting accuracy, increased labor costs, and worker safety concerns. This study investigates waste management practices at South Asia Gateway Terminals (SAGT) and proposes an automated segregation system utilizing image processing and machine learning techniques. A mixed-methods research approach combining surveys, observational analysis, and prototype development assessed operational challenges across twelve months of waste generation data (273 tons metallic waste, 23 tons plastic waste quarterly). Survey results from twenty operational personnel revealed 60% observed improper disposal behaviors, with 90% supporting automation implementation. The developed prototype integrates ultrasonic sensors for object detection, inductive proximity sensors for metallic waste identification, and Convolutional Neural Network (CNN) classification for non-metallic materials. Performance testing across forty segregation cycles achieved 100% accuracy for metals, 82.5% for tin/cans, 72.5% for plastics, and 67.5% for paper products, with response times ranging 9-15 seconds compared to 6-7 hours for manual processing. The CNN model demonstrated 99% training accuracy and 94% validation accuracy using 250+ images per category. Integration with IoT infrastructure enables real-time bin level monitoring and waste analytics through web-based dashboards. Implementation would reduce labor requirements, improve segregation consistency, and enhance environmental compliance. Future enhancements include bidirectional motor optimization, multi angle imaging, and advanced deep learning architectures for improved classification under variable industrial conditions.

Keywords: Solid waste management, automated segregation, machine learning, convolutional neural networks, port terminals, IoT monitoring

LEVERAGING CONVOLUTIONAL NEURAL NETWORK (CNN) CAPABILITIES TO DEVELOP A PORTABLE FIRE DETECTION DEVICE FOR PRELIMINARY BUILDING WORK

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Abstract

Fire incidents during the preliminary construction phase of multi-story buildings pose significant risks due to activities such as welding, flame-cutting, and steel grinding. Traditional smoke-based detection systems perform poorly in these open and dynamic environments, often delaying fire recognition and increasing hazards. This study addresses this gap by developing a computer-vision-based fire and smoke detection approach using Convolutional Neural Networks (CNNs) and the YOLO framework to support the development of a future portable fire detection device. A dataset of 4,600 images was constructed across four classes—fire and smoke, arc welding, gas welding, and steel cutting—to reflect real construction-site conditions. Images were labelled with bounding boxes and used to train a YOLOv9c model with an input resolution of 640×640 and a confidence threshold of 0.25. Comparative experiments determined an optimal data split of 80% training, 10% validation, and 10% testing. Model training was performed on Google Colab to overcome hardware limitations. Evaluation followed the mAP50–95 protocol, where the model achieved 87.3% mAP, 90.5% precision, 88.4% recall, and an F1-score of 90.6%. The model demonstrated strong performance in distinguishing fire from visually similar activities such as arc welding and cutting operations, although detecting small or partially occluded flames remained challenging. A prototype demonstration using a laptop and webcam confirmed real-time detection capability. The proposed system represents a significant step toward a portable, computer-vision-based fire detection device for construction sites. Future work will focus on embedded deployment, improved small-fire detection, and extensive evaluation under real construction scenarios.

Keywords: Fire Detection, Construction Safety, Deep Learning.

ECRISA023

HEMOGLOBIN ESTIMATION AND ANEMIA SEVERITY CLASSIFICATION VIA PPG SIGNAL EXTRACTED FROM MOBILE FINGERTIP VIDEOS

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Abstract
Anemia is a severe health issue of worldwide concern with children and women in low-resource environments being disproportionately impacted. The traditional diagnostic tools, i.e., Complete Blood Count (CBC) tests, are accurate but invasive, expensive, and unavailable to many patients. This study provides a non-invasive method of hemoglobin measurement and anemia severity classification based on the analysis of smartphone fingertip videos, offering a low-cost solution for early screening in underserved areas. This study addresses major limitations of prior works, such as the low quality of signals, the lack of severity categorization, and imbalance of datasets, with a robust pipeline that combines photoplethysmography (PPG) signal extraction, advanced preprocessing, data augmentation, physiologically-aware feature engineering, and machine learning models. Leveraging a publicly available dataset of 150 fingertip videos, collected under institutional ethical approval with informed consent, the values of hemoglobin were manually classified into anemia classes in accordance with the WHO guidelines. The data augmentation (amplitude scaling, jittering, signal wandering) and dynamic frame selection algorithms have been integrated into the optimal methodology to increase signal fidelity. The XGBoost model performed better on hemoglobin regression (RMSE = 0.3896), and the ANN model performed better on anemia severity classification (accuracy = 0.9900). These findings outperform the results of the existing studies regarding this dataset. Future efforts will be aimed at increasing demographic diversity, real-world testing and development of mobile application to increase accessibility and impact.

Keywords: Photoplethysmography, Biomedical Signal Processing, Hemoglobin Estimation, Anemia Classification.

SESSION M_04

Engineering Innovations at the Intersection of Energy, Environment, and Digital Transformation

CHAIR - PROF. (MRS.) J.M.J.W. JAYASINGHE

CO-CHAIR - DR. UDITHA WIJEWARDENA

Prof. (Ms.) Jeevani W. Jayasinghe
Professor of Electrical & Electronic Engineering,
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ANTENNA INNOVATION: BRIDGING ACADEMIA AND INDUSTRY

Industry-oriented innovation has become a central driver of progress in modern antenna engineering, particularly in response to the rapid expansion of wireless communications, Internet of Things (IoT) systems, defence technologies, and space applications. Achieving high-impact antenna solutions increasingly depends on the effective integration of fundamental electromagnetic theory, advanced design methodologies, rigorous experimental validation, and successful industrial translation. Research that explicitly addresses real-world constraints—such as miniaturization, energy efficiency, bandwidth, manufacturability, and cost—has consistently demonstrated the greatest technological and societal impact. Significant advances in this field have been enabled through strong collaboration between academia and industry, allowing antenna concepts to evolve from laboratory prototypes into commercially viable and strategically relevant systems. This presentation highlights key developments from multiple countries that exemplify this translational research pathway. One prominent research direction is illustrated by collaborative work in fractal-based and miniaturized antenna technologies, including the development of Antenna Booster Technology. This innovation has enabled reliable wireless connectivity using extremely compact components and has achieved widespread adoption across the global telecommunications industry through successful industrial deployment and academic collaboration. Parallel progress in defence-oriented antenna systems further underscores the strategic importance of applied electromagnetic research. The development of low-observable, wideband, and electronically steerable antenna platforms—recognized by the 2023 Eureka Prize for Outstanding Science in Safeguarding Australia—has enabled secure, high-capacity data transmission and enhanced spectrum awareness for defence applications. Additional contributions arise from research domains where tight coupling between hardware development and experimental validation is essential. This approach is exemplified by work that bridges fundamental academic research with industry-facing antenna design, measurement, and testing platforms, ensuring both scientific rigor and practical relevance. Overall, this abstract highlights how leadership-driven, internationally collaborative research frameworks play a critical role in advancing antenna innovation, effectively bridging academia and industry, and translating scientific advances into impactful real-world technologies**.**

DEVELOPMENT OF AN ULTRASONIC DEVICE TO MITIGATE MARINE MAMMAL DEPREDATION IN FISHERIES

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Abstract

Longline fisheries face significant challenges from depredation, where orcas consume fish from baited hooks or damage nets to access catch, resulting in economic losses and gear damage. Existing acoustic deterrents operating in the 10–30 kHz range show limited effectiveness and may impact non-target species. Marine mammals such as orcas rely heavily on sound for communication, navigation, and foraging. Their auditory range spans 500 Hz to 40 kHz, with peak sensitivity around 15–25 kHz. Anthropogenic noise within this range can cause disturbance, stress, or displacement. While commercial acoustic deterrents (10–30 kHz) exist, their ecological effects are debated. This study investigates a low-cost ultrasonic sweep generator for marine mammal applications. The apparatus uses a two-stage oscillator architecture, where a high-frequency oscillator is modulated by a low-frequency sweep signal 5 Hz sawtooth waveform at approximately 12 V peak-to-peak, to produce ultrasonic sweeps between 40 and 80 kHz, which overlap the upper range of orca hearing. The system has the potential to achieve acoustic source levels in the range of 165–175 dB re 1 µPa at 1 m when combined with a Class-D power amplifier and a resonant 50–90 kHz piezoelectric ultrasonic transducer. These initial results show that the proof-of-concept is, indeed, feasible, but it needs to be validated by tank tests, underwater calibration, and field trials. Design, component selection, frequency calculation, and oscilloscope measurements are also presented, along with discussions about ecological effects. Future developments will consist of behavioral testing, propagation modelling, and the inclusion of previously unutilized design features will be incorporated to improve system efficiency and applications in acoustic deterrence.

Keywords: ultrasonic sweep, marine mammal deterrent, echolocation, frequency sweep, Orcinus orca (orcas), Longline fisheries, Power amplifier, acoustic source level, Depredation prevention, habituation

Proceedings of International Conference on Emerging Concepts and Research in Integrated Sustainable Adaptation (ECRISA 2026)

ECRISA067

SHAPING ELECTRIFIED MOBILITY: UNVEILING THE DYNAMICS BEHIND CONSUMER INTENTIONS FOR ELECTRIC CAR PURCHASES IN SRI LANKA

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Abstract

Growing environmental concerns and the urgent need for decarbonisation in the transportation sector have intensified global interest in electric vehicles (EVs) as a sustainable alternative to fossil fuel-dependent automobiles. This study investigates the attitudinal and behavioral factors influencing consumer purchase intentions for electric cars in Sri Lanka's emerging automotive market, examining both intrinsic motivations and extrinsic barriers that shape adoption decisions. Accordingly, key influencing purchasing dynamics the Sri Lankan Electric Car market were explored by using online survey by means of a self-administrative questionnaire was carried out with 350 respondents. Findings reveal that economic considerations and infrastructure availability constitute the primary barriers to EV adoption in Sri Lanka. Specifically, energy costs per unit and the limited availability of charging infrastructure emerge as the most significant deterrents to consumer purchase intentions. These practical concerns outweigh other considerations in consumers' decision-making processes. However, the study also identifies positive influences: consumers demonstrating pro-environmental attitudes toward sustainability and those receptive to technological innovations show significantly higher purchase intentions for electric vehicles. The research highlights critical gaps in Sri Lanka's EV ecosystem that require policy intervention on battery replacement and disposal. The charging infrastructure remains inadequate for widespread adoption, while the energy grid's continued reliance on fossil fuels undermines the environmental benefits of vehicle electrification. These findings suggest that successful EV market development in Sri Lanka requires coordinated efforts across multiple domains: expanding charging station networks, transitioning to renewable energy sources for grid electricity, establishing comprehensive service infrastructure, and implementing incentive structures that address economic barriers. In addition, this study identify gaps and limitations in existing research and suggest areas that the relevant authorities need to consider on renewable energy sources rather than fossil fuel stations in the long run, and the availability of rechargeable stations and service stations should be expanded.

Keywords: Consumer behavior dynamics, Electric cars, Purchasing intention.

LIFE TIME DETERMINATION OF LEAD ACID BATTERIES

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Abstract
Lead acid batteries constitute a core element in modern electrical infrastructures, serving as reliable and cost effective energy storage systems. These rechargeable batteries are widely employed in applications such as Uninterruptible Power Supplies (UPS), telecommunication systems, data centers, elevators, and service lifts. Depending on functional requirements, they are generally categorized as backup power, energy storage, power, or starter batteries. The operational lifetime of each category is influenced by several parameters, including manufacturing consistency, ambient temperature, charge/discharge cycling, specific gravity (SG) variation with the state of charge (SoC), and maintenance quality. Hence, accurate lifetime prediction necessitates a detailed evaluation of these influencing factors. Specific gravity remains one of the most reliable indicators of SoC, as it directly reflects electrolyte concentration changes during charging and discharging cycles. This ongoing two year research project focuses on developing a precise SoC estimation framework and predicting battery lifetime through experimental analysis. Parameters such as voltage, current, temperature, and SG were systematically recorded for batteries with different ampere hour (Ah) ratings. A mathematical model has been developed based on the collected battery data, providing a foundation for more accurate State of Charge (SoC) estimation. The repeated charge/ discharge cycles of each battery closely align with the model's predicted behavior, and the model's accuracy is expected to improve further as additional datasets are incorporated. A prototype system was implemented using an ESP32 microcontroller integrated with Wi-Fi, an ACS712 current sensor, and a temperature sensor. The ESP32 enables real time monitoring and remote data transmission. Future enhancements will employ an HSTS016L open loop split core current sensor to achieve higher accuracy and measurement stability.

Keywords: Lead Acid Batteries, State of Charge, Remaining Useful Life, Internet of Things (IoT).

ADOPTION OF INTELLIGENT PROCESS AUTOMATION IN THE TELECOMMUNICATION INDUSTRY IN SRI LANKA—A SYSTEMATIC LITERATURE REVIEW

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Abstract

Intelligent Process Automation (IPA) integrates Robotic Process Automation (RPA) with advanced technologies such as Artificial Intelligence (AI) and Machine Learning (ML) to enable the automation of complex business processes. Although global industries increasingly adopt IPA, empirical evidence on its implementation in the telecommunications sector remains scarce. This study employs a Systematic Literature Review following PRISMA guidelines to assess 30 peer-reviewed journal articles published between 2020 and 2025. Keyword co-occurrence, cluster analysis, and thematic mapping were employed to identify pat terns and research gaps using bibliometric tools, including VOSviewer and Biblioshiny. The findings reveal two dominant themes: enhancing business continuity through automation and accelerating predictive trans formation via AI. Although global literature highlights the strong association between RPA, AI, and business continuity, a significant contextual gap was identified, with minimal studies focusing on Sri Lanka's telecommunication sector. Moreover, a theoretical gap emerged, as only a few studies employed models such as the Unified Theory of Acceptance and Use of Technology (UTAUT) or the Diffusion of Innovation. Methodologically, most studies employed qualitative approaches, with minimal use of quantitative or mixed-methods research. This review highlights the need for empirical studies tailored to the Sri Lankan context and recommends developing a conceptual framework for implementing IPA in the telecommunications sector. The study contributes to the academic discourse by identifying key gaps and offering a foundation for future research on AI-driven automation strategies in emerging markets.

Keywords: Intelligent Process Automation, Robotic Process Automation, Artificial Intelligence, Business Continuity, Digital Transformation, Telecommunication Industry

ECRISA063

UTILIZING MODERN ADVANCED DIGITAL TECHNOLOGIES TO ENHANCE THE ROLE OF QUANTITY SURVEYORS IN SRI LANKA

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Abstract

Modern advancement technologies have become the backbone of the construction industry in a significant impact. The construction industry in Sri Lanka expresses a slow rate of digital technology adoption, posing a significant obstacle to the essential modernization of the Quantity Surveying profession. This research investigates the barriers to implementing advanced digital transformation technologies, specifically Construction 4.0 technologies such as Building Information Modeling (BIM), Artificial Intelligence (AI), and Drones, within the Quantity Surveying (QS) profession in Sri Lanka. The study aims to identify these barriers and propose strategic solutions to enhance QS efficiency and capability. A mixed-methods approach was utilized, incorporating a structured questionnaire survey administered to 45 Quantity Surveying professionals in Sri Lanka. Quantitative data were analyzed using the Relative Importance Index (RII), while qualitative insights were gathered through semi-structured interviews and analyzed using a code-based structure in NVivo 14. The findings revealed that the most critical competency for QSs is Quantification/Measurement, followed by Project Analysis, Evaluation, and Documentation. Key barriers to the implementation of digital technologies were identified, ranked as follows: high initial costs, lack of investment in research and development, resistance to change, and insufficient professional knowledge. These barriers hinder the effective adoption of advanced technologies in the QS sector. Based on the survey and interview findings, the study proposes a final conceptual framework to guide the effective professional adaptation of digital technologies in the Sri Lankan QS profession. To facilitate successful digital transformation in the Sri Lankan QS profession, the study recommends a comprehensive strategy that includes presenting a clear Return on Investment (ROI), promoting Continuous Professional Development (CPD) and training, updating academic curricula, and securing targeted governmental financial support. Based on the survey and interview findings, the study proposes a final conceptual framework to guide the effective professional adaptation of digital technologies in the Sri Lankan QS profession. Additionally, the research highlights a significant gap in empirical evidence regarding how QS professionals in developing economies adapt to emerging digital technologies, emphasizing the need for further studies in this area.

DESIGN AND PERFORMANCE EVALUATION OF A SUPERCAPACITOR BATTERY HYBRID ENERGY STORAGE SYSTEM FOR OFF-GRID PV APPLICATIONS

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Abstract

A low-cost, manually controlled, relay-based supercapacitor-battery hybrid energy storage system (HESS) is presented for off-grid photovoltaic (PV) applications. The dependable provision of power in remote and rural regions continues to be a significant concern owing to insufficient or absent grid connectivity. Solar PV systems present a viable renewable energy alternative; however, their power output is highly dependent on weather conditions and solar irradiance, resulting in intermittent energy generation. Traditional off-grid PV systems generally utilize batteries for energy storage; however, numerous charge-dis charge cycles reduce their longevity, escalate replacement expenses, and heighten environmental issues associated with disposal. This paper proposes a HESS integrating supercapacitors (SCs) with a lithium-ion battery to enhance the reliability, efficiency, and sustainability of off-grid PV applications. The proposed system was bench-tested under controlled laboratory conditions with a regulated 12V, ~3.3W load, and maintains a regulated 12V DC output under varying irradiance and load conditions. In the hybrid configuration, transient power fluctuations are absorbed by the SC, thereby reducing stress on the battery, which is primarily responsible for steady-state power delivery. The system is modelled and experimentally validated under six operational modes, representing different environmental and load scenarios. The results demonstrate that the proposed HESS achieves efficiencies ranging between 75-90%, with substantial improvements in output stability, dynamic response, and storage lifetime compared to conventional battery-only systems. The incorporation of the SC significantly re duces deep-discharge cycles and thermal stress in the battery, leading to enhanced lifecycle performance and reduced maintenance costs. The findings confirm that hybridizing SCs with lithium-ion batteries offers a low-cost, environmentally benign, and technically robust solution for ensuring stable power supply in off-grid PV systems. The proposed architecture holds potential for scalable deployment in rural and isolated regions. Future work will focus on the optimization of power management strategies using intelligent control algorithms to further improve system performance and reliability.

Keywords: Energy Storage, Off-Grid Photovoltaic Applications, Renewable Energy, Supercapacitor-Battery Hybrid System, System Efficiency

Proceedings of International Conference on Emerging Concepts and Research in
Integrated Sustainable Adaptation (ECRISA 2026)

ECRISA043

DEVELOPMENT OF A COST-EFFECTIVE SUPERCAPACITOR-ASSISTED PV SYSTEM FOR RELIABLE DC MICROGRID OPERATION

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Abstract
Access to reliable electricity remains a pressing issue in remote and low-income regions where grid extension is often impractical or costly. Solar photovoltaic (PV) systems provide a promising renewable option, yet their output fluctuates with weather and irradiance, affecting reliability. Conventional battery-based systems, although common, involve high costs, limited lifespans, and disposal concerns. Most hybrid PV systems also rely on complex Maximum Power Point Tracking (MPPT) and automated control, increasing cost and system complexity, which limits their use in resource-constrained environments. This paper presents the design and experimental evaluation of a low-cost solar PV microgrid employing a supercapacitor-assisted configuration for small DC loads such as mobile phone charging. The system integrates a 20W PV module, a six cell supercapacitor (SC) bank (2.7V, 400F per cell), and a regulated 12V grid backup on a common DC bus, managed by a microcontroller-based relay controller and a buck converter interface operating in four voltage-dependent modes: Mode 1 – PV directly powers the load; Mode 2 – PV powers the load while charging the SC; Mode 3 – PV and the SC jointly supply the load during low irradiance; and Mode 4 – the grid powers the load when PV voltage falls below the threshold. Laboratory testing under a constant irradiance profile using a solar array simulator and a programmable electronic load achieved an overall average efficiency of around 85% with minimized relay switching losses, smooth transitions, and stable DC bus voltage. The results confirm that the inclusion of an SC improves voltage stability, mitigates transient dips, and reduces dependence on grid power. Overall, the proposed configuration provides a technically reliable, economical, and sustainable solution for off-grid DC microgrids. Future work will focus on solid-state switching, remote monitoring, and long-term outdoor validation

Keywords: Arduino-based control, Buck Converter, Common DC bus, DC microgrid, Grid-assisted operation, Power Management, Solar photovoltaic (PV), Supercapacitor energy storage

SESSION M_05

Smart Industrial Systems, Automation, and Digital Engineering for Sustainable and Intelligent Operations

CHAIR - DR. AJITH PASQUAL

CO-CHAIR - DR. SANKALPA GAMWARIGE

SESSION M_05
SESSION CHAIR'S ADDRESS

Dr. Ajith Pasqual,
Senior Lecturer,
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"Smart" in Smart Systems has a very deep meaning that captures the essence of sensing (awareness), connectivity, data, intelligence and an outcome by way of an action. Not only this means understanding of the context in which the system is operating but efficient and effective use of resources to achieve the desired outcome. This deeply connects to the core ideas of sustainable development where the primary objective is proper use and management of all resources. "Smart" also captures the element of modelling by way of digital twins/digital engineering where complex systems can be modelled so that the output of such a system can be efficiently produced or changes can be done without the need for expensive physical interaction. This entire concept opens the door for innovation. Re-looking at existing systems to make them smart in today's context is not only worthwhile exercise from a research point of view but can result in significant economic gain. The whole process is filled with opportunities to innovate and now is the time to make use of those opportunities in a proactive manner.

DEVELOPMENT OF AN INTELLIGENT FAULT DIAGNOSIS SYSTEM WITH REAL-TIME MONITORING AND ADJUSTMENT RECOMMENDATIONS FOR THERMIC HEATERS

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Abstract

Thermic heaters are very important mechanisms in textile manufacturing industries as they offer regulated thermal energy to undertake vital processes such as dyeing, drying, printing, and finishing. The common traditional fault detection techniques used mainly depend on manual testing and simple alarm systems, which lead to slower fault detection, longer system outage, and a significant increase in operational costs. This study involves resolving these limitations through the creation of an intelligent fault diagnosis platform comprising an advanced sensor technology, Programmable Logic Controller (PLC) automation, and Human-Machine Interface (HMI) displays to provide real-time monitoring and instant fault identification of thermic heater systems. The suggested system entails the use of various types of sensors, such as K-type thermocouples (0-600 °C temperature range), pressure transducers (0-100 bar), piezoelectric accelerometers (0-10 mm·s^{-1} RMS), and optical infrared sensors to monitor the oil level, which are all linked to a Mitsubishi FX3U-24MT PLC. The programmed ladder logic algorithms operate sensor inputs to constantly check abnormal operating conditions, activate real-time alarms and present appropriate fault codes on the HMI panel with maintenance recommendations. With automated detection algorithms, the system manages to cope with normal operational problems such as overheating, heat transfer fluid degradation, pump failures, burner malfunctions, pressure anomalies, and system leaks. The prototype testing confirmed the ability of the sensor to scale the signals correctly, calibrate the sensor, and detect faults in all the parameters monitored. The sensor-based system greatly improves the precision of fault localization, increases the operational reliability, decreases unplanned downtimes, and even allows more efficient and safer thermic heater operation in industrial textile processes.

Keywords: Thermic Heater; Fault Detection; PLC Automation.

DESIGN AND DEVELOPMENT OF A LOW-COST 3D PRINTING SYSTEM FOR SUSTAINABLE CEMENTITIOUS CONSTRUCTION: A PROTOTYPE IMPLEMENTATION

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Abstract

This paper presents the design, development, and implementation of a low-cost Cartesian 3D printing system intended for sustainable construction applications in developing economies. A functional prototype was constructed using readily available components, including aluminum extrusion framing, NEMA 17 stepper motors, TB6600 drivers, and RAMPS 1.6 control architecture with modified Marlin firmware. The system demonstrates the feasibility of creating an accessible 3D construction printer at significantly reduced cost (approximately USD 8,000-10,000) compared to commercial alternatives (USD 150,000-500,000). Based on established literature, a sustainable cementitious material formulation is proposed, incorporating 50% Ordinary Portland Cement, 25% fly ash, 15% rice husk ash, and 10% fine sand. Literature indicates such formulations can achieve compressive strengths of 30-35 MPa while reducing CO_2 emissions by 40-50% compared to conventional concrete. This work presents a validated hardware platform and identifies material formulations for future experimental investigation, providing a pathway toward affordable, sustainable construction technology.

Keywords: 3D Concrete Printing; Low-Cost Construction; Sustainable Materials; Fly Ash; Rice Husk Ash

DATA PATTERN CONVERSION FOR LEGALIZED WEIGHING INDICATOR INTERFACE BETWEEN HIWEIGH X1 AND EVEREST INSTRUMENTS MONITORING SYSTEM: A SRI LANKA FIRST

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Abstract
Sri Lanka's dairy and retail sectors rely heavily on automated weighing systems for daily trade operations. A recurring issue in the field is that several imported indicators used with Everest Instruments monitoring units are not approved by the Department of Measurement Units, Standards, and Services (MUSSD). This limits their use in legal transactions. The locally certified Hiweigh X1 indicator offers a compliant option, yet its output format is incompatible with Everest's monitoring platform. This study introduces a practical conversion interface that enables the X1 indicator to communicate with Everest systems through a standardized serial link and Wi-Fi transmission. The prototype uses an Arduino Nano only as a temporary protocol translator. The hardware receives RS232 data from the X1 through a MAX3232 level shifter, restructures the frame into the Everest format, and forwards it through another MAX3232 module to the Wi-Fi adapter. Tests carried out in a real dairy environment confirm full accuracy, fast response time, and consistent stability. The system represents the first working bridge between a MUSSD-approved Sri Lankan weighing indicator and an international monitoring system, providing a compliant and cost-effective upgrade path for existing installations.

Keywords: Weighing indicator; RS232 serial conversion; Legal metrology; Data frame translation; Wi-Fi monitoring; Protocol mapping

REAL-TIME SCADA IMPLEMENTATION FOR INDUSTRIAL MONITORING AND PREDICTIVE OPTIMIZATION

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Abstract

This paper presents the design, development, and implementation of a real-time Supervisory Control and Data Acquisition (SCADA) system aimed at improving industrial automation, operational visibility, and production performance within a manufacturing environment. The proposed solution integrates Siemens and Allen-Bradley Programmable Logic Controllers (PLCs) with the Ignition platform by Inductive Automation, supported by a MySQL database and browser-based visualization interfaces. A centralized SCADA gateway architecture facilitates reliable, low-latency data exchange via Ethernet/IP, ensuring cohesive communication across all automation layers. Real-time dashboards and automated reporting provide continuous monitoring of key production metrics, including machine status, speed, Overall Equipment Effectiveness (OEE), and Mean Time to Failure (MTTF). Predictive maintenance analytics and alarm management further enhance operational reliability by identifying potential faults before equipment failure. The implementation has enabled to log critical data with 100% accuracy, increased operating time per shift up to 25% in average, increased production count per shift up to 15 000 in average and streamlined performance analysis, contributing to data-driven decision making and sustainable productivity in line with Industry 4.0 standards.

Keywords: SCADA, Industrial Automation, Predictive Maintenance, Industry 4.0, OEE

ECRISA055

SMART LOCATION-BASED TOURISM INFORMATION SYSTEM: INTEGRATING GPS AND BEACON TECHNOLOGIES FOR ENHANCED VISITOR EXPERIENCES IN SRI LANKA

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Abstract

The tourism industry is increasingly shaped by digital technologies, which enable destinations to deliver more personalised, interactive, and efficient services to visitors. Tourists now expect location-specific, multilingual guidance that allows them to navigate seamlessly and obtain information about the places they visit. This paper proposes the development of a hybrid Smart Tourism Information System that integrates Global Positioning System (GPS) technology with Bluetooth Low Energy (BLE) beacons to create an end-to-end navigation and information platform. GPS technology facilitates outdoor navigation, while BLE beacon technology for indoor and dense urban micro locations in order to obtain site-specific content when visitors arrive at specific points of interest. The system is designed to enhance visitor experiences, support industry revenue generation, and provide strategic data for tourism planning. A phased implementation strategy is proposed, beginning with a pilot project at a UNESCO World Heritage site, Lion's Rock, Sigiriya, and gradually expanding to cover the entire island. The expected outcome is a scalable, cost-effective, and economically sustainable solution that strengthens Sri Lanka's competitiveness in the global tour ism sector

Keywords: Smart Tourism, Bluetooth Low Energy (BLE), GPS Navigation, Beacon Technology, Smart Destination Management.

Proceedings of International Conference on Emerging Concepts and Research in Integrated Sustainable Adaptation (ECRISA 2026)

ECRISA054

ADOPTION AND SECURITY CHALLENGES OF BIG DATA STORAGE IN CLOUD ARCHITECTURES: GOVERNMENT VS. PRIVATE SECTOR IN SRI LANKA

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Abstract

In modern day information technology era, cloud computing and big data have emerged as widely used main concepts in the world. Big data enables a large number of data set processing, storage and retrieval, while cloud computing offers a cost effective and scalable pay as you go basis infrastructure to support these big data processing operations. However, the integration of these two technologies raises concerns about privacy and security issues. This research focuses on the government and private sector privacy and security issues associated with storing and managing big data in cloud architectures. To gather data from the users, a mixed method approach is used. As qualitative data gathering, insights from interviews with IT professionals have been used. Further, for the quantitative data gathering, a survey has been conducted. The gathered data analysis shows that private sector organisations are more likely to tend towards higher adoption of cloud and Big Data architectures than the government sector. As per the results, the government sector organisations still rely on the traditional databases. As the key challenges of adopting big data storage in the cloud in the government sector, high operational costs, lack of technical expertise, vulnerabilities such as weak authentication, and inadequate encryption can be elaborated. A comparative analysis of the big data storing architectures, such as Hadoop and NoSQL, highlights their scalability and cost advantages but also exposes limitations in embedded security mechanisms. The study concludes with recommendations for enhancing cloud adoption in government institutions. To enhance areas, the study recommends conduct staff training, adopting robust policy frameworks, and using stronger encryption methods. The results of this study may fill the gap between theoretical research and practical implementation in developing countries like Sri Lanka. Further, this study provides actionable insights for secure and effective use of cloud-based Big Data systems.

Keywords - Cloud Computing, Big Data, Data Security, Privacy Issues, Data Storage Architectures

DESIGN OF A TIME-BASED EXTERNAL RESET MECHANISM TO IMPROVE MICROCONTROLLER SYSTEM RELIABILITY

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Abstract

Microcontroller based systems are widely adopted in applications that demand high reliability, including (Internet of Things) IoT devices, industrial automation, and embedded control systems. Despite their versatility, these systems remain vulnerable to software faults, peripheral failures, and transient errors that can lead to freezes or unpredictable behavior, adversely affecting system performance and operational continuity. This paper introduces a **novel time based external reset mechanism** that automatically restores microcontroller operation after a predefined interval, ensuring continuous functionality and minimizing downtime. The mechanism was implemented on **ESP32 based platforms** and integrated into two ongoing projects: a "Life Time Determination of Lead Acid Batteries" and a "Design and Implementation of a C_{10} & C_{20} Capacity Tester for Lead Acid Battery Discharge Evaluation". The study provides a comprehensive overview of the circuit architecture, hardware design, and operational principles, highlighting seamless integration with ESP32 microcontroller systems. Unlike conventional approaches, this design offers precise, configurable timed resets that enhance system resilience and fault tolerance without manual intervention. Experimental evaluation demonstrates that the proposed mechanism significantly improves fault recovery, stabilizes system operation, and increases overall uptime. The results confirm that it provides a simple, cost effective, and highly practical solution for enhancing the reliability of microcontroller-based systems. Furthermore, the design supports long term continuous operation, making it suitable for real world industrial, embedded, and IoT applications where consistent performance is critical. By combining innovative design with practical implementation, this research offers a robust method to improve system reliability, mitigate operational risks, and maintain uninterrupted functionality in critical microcontroller deployments.

Keywords: Microcontroller Based System, External Reset, System Reliability, Internet of Things (IoT), Industrial Automation.

SESSION H_02

Multimodal AI for Human-Centric Automation

CHAIR - PROF. JANAKA WIJAYANAYAKE

CO-CHAIR - DR. SUSARA THENUWARA

CO-CHAIR - ENG. D. S. WICKRAMASINGHE

SESSION H_02
SESSION CHAIR'S ADDRESS

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MULTIMODAL AI FOR HUMAN-CENTRIC AUTOMATION

The rapid evolution of artificial intelligence is transforming automation from task-oriented, isolated systems into intelligent, interactive collaborators. Multimodal AI refers to systems capable of simultaneously processing and integrating multiple forms of data such as text, speech, images, video, and contextual signals to achieve a richer and more human-like understanding of real-world situations. By mirroring the way humans naturally perceive and interpret their environment, multimodal AI provides a foundation for more intuitive, adaptive, and context-aware automated systems. The presentation highlights how multimodal AI enhances human-AI interaction by supporting natural communication, improving situational awareness, and enabling adaptive responses based on user intent and context. Through examples from healthcare, education, industrial environments, and public services, the speech demonstrates how human-centric automation can improve decision-making, safety, inclusiveness, and productivity while maintaining human oversight and accountability. Rather than replacing professionals, multimodal AI functions as a decision-support partner that reduces cognitive load and enhances human capability. The speech also addresses critical ethical and design considerations, including transparency, fairness, privacy, and the importance of keeping humans in the decision loop. It argues that without a human-centric perspective, multimodal automation risks reinforcing bias, eroding trust, and undermining human agency. The presentation concludes by positioning multimodal AI as a catalyst for a future in which automation evolves into collaboration, emphasizing that the ultimate goal of intelligent systems is not merely higher efficiency, but the creation of technology that aligns with human values and supports sustainable, responsible innovation.

DEEP LEARNING APPROACHES FOR SINHALA HANDWRITTEN CHARACTER RECOGNITION

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Abstract

Sinhala is the primary national language of Sri Lanka and comprises a script of 60 characters, making it considerably more complex than alphabet-based writing systems such as English. Despite approximately 25–30 studies conducted since 1990, Sinhala handwritten character recognition remains a developing area within pattern recognition. Accurately recognizing Sinhala handwritten characters continues to be challenging due to the high visual similarity among many characters and the curved, variable nature of handwritten forms. As a result, existing recognition systems often fail to achieve the reliability required for practical deployment. This study focuses on deep learning–based approaches to improve Sinhala handwritten character recognition. Two Convolutional Neural Networks (CNNs) models and Gabor-initialized Convolutional Neural Networks are implemented and evaluated. The research investigates the effect of dropout on recognition accuracy and analyzes the influence of different Gabor filter parameters on the performance of the Gabor-initialized CNN model when applied to Sinhala character datasets. The CNN model I achieved a training accuracy of 96.33% and a testing accuracy of 90.14%, representing the highest reported performance for all 60 Sinhala characters compared with previously published methods. The optimal results were obtained with a dropout rate of 0.5. The Gabor initialized CNN model achieved 95.15% training accuracy and 80% testing accuracy; although the training accuracy was slightly lower, this architecture exhibited faster convergence, reducing computational cost and training time. The findings indicate that the Gabor-initialized CNN model offers the best overall performance for Sinhala handwritten character recognition. The analyses of drop out effects and Gabor filter parameters provide useful insights for future model refinement and contribute to the development of more accurate and computation ally efficient recognition systems for Sinhala script.

Keywords: Handwritten Sinhala character recognition, Convolutional Neural Networks, Gabor filter bank, Gabor-initialized CNN

INTELLIGENT EXAM EVALUATION SYSTEM WITH AI BASED ANALYTICS

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Abstract

Manual exam evaluation is time-consuming, inconsistent, and susceptible to human bias, especially when grading diverse question types and handwritten scripts. This study introduces an Intelligent Exam Evaluation System that automates assessment through an integrated multimodal pipeline combining Transformer-based OCR (TrOCR), Retrieval-Augmented Generation (RAG), and multi-LLM grading using OpenAI GPT, Google Gemini, and DeepSeek. The system supports Multiple Choice Questions (MCQs), short answers, list-type responses, essay questions, and mathematical expressions, enabling semantic, rubric-aligned scoring. Experiments on 50 text based answer sheets, 50 mathematical answer sheets, and 20 handwritten answer sheets show strong alignment with human grading. Results indicate that few-shot prompting at temperature 0.0 delivers the most consistent performance, system achieved the highest accuracies of 74% for short answers with Gemini, 80% for list-type questions with OpenAI, and 55% for essays with Gemini, while tolerance-based evaluation further improved robustness. This optimal configuration was then applied across all remaining question categories. Equation-based questions were assessed with multiple LLMs, where OpenAI achieved the highest accuracy about 63.43%. Overall, the system offers a scalable, explainable, and analytics-driven solution that enhances fairness, reduces evaluator workload, and improves the efficiency of educational assessment.

Keywords: Artificial Intelligence, Exam Evaluation, Handwriting Recognition, Large Language Models, Retrieval-Augmented Generation

A SURVEY ON ADVANCEMENTS IN COMPUTATIONAL TOOLS FOR MATHEMATICS EDUCATION

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Abstract

Computational mathematical tools are increasingly essential in fields such as physics, engineering, biology, ecology, and computer science. Their role in mathematics education is also expanding. This systematic review examines widely used mathematical tools, their interdisciplinary applications, and the development of Artificial Intelligence (AI)-driven tools, while identifying their reported limitations. This comprehensive search of studies published from 2015 to 2025 was conducted with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We analyzed the selected 59 studies after screening and full-text review to examine their functionalities, applications, and limitations. The results show that AI-driven cloud-based platforms are becoming a leading trend in computational mathematics by providing greater accessibility and processing power. These advances nevertheless expose ongoing challenges, particularly in ensuring privacy, maintaining security, and overcoming digital barriers to equitable access. The review also demonstrates that these tools enhance secondary mathematics education through dynamic visualization, automated reasoning, and interactive learning. These findings highlight the transformative potential of AI-driven platforms and the importance of addressing their limitations to ensure secure, equitable, and effective educational adoption. Future research should examine the growing impact of Large Language Model (LLM)- enabled mathematical tools on teaching, learning, and assessment in mathematics education.

Keywords: AI-driven Platforms, Computational Tools, Technology Integration, Artificial Intelligence, Mathematics Education, Secondary Education.

ECRISA039

QUANTUM NEURAL NETWORKS IN THE NISQ ERA: ARCHITECTURES, CHALLENGES, AND APPLICATIONS

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Abstract

Quantum Neural Networks (QNNs) have emerged as a promising paradigm at the intersection of quantum computing and machine learning. As we advance through the Noisy Intermediate-Scale Quantum (NISQ) era, these models offer both opportunities and challenges. On the one hand, QNNs promise novel ways of representing data and solving problems in domains ranging from pattern recognition to scientific simulation. On the other hand, their development is hindered by practical constraints such as hardware noise, limited qubit counts, and difficulties in training. This paper provides a concise overview of QNN architectures and training strategies, highlights key open challenges, and discusses their implications for near-term quantum computing. To make the field more accessible, we also provide a tutorial-style example that constructs and trains a simple four-qubit QNN classifier on the two-moons dataset. In this illustrative ex ample, the QNN model achieves test accuracy in the range of $92 \pm 2\%$ and we include a small multilayer perceptron as a classical baseline to contextualize performance. Our goal is to present a balanced resource that both introduces the fundamentals and reflects the current perspectives serving as a guide for new comers and practitioners.

Keywords: Quantum Neural Networks, Variational Quantum Circuits, Quan tum Machine Learning, Noisy Intermediate-Scale Quantum computing

AUTOMATED EVALUATION OF HANDWRITTEN ANSWER SCRIPTS USING VISION-LANGUAGE MODEL AND SENTENCE TRANSFORMATION

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Abstract

The handwritten answer scripts take a lot of time, effort to be evaluated subjectively, as well as less scalable, because an effective learning process is very much dependent on timely feedback. A computer-based evaluation system that combines Vision-Language Modeling with Sentence Transformation was developed and used in this study, that detects text from handwritten answer scripts and uses keyword comparison for evaluation. The key methodology consists of allenai/olmOCR-7B-0725 Vision-Language Model based on handwritten text recognition and all-MiniLM-L6-v2 utilizing semantic similarity estimation against reference model answers. The system performs a full image preprocessing arch, i.e., noise reduction, binarization, and skew removal, to maximize the accuracy of text recognition. Then it calculates the cosine similarity of 384-dimensional representations of the text in the handwritten responses and the model answers to compute assessment scores. With the use of 75 handwritten answers in the diverse fields of education, the experimental validation demonstrated the Word Error rate of 7.11% in text recognition, which is much lower than that of the traditional Optical Character Recognition system with 15.0-25.0% error rate. The proposed system had a Mean Absolute Error value of 1.000 and a Pearson correlation coefficient of 0.705 with the manual grading criteria, which is closer to the inter-rater reliability values of human assessors. The mean processing time was 19.18 seconds per answer script. This enables performing real-time assessments, which would be appropriate in large-scale educational settings. The automated evaluation scores were compared with human evaluation scores to determine its accuracy and effectiveness. The results indicate that this study would introduce an effective synthesis of the artificial intelligence capabilities in education assessment that is scalable, to overcome issues of manual grading as well as assessment consistency. The study provides an automated solution that can be used in formative assessment practices that can expedite the evaluation and feedback in a learning process.

Keywords: Handwritten text recognition; Vision-language models; Automated assessment; Educational assessment; Automated grading, Semantic similarity

BENCHMARKING CODE GENERATION MODELS FOR QUANTUM COMPUTING: LARGE LANGUAGE MODELS VS. FEYNMAN MULTI-AGENT SYSTEM ON IBM QISKIT V2

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Abstract

The emergence of large language models (LLMs) has enabled the automated synthesis of code across a broad range of programming domains. Here we report a systematic evaluation of single-agent and multi-agent model architectures in generating executable code for the Qiskit quantum computing framework. We assess model performance along multiple dimensions, including success rate, prompt-specific ac curacy, convergence dynamics, reliability across diverse quantum programming tasks, and inter-model consistency. Using a curated dataset of Qiskit prompts, we benchmark two single-agent models (GPT-5 and Claude Sonnet 4) against two multi-agent systems (Multi-agent V1 and V2). Our experiments show a clear and statistically significant performance advantage for multi-agent architectures. Multi-agent V2 and V1 achieved success rates of 100 per cent and 98 per cent, respectively, with high first-attempt accuracy and rapid convergence over iterative trials. They exhibited robust and consistent behaviour across task categories, whereas single-agent models particularly GPT-5 showed variability and incomplete execution on complex prompts. Statistical analyses, including hypothesis testing and effect size estimation, corroborate these findings. The results indicate that multi-agent systems can deliver more reliable and efficient solutions for domain-specific code generation, marking a substantial advance toward automated programming in specialized fields such as quantum computing with Qiskit.

Keywords: Quantum Computing, IBM Qiskit v2, Quantum Code Generation , AI Code Generation , Multi Agent Systems

NATURAL LANGUAGE INTERFACES FOR NETWORK CONFIGURATION USING LARGE LANGUAGE MODELS: BUILDING HUMAN INTENT AND AUTONOMOUS NETWORK MANAGEMENT

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Abstract

Modern network infrastructures, characterized by their scale, heterogeneity, and complexity, have rendered traditional manual management paradigms untenable. The operational friction and high error rates associated with command-line interface (CLI) configurations necessitate a shift towards greater automation. Intent-Based Networking (IBN) offers a promising abstraction by separating an operator's goal ("what") from the underlying implementation ("how"). However, the translation of ambiguous, high-level human intent into precise, low-level network policies remains a significant challenge. This paper proposes that combining IBN with Large Language Models (LLMs) is a game-changing solution. We present the Intent-LLM Translation and Verification Loop (ILTV-Loop), a new way to connect human language and autonomous network operations. The ILTV-Loop has a multi-modal intent interface, an LLM-powered translation engine, a dynamic knowledge base, and a module for critical verification and explainability. This closed-loop system not only creates multi-step, vendor-agnostic configurations from natural language, but it also formally checks their correctness and gives human-readable explanations, which builds trust in the operators. We look at the main parts of this method, its security risks, and its ethical issues. We see the ILTV-Loop as a first step toward network management that is truly autonomous, resilient, and focused on people.

Keywords: Network Automation, LLM, Natural Language Interfaces (NLI), IBN, Formal Verification, Explainable AI (XAI)

FUSION-BASED DEEP LEARNING APPROACH FOR COMPREHENSIVE HUMAN BEHAVIOR ANALYSIS FROM VISUAL CUES

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Abstract

Facial recognition is an essential component of computer vision, with applications in healthcare, behavioral science, security, and human–computer interaction. However, most existing techniques treat age estimation, emotion recognition, and personality prediction as separate problems, overlooking the natural relationships among these attributes. This study addresses that gap by introducing a unified Multi-Task Learning (MTL) and fusion-based framework capable of predicting all three characteristics simultaneously from facial data. The proposed model integrates three benchmark datasets: UTKFace for age estimation, FER2013 for emotion recognition, and the ChaLearn First Impressions dataset for personality analysis. Comprehensive preprocessing ensured data balance, consistency, and compatibility across tasks. The architecture employs Convolutional Neural Networks (CNNs) enhanced with attention mechanisms and transfer learning to extract high-quality feature representations. A combination of classification, regression, and ensemble learning methods was used to improve predictive accuracy and model robustness. Experimental results demonstrate that the MTL model outperforms individual single-task models. The system achieved 92.14% accuracy (F1 = 0.9213) in age-group classification, a real-age estimation performance of MAE = 5.40 years with R^2 = 0.91, and 69% accuracy for seven-class emotion recognition. Personality prediction also showed strong reliability. A fusion model further boosted the overall predictive power to 88.97%. Beyond performance, the research emphasizes ethical considerations, including privacy protection, bias reduction, and informed consent. These measures promote responsible and fair deployment of facial analysis technologies. The findings highlight the potential of holistic, ethically aligned facial analysis systems for applications in medical diagnostics, personalized e-learning, adaptive interfaces, and behavioral assessment.

Keywords: Multi-Task Learning (MTL), Facial Feature Analysis, Deep Learning, Ensemble Learning, Convolutional Neural Networks (CNNs)

POSTER PRESENTATION

JUDGE PANEL

DR. AJITH PASQUAL

DR. JANAKA ADASSURIYA

DR. GAYANTHA KODIKARA

INTEGRATED CONTROL SYSTEM FOR INDUCTION MOTORS WITH VFD, PID, PLC, AND HMI

Vijayasothy Vijayagopal [1], N.D.S. Jayawardene[1], Vijayagopal Vijayavahini[1], U.D. Niriella[1], S.K. Vijithananda[1], P.K.P. Anuruddha[1]

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Abstract

Induction motors are widely used in industrial applications because of their simple operation. High efficiency, less expensive than other motors with similar performance and very little maintenance (no brushes need to be replaced). The speed of an induction motor can be controlled by employing several techniques, such as the voltage control method and the frequency control method, etc. Frequency control is a widely employed technique, particularly useful in variable speed applications that require a wide speed range, torque control, energy efficiency, and lower mechanical stress. While most variable frequency drives (VFDs) feature built in PID controllers, their internal functions often come with limitations in terms of tuning flexibility, feedback compatibility, and integration into modern automation systems. Effective speed control is crucial in many processes. To achieve accurate and flexible speed regulation, this study offers an integrated motor control system that makes use of a PLC-based PID controller, encoder feedback, and an HMI interface. Customized logic, improved monitoring, and smooth VFD coordination are made possible by the PLC's execution of the PID algorithm. When compared to depending only on the internal PID of the VFD, experimental results show that the external PLC PID setup offers better control accuracy, dynamic response, and operational flexibility. While this work concentrates on a PLC-based PID loop, advanced control concepts like gain scheduled PID, anti-windup strategies, and feed-forward compensation can be used to improve the system. These enhancements can help to reduce overshoots, improve tracking, and increase stability under varied load and speed situations.

Keywords: Human Machine Interface (HMI), Variable Frequency Drive (VFD), Programmable Logic Controller (PLC), Proportional Integral Derivative Controller (PID controller).

DESIGNING A BLOCKCHAIN-POWERED HEALTHCARE DATA MANAGEMENT SYSTEM TO ENHANCE SECURITY AND PRIVACY

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Abstract
Nowadays, traditional medical data is used as Electronic Health Records (EHR). These EHRs suffer from data fragmentation across siloed hospital databases, vulnerability to centralized breaches and lack of patient sovereignty over their sensitive medical information. This research aims to design a blockchain-powered platform to address the above challenges while creating a secure, transparent, and patient-centric healthcare data ecosystem. This study shows the successful utilization of a hybrid architecture, using the Ethereum blockchain for secure access logs and consent management. In this study, the sensitive medical files of patients are encrypted on the client-side using AES-256 + GCM and stored on a decentralized off-chain network (Storj). The access to the data is controlled by Solidity smart contracts, which enforce a hybrid Role-Based (RBAC) and Attribute-Based (ABAC) control model. This ensures only authorized stakeholders can access data under patient-defined conditions. This developed system automates data-sharing processes and ensures auditable compliance with patient consent. The implemented prototype evaluated its security, performance, and usability under testing, and the results demonstrate that patients with direct control over their records. As a result of the research this study establishes a practical blueprint for a decentralized, transparent, and efficient future in health information management. The proposed framework not only strengthens security but also fosters interoperability across healthcare providers, reducing duplication of medical records. This system achieves scalability without compromising privacy by integrating blockchain with decentralized storage. The hybrid Role-Based Access Control model introduces Specific access control, ensuring flexibility for diverse medical use cases. This approach demonstrates practical possibilities for adherence to different data protection regulations. Future research studies can expand this model predictive healthcare analytics by incorporating artificial intelligence.

Keywords: EHR, Blockchain, Cryptography, Smart Contracts, Access Control

ENHANCED EEG BASED USER AUTHENTICATION USING MACHINE LEARNING OPTIMIZATION

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Abstract

Electroencephalogram (EEG) presents a unique opportunity for biometric authentication that is hard to spoof due to complex neural patterns and can be acquired with low-cost hardware. This study ad dresses three key limitations; dependency on expensive medical grade equipment, reliance on handcrafted feature extraction, and lack of systematic protocol comparison. We propose a practical framework using an OpenBCI Cyton board (8 channels plus reference/ground) and three short cognitive protocols eyes closed with audio, number watching, and number imagining designed to elicit reproducible neural patterns. Seven participants completed 10 sessions each with standardized 30 second recordings. EEG data were preprocessed using band pass, notch, and moving average filtering, then classified directly without manual feature engineering using Support Vector Machine, K-Nearest Neighbors, and Random Forest models optimized per state. KNN and RF achieved 92.86% accuracy; number watching and number imagining states reached 91.30±2.2% accuracy with minimal overfitting (RF gap:-0.022). Fivefold cross validation confirmed stability (F1 > 90%), and all models trained in seconds on a laptop. Results demonstrate that low cost hardware and raw signal pipelines support efficient EEG based identification, motivating future work on authentication grade metrics (FAR, FRR, EER) and larger session disjoint cohorts for cyber physical deployment.

Keywords: Electroencephalography, EEG based authentication, Raw EEG data, Machine learning, OpenBCI, Cognitive state protocols, Low-cost biometrics

SELF-DEFENDING SMART NETWORK WITH ML-POWERED INTRUSION DETECTION AND RESPONSE

R.M.S. Madushan[1], G.A.S. Malinda[1], S.G.N. Thilakarathna[1], T.S.U.M. Wijayarathne[1], R. Saahith Ahamed[1], A. Affin Ajanthan[1], and T.N. Weerasinghe[1]

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Abstract

With the increasing complexity of cyber-attacks, modern networks re-quire smart and flexible security measures, yet traditional Intrusion Detection Systems (IDS) with fixed, signature-based configurations struggle to detect and respond to intrusions in real-time. Traditional IDS largely rely on predefined rules and known attack patterns, which limits their effectiveness in dynamic en-vironments such as Software-Defined Networking (SDN). To address these lim-itations, this work designs and evaluates a self-defending smart network using an SDN framework combined with Machine Learning (ML) for automated intrusion detection and response. A Mininet-based SDN testbed was created with Open vSwitch (OVS) in the data plane and a Ryu controller in the control plane, ena-bling real-time flow monitoring, feature extraction, and classification of Denial of Service (DoS), Distributed Denial of Service (DDoS), Probe, Brute Force Au-thentication (BFA), and User-to-Root (U2R) attacks. The intrusion detection pipeline integrates frequent pattern mining with an Iterative Dichotomiser 3 (ID3) classifier: Apriori-based patterns enhance decision boundaries, while SHapley Additive explanations (SHAP) guide feature selection and improve transparency in classifier decisions. The optimized ID3 model achieves high real-time detection accuracy across all attack classes, and an automated threat-re-sponse mechanism installs OpenFlow rules to block malicious sources in the data plane. Experimental results show over 99% testing accuracy and effective miti-gation in the emulated SDN environment, demonstrating a practical self-defend-ing SDN security framework that unifies ML-based intrusion detection, pattern mining, and XAI-driven explainability in a single controller-driven pipeline.

Keywords: SDN, Intrusion Detection, Machine Learning, Pattern Mining, Ex-plainable Artificial Intelligence (XAI), OpenFlow.

USAGE OF ARTIFICIAL INTELLIGENCE IN DEVELOPMENT AND IMPROVEMENT OF PLANT-BASED MEDICINE

D. M. Costa[1], R. Rasika[1], D. L. J. H. Wimalajeewa[1], M. M. S. Dharmasena[1], Y. Weerasinghe[1], H. G. S. S Hettigoda[1], K. A., K. G. M Dharmasiri[1], S. A. K. Sapumohotti[1], Abid Yahya[2], U. P. Liyanage[3] and D. N. A. W Samarakoon[1*.]

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Abstract

The integration of Artificial Intelligence (AI) into phytomedicine has transformed modern drug discovery and development. AI offers computational tools to overcome the challenges in identifying, standardizing, and extracting complex bioactive compounds from medicinal plants. The use of AI and computational biology is accelerating the development of effective plant-based medicines. This review aims to explore the main AI tools used in plant-based drug development, focusing on their role in compound identification, extraction and separation of bioactive compounds. The study was conducted using the PRISMA 2020 guideline using Google Scholar (42), PubMed (3), ResearchGate (12), Scopus (6) and Web of Science (4) databases. "AI", "drug discovery", "modern technology", "phytomedicine" and "plant-based medicine" were used as keywords and targeting publications from 2015 to 2025. From 67 retrieved articles, 20 met the inclusion criteria after screening. The applications of AI significantly increase the efficiency of compound identification and molecular characterization, target prediction, virtual screening, in silico bioactivity modeling and ethnobotanical analysis. Machine learning (ML) algorithms such as regression models (support vector machines (SVM) (35%) and generative models (Generative Adversarial Network (GAN) (20%) combined with computer vision, improve plant species identification using morphological and molecular features. These tools simplify the traditionally complex process of isolating pure compounds by uncovering structural relationship within large natural product databases. The screened articles prove that the usage of novel AI tools such as SVM and GAN, DI models analyzing mass spectrometry data plays a crucial role in accelerating phytomedicine research and supporting the development of effective plant-based therapeutics.

Keywords: Artificial Intelligence, Bioactive compounds, Drug discovery, Medicinal plants, Phytomedicine

ECRISA049

LEVERAGING ARTIFICIAL INTELLIGENCE FOR SMART DIET PLANNING AND NUTRITIONAL GUIDANCE: A DIGITAL TOOL FOR NUTRITION PROFESSIONALS

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Abstract

Diet-related non-communicable diseases such as obesity, diabetes, and cardiovascular disorders have emerged as major global health concerns, primarily driven by unhealthy dietary habits and sedentary lifestyles. This has intensified the need for efficient and personalized nutrition guidance to support preventive healthcare. Traditional dietary assessment methods are time-consuming, memory-bias and are complex to address individual variations in health conditions. Furthermore, nutrition professionals are required to spend significant time on obtaining dietary recalls, manually calculating nutrient and energy needs, limiting their capacity to provide effective patient-centered care. To overcome these challenges, this study introduces an artificial intelligence (AI)-integrated digital platform designed for personalized diet planning and nutritional guidance. The primary objective of the study is to develop an AI-powered nutrition platform for professional use by incorporating novel calorie calculating systems and evidence-based nutritional knowledge into the platform. The developed tool allows users to upload photographs of daily meals, from which it automatically identifies food items, estimates nutritional composition and calorie content. It automatically calculates energy intake, Basal Metabolic Rate (BMR), energy expenditure, and activity level of a person. The platform, accessible via https://edietetics.com, was specifically developed to assist nutrition professionals in delivering data-driven, efficient, and adaptive dietary guidance. The system was evaluated by 32 nutrition professionals, and 90.6% of them recommended its use to other professionals. Almost every participant agreed that it also incorporated local Sri Lankan food preferences. Overall, this study highlights the transformative potential of artificial intelligence in digital nutrition, empowering nutrition professionals while promoting sustainable and preventive dietary practices.

Keywords: Artificial Intelligence; Personalized Nutrition; Diet Planning; Nutritional Guidance; Digital Nutrition

INFORMATION DISTILLATION TRANSFORMER WITH LAYER SCALED WEIGHT SHARING AND POOLED SPATIAL GATING FOR EFFICIENT SUPER RESOLUTION

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Abstract

Transformer-based Super-Resolution (SR) models achieve state-of-the-art performance through their capacity to model long-range dependencies. However, their substantial computational complexity precludes real-time deployment on resource-constrained devices. To overcome this limitation, we propose a Weight Sharing Information Distillation Network that maintains competitive performance while dramatically reducing computational overhead. Our framework integrates three core innovations: a channel bottleneck employing lightweight pointwise projections for transient feature compression, layer-scaled weight sharing that binds a single attention module across multiple refinement steps with learnable per-layer scale factors and Enhanced Spatial Attention Lite (ESA Lite) for efficient pooled spatial gating on down sampled representations. This unified design substantially reduces FLOPs, activation memory, and parameter count while preserving representational fidelity and spatial selectivity, enabling improved inference speed. Extensive experimental validation demonstrates that our method achieves competitive performance with state-of-the-art approaches while delivering significant computational savings, enabling practical real-time SR.

Keywords: Image Super resolution; Layer -Scaled weight sharing; Efficient Super resolution; Information distillation transformer.

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