



15TH INTERNATIONAL RESEARCH CONFERENCE

*Economic Revival, National Security, and Sustainability through
Advancement of Science, Technology, and Innovation*

29TH - 30TH SEPTEMBER 2022

ENGINEERING

ABSTRACTS



GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY



15TH INTERNATIONAL RESEARCH CONFERENCE

ECONOMIC REVIVAL, NATIONAL SECURITY, AND SUSTAINABILITY
THROUGH ADVANCEMENT OF SCIENCE, TECHNOLOGY, AND INNOVATION

ENGINEERING

ABSTRACTS



General Sir John Kotelawala Defence University
Ratmalana, Sri Lanka

This book contains the abstracts of papers presented at the Engineering Session of the 15th International Research Conference of General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka held on the 29th and 30th of September 2022. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form, without prior permission of General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka.

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Message from the Secretary, Ministry of Defence



I am indeed delighted to pen this message whilst extending my earnest felicitations to the KDU on this significant occasion of the annual International Research Conference. At this juncture, I would also like to congratulate the Vice-Chancellor and the team for continuing the tradition of organising this conference consecutively for the 15th time, despite the numerous economic and social challenges faced by the country in the post-COVID environment.

Further to that, I am delighted to perceive that this year's conference theme; 'Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation' focuses on the National Economic Growth and National Security as core concepts, and suggests that 'economic development' and 'security' of a country should always go hand in hand. Therefore, this conference would undoubtedly become a forum for academia to discuss an area of absolute need in the development interests of our motherland.

Moreover, I am pleased to witness that KDU, under our ministerial guidance, is setting an example for all other universities in Sri Lanka in progressing research in many academic fields. I hope this year's conference will produce a significant research outcome that the policy community of Sri Lanka could utilise to support the present development drive of the country. Further, I would like to urge the conference organisers to explore the possibility of distributing the outcomes of the conference to all the relevant Ministries and Departments of the country so that said entities could link with the researchers and employ their valuable research outcomes for the benefit of the nation.

I wish that KDU IRC 2022 will enhance the wisdom of all the participants to serve Mother Lanka for a better tomorrow.

GENERAL KAMAL GUNARATNE (Retd)

WWV RWP RSP USP ndc psc MPhil
Secretary - Ministry of Defence

Message from the Keynote Speaker



It gives me immense pleasure to send this message on the occasion of the 15th International Research Conference of the General Sir John Kotelawala Defence University (KDU). I would like to congratulate KDU for being able to conduct its International Research Conference in 2022, consecutively for the 15th time. It is not an easy task to organize such a momentous event particularly under many difficulties and challenges posed by the COVID 19 pandemic situation and social and economic crisis. It is gratifying to witness that KDU, the only Defence University in the country, has been able to transform a challenge into an opportunity, as it usually does.

The theme of the conference, namely the “Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation,” is very timely and of great significance for deliberation in expert panels of this conference. The nexus between National Growth and National Security is closely interwoven. The ‘economic revival’, ‘sustainability’ advancement’ and ‘security’ of a country cannot be compartmentalized and discussed in isolation of each other. There is no security for a nation without economic and social progress, and likewise, economic and social progress cannot be achieved without stability and a secure environment. I hope various panels of this conference will be able to discuss many facets of economic revival, national growth, sustainability and security and their interconnectedness. These two areas have a direct bearing on the development of Sri Lanka, a country which succeeded in ending a 30-year long separatist war. In the context of the present need for robust development, it is absolutely necessary to engage in serious research which leads to discoveries as well as policy-oriented recommendations. Therefore, all academic establishments must provide a conducive space for their intellectuals to reach new frontiers in research. I am glad that KDU is setting an example for all other universities in Sri Lanka in this regard. I hope this year’s conference will produce significant research outcomes that the policy community in Sri Lanka could utilize for the benefit of the country. I wish this conference all the success.

HON PROF SUBRAMANIAN SWAMY

Former Minister of Commerce, Law & justice, India

Message from the Vice Chancellor



The International Research Conference (IRC) of General Sir John Kotelawala Defence University held for the 15th consecutive year is significant in terms of the continued contribution of the University to the field of research in diverse disciplines much needed for the progression of the nation, especially in the face of unprecedented challenges caused by the COVID-19 pandemic and the current economic crisis in the country.

The conference themes carefully selected by KDU each year have addressed contemporary needs of the country that are linked up with national security perspectives, and they are complementary to the development paradigm of the country. This year's theme "Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation" encompasses a wide range of research possibilities for scholars of different disciplines to engage in much useful research relevant to the current issues faced by the nation.

It is heartening to note that the number of papers submitted for the conference has increased despite the challenging circumstances, which is a positive indication of the enthusiasm growing in the country on development and security related multi-disciplinary research. In this respect, I am extremely glad that the KDU's efforts in expanding higher educational opportunities, increasing quality of higher education, enhancing research and innovation, linking up research with the industry and so on have increasingly been acknowledged by many, which is also reflected in the Times Higher Education Impact Ranking, 2022 table, where KDU has been ranked 2nd in Sri Lanka for Quality of Education and 4th in the overall ranking in the country and in the 801-1000 range globally.

KDU IRC also creates a sound platform to initiate collaborative research at both national and global levels, and I invite all participants to use this conference to make lasting and productive connections and networks at the individual, institutional, national, and international levels to envisage and explore mutually beneficial research possibilities and higher education experiences for the future.

While appreciating the commitment of the organizers of this year's conference, I wish you all, the presenters and participants taking part in the conference all the very best, and I hope you will enjoy every moment of this two-day academic endeavour.

MAJOR GENERAL MILINDA PEIRIS

RWP RSP VSV USP ndc psc MPhil (Ind) PGDM
Vice Chancellor
General Sir John Kotelawala Defence University

Message from the Conference Chair



For the 15th consecutive year, General Sir John Kotelawala Defence University (KDU), organises its International Research Conference (KDU IRC 2022) under the theme of “Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation”. It is with great pleasure and honour that the organising committee extends its compliments to all of you taking part in KDU IRC 2022. Holding the KDU IRC 2022, under the patronage of the Vice Chancellor, amidst many challenges encountered throughout the year, was a remarkable experience for me. I believe that the organising committee accomplished a very successful mission.

Despite the economic crisis, KDU IRC 2022 is a tremendous opening for many researchers all over the world encompassing various disciplines such as Defence and Strategic Studies; Medicine; Engineering; Management, Social Sciences and Humanities; Law; Built Environment and Spatial Sciences; Allied Health Sciences; Basic and Applied Sciences; Computing; Criminal Justice and Technology to present their research to fellow scholars, professionals, and students.

In this context, we have assembled excellent thought-provoking scientific sessions under the conference theme of this year, and it is remarkable to highlight your participation, at this conference through a highly competitive selection process. In addition, world-renowned invited speakers will deliver keynote and plenary speeches while covering a wide range of important sessions with great networking opportunities and providing solutions using science, technology, and innovation. It is the esteem of the conference to bring together a diverse group of people to disseminate high-quality and novel research results, which will assist to chart our journey forward to reach new heights.

Finally, I would like to extend my best wishes to all the presenters, authors and participants, joining the KDU IRC 2022 on site or online, and I hope that all of you will find this conference informative, enjoyable, and encouraging to feel the experience of KDU hospitality during these two fruitful days.

DR KALPA W SAMARAKOON

PhD, MSc, BSc, MACS (USA), M.I.Biol (SL), C.Biol (SL)
Conference Chair
General Sir John Kotelawala Defence University

Message from the Conference Secretary



Together with the committees and participating academia of this university, I share the immense pleasure and honour of perseverance with the 15th International Research Conference of KDU (KDU IRC 2022), amidst many challenges, under the patronage of our Vice Chancellor and Deputy Vice Chancellor.

The timely congregation for IRC 2022, of all our staff, students and contributors from faculties all over the world, under the theme “Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation”, is of paramount importance in this current climate of the global recession.

Whilst thanking all of you, I express my sincere hope that this would be an ideal platform for academia and professionals to discuss economically viable intelligent solutions for diverse problems for the nation to emerge stronger out of the recession, with the ability to provide equitable health, food, and social security, quality education, and enforcement of law and order in our country, for the betterment of our society.

DR PANDULA ATHAUDA-ARACHCHI

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ORAL PRESENTATIONS

Home Automation Application using Raspberry Pi 3 and Windows 10 IoT

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In the present situation demand for electricity stack, up with population growth, is one of the major challenges all over the world. Inadequate amounts of electricity create an awareness to conserve energy in all viable methods. As a result, we made an appliance to minimize the energy wastage by the concern of Smart Home. Home automation refers to controlling home appliances and domestic features by local networking or remote control. The devices' respective apps in smart homes allow users to track energy usage over time. They can also get an estimate of how much they are paying for whatever they have plugged in. By and by, this will have an impact on consumer behaviour and will help people to be more energy conscious and, in the long run, responsible. Apart from that, the current commercial home automation systems are general, and they have not been specifically designed for the Sri Lankan context. So, we designed a smart home automation system with the sense of Sri Lankan electricity tariffs and practices. This scheme involves the design and construction of individual control home appliances using Raspberry Pi 3, Arduino, and Windows 10 IoT core. This combination can implement the primary home automation functions by using numerous sensors, and with that it will deliver suggestions and illustrate the process of the electricity tariff system to the users. With this attempt, the consumer can reach optimum power consumption.

Keywords: *raspberry Pi, arduino, smart home automation, power measurement, IoT*

Intelligent Battery Control Mechanism for Electric Bicycle

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Transportation is a basic requirement of humans. Currently, fossil fuels are the main source used in automobiles, and the trend is moving towards electric vehicles, which is more environmentally friendly. Battery is one of the main components in an electric vehicle. This paper aims to introduce an intelligent battery control system which integrates a dual battery mechanism and four riding modes. Two lithium-ion battery packs with 48V and 16AH each are used. Full electric, paddle assist, neutral and continuous charging are the four driving modes. The paddle assist mode is implemented with new control mechanism, and continuous charging is a new concept to E-bicycles. An alternator is used as an energy harvesting mechanism. The state of charge of each battery pack is automatically detected and the pack with lower state of charge is assigned to store the energy harvested from regenerative mechanism. The battery pack with higher state of charge is allotted to drive the bicycle. The system will automatically interchange the role of each pack when the driving pack reaches to its acceptable minimum state of charge. The proposed system will allow both battery packs to charge or discharge within its full nominal range which is not linear. Thus, it allows an increase in per charge travelling distance. The inter connection between subpacks are controls through a relay panel based on voltage readings. Finally, the bicycle was subjected to road trials under three riders with different weights. The proposed system helps to cover 41.6km under electric mode and covers 49.4km in paddle assist mode. Bicycle needs to cover 61km in continuous charging mode to fully charge the battery.

Keywords: *e-bicycle, dual-battery mechanism, driving modes*

Comparison of Printed Circuit Board Fabricated by using Conventional Method and Laser Cutting Method

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There are multiple methods of manufacturing printed circuit boards (PCB). The approach used by electronic enthusiasts is ironing the circuit from the glossy paper onto the copper plate (the homemade method). Industrial PCB manufacturers use laser cutting or computerized numerical control milling to cut the pathways, thus etching the circuit on the board. The former is time-consuming and the latter carries the risk of damaging the board during the manufacturing process, in addition to several other drawbacks. The approach that is presented in this paper avoids these disadvantages. In the proposed method, a polyvinyl chloride sticker is pasted on the copper board and unwanted sections of the sticker are removed by using laser cutting. Subsequently, the copper board with the sticker is immersed in a ferric chloride solution, washed off and the remaining parts of the sticker are removed. The advantages of this approach are the capability of accurately obtaining fine tracks (of 30 mil in width) and being comparatively less time-consuming than other methods used by electronics enthusiasts. In this paper, the procedure for making a PCB with the proposed method is laid out. Then, the function and design of a low-power laser cutter to accomplish the former is discussed.

Keywords: *printed circuit board, laser cutting, polyvinyl chloride sticker*

CREEPER: The First Indigenously Developed Hand-held Digital Mobile Radio (DMR) in Sri Lanka

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Communication plays a crucial role in the context of military operations. The Revolution of Hand-Held radio from Analogue to Digital Technology reached up to many advanced radios with the application of Modern Technology. A famous means of communication which is utilized in modern military warfare is Digital Mobile Radio (DMR). However, due to highly expensive DMRs, it cannot be easily catered to suit various requirements. This paper aims to discuss the first Hand-Held DMR designed and developed for the Sri Lanka Military named the Creeper (The unique bird who can sing vast frequency bands). Creeper aims to reduce the capital cost investment on expensive DMR and provide flexibility for future improvements. The Creeper DMR is checked against existing DMRs such as Racal Cougar, tested on the field, and many improvements were made. A Voice Coder (Vocoder) is used to meet the VHF frequency bands designed and then further developed to work on both VHF and UHF bands. The test results were satisfactory in the field and it is currently being used by Tri-services in Sri Lanka. Creeper has successfully provided a cost-effective solution and would stand out as possible future foreign market.

Keywords: *creeper, digital mobile radio, military communication, UHF, VHF*

A Numerical Study on Effect of Change in Longitudinal Centre of Gravity on Planing Capability of a Coastal Patrol Craft: A Case Study, Sri Lanka Navy

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The pressure that acts on the wetted surface area of coastal petrol craft always maintains the equilibrium with the weight of the vessel. The acting pressure comprises of two elements, i.e. hydrostatic which relates to buoyancy and hydrodynamic which relates to speed of the vessel. The authors were involved in planning a novel design of a monohull Coastal Patrol Craft with unknown capabilities of dynamic behaviour with planning at initial stage. The research objectives were to estimate the total weight, compare resistance for different LCG positions, and the dynamic wetted area comparison for different LCG positions, Effective power demand comparison for different LCG positions, dynamic trim comparison for different LCG positions, and Planning capabilities for different LCG positions. Five different LCG positions were considered during the study to realize the craft's behaviour. According to the numerical approach, craft's behaviours explored with the change in LCG positions and anticipated effect on the resistance, effective power demand, dynamic trim, and Planning capabilities. Based on the results, a small initial trim angle is required for the CPC to display optimal performance at speeds in the upper range of the planing regime. On the other hand, an initial trim by aft would increase the performance of the CPC at speeds lower than the planing region but would adversely affect the performance at higher speeds as the trim further increases due to dynamic behaviour. Further, this increase in trim at higher speeds would result in dynamic instability and be detrimental to the performance of the craft.

Keywords: *longitudinal centre of gravity, planing, hydrodynamic forces*

Novel Design of Cost-effective Solar Powered Brackish Water Reverse Osmosis Plant: A Possible Solution for an Affordable Supply of Safe Drinking Water for the Rural Communities in CKDu-affected Areas in Sri Lanka

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The government of Sri Lanka has established a Community-Based Organization (CBO) to supply safe drinking water on a payment basis through the application of electrically driven Brackish Water Reverse Osmosis (BWRO) plants in CKDu-impacted areas. Due to major drawbacks such as cost, issues in regular maintenance, membrane clogging, lack of expertise to rectify the defects encountered in electrically driven BWRO plants, etc. In this design, a multistage centrifugal high-pressure pump was integrated with the BWRO plant drastically bringing down the manufacturing cost. Then, evaluate the performance of the Brackish Water Reverse Osmosis system powered by solar electric energy under Sri Lankan weather, and environmental circumstances, and enhance the recovery ratio up to 75% through an automated mixture. The novel design of the solar-powered BWRO plant can be manufactured locally at a low cost, and hence it would be the ideal replacement for imported BWRO plants to provide high-quality drinking water for the farming community who could not have sufficient wealth to obtain safe drinking water on a payment basis. The solar-powered BWRO plant considerably reduces the government overheads to reduce the water purification cost up to 90% of the existing expenses. Further, it leads to protecting the environment by reducing Green House Gas (GHG) emissions with a more than 75% of recovery ratio. Further, cost comparison of SLN manufactured BWRO vs imported BWRO in a similar capacity revealed that the SLN-manufactured BWRO plant was 7fold cheaper than that of the imported BWRO plant.

Keywords: *brackish water reverse osmosis, chronic kidney disease, safe drinking*

Design and Development of an Autonomous Underwater Vehicle (AUV): For Rip Current Data Collection and Shallow Water Explorations

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Autonomous Underwater Vehicle is an emerging trend in the modern maritime scenario. Though there are various developed designs, researchers are keen on developing more manoeuvrable, stable and enduring structures with improved capabilities. Based on utilization, AUVs can be divided into two major categories; Deep-water operated and shallow-water operated. The purpose of the AUV designed and developed in our study is two-fold; this can be utilized for rip current data collection and shallow water exploration operations. However, the project is planned under two phases and this paper only describes the design and constructional aspects of the vessel with improved stability, manoeuvrability and lighting capability. On achievement of the full design, it will enable precise rip current data collection and conduct shallow-water exploration operations in both sea and freshwater streams with an online video streaming facility. In the present context, such operations are undertaken in the presence of a diver and our new design eliminates the need of a diver.

Keywords: *Autonomous Underwater Vehicles (AUV), manoeuvrability, stability*

Indigenously Designed Addressable Bilge Alarm System for Naval Vessels

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The primary purpose of an Addressable Bilge Alarm Panel is to provide an early warning of the bilge level of a vessel so that the personnel, equipment and valuable resources can be protected and action can be taken to remove bilges as soon as possible, all according to a predetermined plan. This study presents aspects of the bilge alarm system on-board Sri Lanka Naval Ship (SLNS) Sagara, by analysing the existing system based on automation and advanced microcontroller programming using Raspberry Pi3, and ATMEGA 328P microcontrollers. The designed system is an addressable type bilge alarm system that communicates in serial RS 485. The novelty of the designed system are the own data protocol used in RS 485 communication, voice command of specific bilge location and the self-designed advanced graphical user interfaces (GUI).

Keywords: *Bilge alarm, communication protocol, GUI*

Thermographic Inspection System for Surface Coating Defects on Aircraft Fuselage

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Aircraft outer shell is coated with a corrosion resistant layer because its alloy does not possess sufficient intrinsic resistance to wear and corrosion. Impacts by small particles or large objects such as bird strikes can lead to damage the coated surface inducing surface defects. Micro cracks initiated due to surface damages create stress concentration zones which could lead to catastrophic failure of the aircraft due to fatigue crack formation. Therefore, the importance of regular inspection of surface coating is highlighted. Visual inspection is widely used for surface damage identification, but manual procedures with the bare eye are time-consuming and lead to human errors. Effective automation of the inspection can be considered a viable solution. The aim of this project was to develop an automated inspection system based on non-contact, non-destructive Infrared Thermography to identify defects on an aircraft's surface coating. The system developed was a two-axis gantry attached to a four-wheel structure equipped with a tiltable thermal camera assembly and a control panel. The inspection method follows a sequence – Firstly, thermal image capturing, secondly image processing and identifying the defective area, and thirdly, giving a signal to the operator if a defect is present. The system was tested on a significant dataset, and its capability of detecting surface defects on an aircraft's coating was demonstrated. The results suggest an automated thermographic inspection system for surface coating defects on aircrafts can successfully replace visual inspection leading to a 9.25 % increase in efficiency minimizing its inherent disadvantages.

Keywords: *thermographic inspection, aircraft defect detection, image processing*

Estimation of Lift Hysteresis of an Airfoil in Low Speed Flow

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A phenomenon called hysteresis leads to a difference in separation and reattachment angles of an airfoil at angles of attack near and above stall. This occurs when there is a difference in the lift distribution of an airfoil than expected for a given angle of attack when recovering from a stall. This leads to asymmetric flow parameters around a body even when the boundaries remain symmetric. Empirical results for lift and pressure coefficients were obtained for a two-dimensional Clark Y-14 at low speeds. The lift characteristics of the airfoil were observed while varying angle of attack and Reynold's number. It was seen that the extent of the lift hysteresis largely depends on Reynold's number. Further experiments and Computational Fluid Dynamics (CFD) simulations will be conducted in order to determine the relationship of the effective body of the stalled airfoil and the presence of hysteresis loops.

Keywords: *coefficient of pressure, lift hysteresis, lift curve, flow separation, stall*

An Analysis of the Impact of Technical Communication on Aviation Risk Mitigation in the Context of Aircraft Maintenance Operations in Sri Lanka

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Aviation safety plays a vital role in the airline industry including aircraft maintenance operations. The equilibrium between safety and productivity is inversely proportionate as additional efforts on safety have an inverse impact on operational efficiency. Therefore, a major attribute that decides the operational effectiveness of an aircraft maintenance establishment is decided on how effectively it can handle the equilibrium between safety and productivity. Accordingly, this paper empirically evaluates the impact of technical communication on aviation safety through the theoretical framework of aviation safety management in the context of commercial aircraft maintenance operations in Sri Lanka. A conceptual framework is formulated with independent variables addressing written and verbal communication, information understanding, and employee engagement and safety risk mitigation being the dependent variable. The statistically tested hypothesis reveals positive strong support for all three independent variables with the dependent variable. So, in conclusion, it is understood that high emphasis needs to be paid to improving written and verbal communication, active employee engagement towards communication feedback systems and relatively lesser significance to be paid to information understanding processes as such systems are already well established within the aviation industry.

Keywords: *technical communication, risk mitigation aviation safety management*

An Empirical Analysis of the Impact of Aircraft Maintenance Technical Training on Risk Mitigation in the Sri Lankan Aviation Industry

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The operational efficiency of aircraft maintenance activities is pivoted on the equilibrium between safety and productivity. Against this backdrop, aviation safety management systems play a vital role in ensuring safe operations while enhancing operational efficiency. Out of the main four pillars of safety management systems, safety promotion and to be specific technical training and its impact on risk mitigation are analysed in this paper through an empirical study. A conceptual framework with the independent variables covering initial training, continuous training, and the availability of training infrastructure is evaluated against the impact on risk mitigation. This addresses a very specific research gap, especially in the context of the Sri Lankan commercial aviation sector where the relationship between technical training and aviation safety is very rarely researched. The research is conducted in the form of a hypothetic deductive study based on the empirical responses of aircraft maintenance field stakeholders evaluated through statistical analysis. The outcome of the research reveals some important points as all three hypotheses are positively supported and highlight the importance of qualitative improvement of initial training and continuous training. Meanwhile, it also highlights the importance of expanding the training infrastructure to cater to the increasing technical manpower demand.

Keywords: *aviation safety management system, safety promotion, technical training*

Predicting the Freezing of Gait in Parkinson's Patients based on Machine Learning and Wearable Sensors: A Review

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Freezing of Gait (FoG) is a common incapacitating complication in Parkinson's patients, which will temporarily hinder the forward progression and will prevent them from re-initiating their normal gait. This can lead to potentially fatal falls and severely affect the quality of life of the patient. Due to characteristic changes in their gait, FoG can be identified by using wearable sensors such as pressure sensors, Inertial Measurement Units (IMU), and Electroencephalogram (EEG) electrodes. Classification models that run on machine learning algorithms have been frequently used. Prediction of FoG would be highly useful for the patients since this identifies the changes in their gait preceding the event and the patient can be notified. This will allow them to overcome FoG. This systematic review identifies the best sensors, sensor placements, predictive algorithms, and the limitations of the existing prediction systems. Out of all the methods reviewed, combinations of plantar pressure sensors placed on the insoles and IMUs placed on the shank produced the highest accuracies with a specificity of 91.6%. The best algorithm was identified as Convolutional Neural Networks.

Keywords: *freezing of gait, prediction, machine learning, wearable sensors*

Local Binary Pattern based Features for Prostate Cancer Detection

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Prostate cancer is one of the most common cancers in males and one of the significant causes of cancer mortality. Most prostate malignancies are presently diagnosed based on an increased PSA level, despite this biomarker having only limited accuracy. Prostate cancer differs from most other cancers because it is frequently multifocal and does not appear as a single spherical mass. The illness progresses at different rates, and it is frequently asymptomatic until it has gone to late stages. Multi-parametric MRI (mpMRI) has advanced dramatically in the last 20 years, as has the treatment of localised prostate cancer. As a result, this research aims to develop an algorithm to identify features based on the Local Binary Pattern (LBP) based histogram and Grey Level Run Length Matrix (GLRLM) characteristics of mpMRI images, to improve detection rate and accuracy of prostate cancer diagnosis. Local binary patterns are texture descriptors that have been effectively employed as image descriptors in various applications. Images were gathered from a public image database to complete this work. The operator is applied to the selected region of interest (ROI) to generate the LBP image. Texture pattern probability was summarised into a histogram, and second-order statistics were obtained using the GLRLM operator. The statistical significance of the eleven characteristics was determined using an independent two-sample t-test using four features from the histogram and seven features from the GLRLM operator. The suggested approach yielded three favourable outcomes in the research, which can be utilised to identify malignant tumours from benign tumours. The positive results include the first-order statistics standard deviation and kurtosis and the second-order statistic Run Length Non-uniformity (RLN).

Keywords: *prostate cancer diagnosis, LBP, GLRLM*

Methods of Measuring CSF Pressure: A Review

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Cerebrospinal fluid pressure is considered as one of the key diagnostic parameters to identify different pathological conditions related to the central nervous system. Different clinical methods have been used to measure the intracranial pressure (ICP) inside the craniospinal compartment of the brain. But most of those invasive methods pose a significant risk for the patients. Hence, CSF pressure is measured during Lumbar Puncture procedure as an indication to the ICP. The main aim of this review is to study and analyse the different methods of measuring CSF pressure especially during Lumbar Puncture procedure. But there is a limited literature regarding modern advanced methods of measuring CSF pressure during LP. Hence, this review emphasises on the existing methods and peer review literature that focus on different methods of measuring CSF pressure.

Keywords: lumbar puncture, CSF pressure, intracranial pressure

Ceramic Tile Waste as Fine Aggregate for Marine Concrete Modules in Sri Lanka

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Construction waste has a major impact on the environment. Reusing and recycling this waste can reduce the extraction of raw materials and help waste management. Therefore, this study was focused on ceramic tile waste which is released in the squaring process of tile manufacturing to develop a design to protect the coastal area as an end product. A mixed design was based on BS 5328 with M15 and the targeted strength was achieved with the use of cement, water, and aggregates, where fine aggregates were replaced with ceramic tile waste in 25%, 50%, 75%, and 100%. XRD test was conducted to test the constituents of ceramic tile waste. Results indicated that a higher compressive strength was achieved when the replacement was at 25%. No heavy metals were detected in the XRD test. This study concludes that the optimum percentage and the water/cement ratio would be 25% of fine aggregates replaced with ceramic tile waste with a 0.5 W/C ratio. Two designs were introduced and samples were deployed in Polhena beach, Sri Lanka. The growth of corals on the designed structure indicated the appropriateness of the material and the structure of conserving corals.

Keywords: *ceramic tile waste, corals, marine conservation, mix designs*

Identifications of Pathways for Phosphorus-based Product Recovery from Sewage Sludge using Multicriteria Decision Analysis for Sri Lankan Context

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This study was carried out to inspect the suitability of 5 methods to produce phosphorus-based products using sewage sludge as an alternative to the rock phosphate demand to produce phosphate fertilizers. The considered methods are supercritical water gasification of sewage sludge, struvite precipitation, thermochemical treatment of sewage sludge, wet chemical treatment of sewage sludge and electro dialysis of sewage sludge. These methods are compared with each other to determine best method using 11 different criteria selected in Sri Lankan context. The comparison was carried out using a multi-criteria decision making (MCDM) technique called TOPSIS under 3 different scenarios which assigned different values to the criteria in environmental, economic and fertilizer suitability aspects. An analysis was carried out regarding results of the MCDM to determine the best method, and struvite precipitation was selected as the best method in Sri Lankan context to recover the phosphorus in wastewater.

Keywords: *phosphorus, wastewater, multiple criteria decision, sludge processing*

Optimization of Coagulation and Flocculation Process in Kandana Water Treatment Plant

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Coagulation and Flocculation process is used to remove colloidal particles and fine suspended materials from drinking water. Aluminium Sulphate /Alum is the most commonly used and widely available inorganic coagulants in the water treatment plants in Sri Lanka. But due to reduction of pH value, high sludge handling cost, presence of residual Aluminium and slow floc formation, alternative coagulants for the coagulation process become required. The efficiency of iron-based coagulants such as Ferric Chloride and Ferric Sulphate was compared to that of alum in this study. For this study, Kandana Water Treatment Plant was selected and raw water was taken from the Kalu Ganga. The quality of the treated water was analysed by conducting standard jar test and compared with alum. Raw and treated water samples were tested for turbidity, alkalinity, pH and colour. The main goal of this research was to use iron-based coagulants to improve the coagulation and flocculation process at Kandana Water Treatment Plant. According to the results obtained from the study, Ferric Chloride showed the highest turbidity reduction effectiveness. The combination of alum and ferric chloride (50 %+ 50 %) showed the best colour removal efficiency. The floc sizes generated with both Ferric Chloride and Ferric Sulphate, were greater than those with Alum.

Keywords: *coagulation and flocculation, Alum, turbidity, water treatment plant*

POSTER PRESENTATIONS

Genetic Algorithm-based Path Planning for an Unmanned Aerial Vehicle Considering Energy Consumption and Payload

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Unmanned Aerial Vehicles (UAVs), more commonly known as drones, have a wide range of applications spread across various industries. Drones are plagued with several challenges concerning their limited battery life and payload. Until researchers come up with a much more advanced and long-lasting battery solution, drones must use the most optimum path for delivery, which will increase battery efficiency and reduce overheads. This study analyses the battery energy consumption, velocity, and flight time of the quadcopter for varying payloads and develops a suitable mathematical relationship for path planning problem formulation. This paper proposes a Genetic algorithm -based path optimization to obtain the most energy optimal path for the drone carrying a certain payload for a set of specified destinations.

Keywords: *path planning, unmanned aerial vehicle, genetic algorithm*

Current Phasor Measuring Device for Three Phase Distribution Lines

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Protection and reliability are the most paramount considerations in the power system. Current measurement of distribution lines is essential for the power and quality evaluation purposes. The current measuring devices are used for controlling, monitoring and protection purposes. While the measurement of current at an end connected to a substation can be carried out without too much trouble, intermediate current measurements cannot be carried out with ease. Further, instantaneous phase angle differences need to be measured to be able to evaluate power flow in distribution lines. Thus, at present, power loss calculations are approximately carried out by the utility. So, the power quality analysis, switching operations and load transferring in distribution lines are not much accurate. The use of a flux concentrator and hall-effect sensor, with a filter, has demonstrated that a sinusoidal current waveform, with the correct phase angle, can be obtained. The use of the device on an existing line does not need disconnection, nor a separate earth connection to obtain the magnitude and phase angle of the current accurately. The data from the transducer is transmitted to the operator using radio signals rather than Wi-Fi.

Keywords: *current phasor, hall effect transducer, magnetic flux, current transformer*

Analysis of the Behaviour of Improved Soil under Shallow Concrete Foundations

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As a step towards sustainability and environmental protection, use of waste material and by-products in construction activities is becoming a trend. Quarry dust is a waste product of stone crushing process, which can be effectively used as a shallow ground stabilizer. This research investigates the behaviour of improved soil under a shallow foundation, by adding various mix proportions of quarry dust to the natural weak soil. Further, based on the foundation stability analysis, determining an optimum proportion of soil + quarry dust mix is studied. This is done by numerically analysing the displacement, shear strength, stresses, strains, and safety factors of stabilized soil underneath a shallow foundation. The study confirms that mixing quarry dust with natural weak soil - layered under a shallow foundation can significantly improve the stability of the respective foundation. This is due to the improvement of soil shear strength parameters, i.e. cohesion and friction angles, which are used for the stability analysis in the numerical model – incorporating the Mohr-Coulomb failure criterion. Further, it can be concluded that the optimum quarry dust mix proportion that yields the highest factor of safety of the foundation is around 60% - 80%, in which further increase in quarry dust % can cause reduction in the stability, due to unbalanced effect of cohesion and friction angle of mixed soil. Overall, the study concludes that mixing quarry dust with natural weak soil can be considered as a better ground improvement technique; however, the optimum mix proportion has to be determined after a careful analysis of the specific soil types, ground conditions and the applied loads.

Keywords: *ground stabilization, quarry dust, shear strength, shallow foundation*

Improving Turbidity Removal Efficiency in Slow Sand Filter during the Occurrence of High Turbidity Levels in Surface Water

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The prominent drinking water treatment process practised to eliminate turbidity from surface water, especially during high turbidity occurrence in the surface water, is coagulation, sedimentation and rapid sand filtration for many years. However, the possibility of turbidity removal using a slow sand filter (SSF) was not extensively studied in the case of high turbidity occurrence in the surface water. This study aimed to evaluate the performance of SSF in terms of turbidity removal in surface water, when pre-adding poly-aluminium chloride (PACl) as a coagulant chemical along with the pre-treatment by roughing filter. One per cent of PACl is prepared and dosed at the rate of 20 mg/L with raw water into the water intake chamber before it reaches the SSF. The raw and treated water samples were collected every six-hour intervals. The raw water samples whose turbidity level was more than 50 NTU were considered and analysed from 174 number of trails. Turbidity level of raw water and filtered water was observed in the range of 50-313 NTU and 0.31-5.5 NTU respectively. The turbidity of treated water by SSF was observed to be well below the SLS 614-2013 acceptable limit of 2 NTU in 98.8% of the treated samples. It is observed the turbidity removal efficiency increases when the raw water turbidity level increases. The result shows that the turbidity of treated water from SSF was complying with the requirement in 98.5% of the trails, which enable the proper function of the treatment plant during the high raw water turbidity by complying with SLS 614-2013 when adopting this methodology.

Keywords: *drinking water, poly-aluminium chloride, surface water treatment*

Study of Issues in Sludge Disposal and Management in Wastewater Treatment Plants

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Improper methods of treatment, disposal and management of sludge generated by wastewater treatment plants has become a major environmental issue at present. This research focuses on identifying the environmental impact caused by the methods used when disposing and reusing the produced sludge as fertilizer, by the Biyagama CWWTP, Ratmalana/ Moratuwa WWTP, Ja-Ela/ Ekala WWTP and Raddolugama sewerage treatment plant. The sludge samples collected from the dumpsites were tested for heavy metals, nutrients, and organic compounds present in them. After analysing the constituents present in the sludge, the issues in respective treatment plants and its procedures were identified. Moreover, the possibility of using the sludge as construction material, fertilizer and whether it satisfies the requirements to use as a fertilizer for crops cultivated for human consumption were discussed. In addition, a model limitation scale for the sludge standards was introduced through this study after observing various limitations maintained in other international standards. As per the results, only sludge from Raddolugama Plant was assured as safe for land application, and sludge in Biyagama plant was found to be the most suitable for fertilization among the others although other minor hitches were found. Conclusively, eco-friendly and sustainable solutions were suggested to improve the sludge qualities and overcome the issues found and proposed how sludge could be utilized for greater uses without wasting a valuable asset.

Keywords: *sludge, wastewater treatment plant, sludge disposal, sludge management*

Assessment of Groundwater Quality due to Leachate Generated from a Solid Waste Dumpsite

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In Sri Lanka, one of the main sources of groundwater pollution is the leachate generated from solid waste dumpsites. Karadiyana landfill is located 2km from Ratmalana airport, which receives nearly 500 tons of Municipal Solid Waste (MSW) daily. There is a considerable number of wells in the surrounding area, which are being used for drinking and other domestic purposes. The main focus of this study was to identify whether there is any effect of leachate on groundwater in nearby areas of Karadiyana dumpsite. Thus, well waters in nearby areas of the Karadiyana Dumpsite were collected. Subsequently, parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Phosphates and Ammoniacal Nitrogen included in these groundwater samples were determined. After the obtained concentrations were compared with permissible standards for drinking water, it was identified that some of the groundwater samples contained several contaminants exceeding the permissible limits. Moreover, the effect of distance on the degree of leachate contamination was also determined. Accordingly, it was suggested to identify the causing grounds for the anomaly obtained in these outcomes. As the conclusion, it was determined that for the time being, there is no significant effect of leachate on groundwater within the area starting from 400m away from the Karadiyana Dumpsite.

Keywords: *groundwater pollution, dumpsite, solid waste disposal, leachate*