



# 13<sup>TH</sup> INTERNATIONAL RESEARCH CONFERENCE

HOLISTIC APPROACH TO NATIONAL GROWTH AND SECURITY

# 15<sup>TH</sup> - 16<sup>TH</sup> OCTOBER 2020

Engineering

# ABSTRACTS



**General Sir John Kotelawala Defence University** 



# 13<sup>TH</sup> INTERNATIONAL RESEARCH CONFERENCE

HOLISTIC APPROACH TO NATIONAL GROWTH AND SECURITY

ENGINEERING

# ABSTRACTS



General Sir John Kotelawala Defence University

Ratmalana, Sri Lanka

This book contains the abstracts of papers presented at the Basic and Applied Sciences Sessions of the 13<sup>th</sup> International Research Conference of General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka held on 15<sup>th</sup> and 16<sup>th</sup> of October 2020. 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 Hon. Minister of Education



It gives me immense pleasure to send this message on the occasion of the 13th International Research Conference of the General Sir John Kotelawala Defence University (KDU). I would like to congratulate the KDU for being able to conduct its International Research Conference in 2020, consecutively for the 13th 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. 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 "Holistic Approach to National Growth and Security," 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 'development' 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 national growth 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 30year 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 and I wish this conference all the success.

#### Hon. Professor GL Peiris,

Minister of Education

#### Message from the Secretary, Ministry of Defence



I am delighted to send the best wishes to the KDU on this significant occasion of the annual international research conference. I would also like to congratulate the Vice-Chancellor and the team for continuing the tradition of organizing this conference consecutively for the 13th time, despite the emerging contested health environment.

This years conference theme: "Holistic Approach to National Growth and Security" focuses on the National Growth and National Security as core concepts, and it, further, suggests that 'development' and 'security' of a country should always go hand in hand. Therefore, this conference would undoubtedly become a vital forum to discuss an area of study which has a direct bearing on the development interests of our motherland.

I am glad 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 utilize to support the present development drive. Further, I would like to urge the conference organizers to see the possibility of distributing the conference outcome to all the relevant Ministries and Departments of the country so that these entities could link with the researchers and employ their valuable research outcomes for the benefit of the nation.

I wish that KDU IRC 2020 will enhance the wisdom of all the participants to serve Mother Lanka for a better tomorrow.

#### Major General (Retd) GDH Kamal Gunaratne

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

#### Message from the Vice-Chancellor



The International Research Conference taking place for the 13th consecutive time is a landmark in terms of keeping continuity of events at KDU. This year's conference attracted a large number of paper submissions and it indicates the enthusiasm growing in the country on development and security research.

KDU, from its inception, was instrumental in handing down the core values of security to the development paradigm in Sri Lanka. This year's theme 'Holistic Approach to National Growth and Security" highlights the importance of maintaining a harmonious blend in security and development in all national projects.

I believe the efforts of security-based education aiming at strengthening national development should be more cooperative in the future and KDU has always facilitated any research efforts that strengthens the national security of our nation. We urge the academic community of Sri Lanka to join hands with us in all our future endeavours to support the nation especially through productive research in diverse disciplines.

The organizers of the KDU international research conference intend to set the tone to initiate more collaborative research at national and global levels. This research conference is an ideal platform to make connections. I hope that authors of KDU and various other local and international universities will take the opportunity to interact and develop friendly relationships, establish networks and to explore win-win situations. I wish all the very best for the presenters and hope you will enjoy every moment of this academic fusion taking place on two whole days.

#### 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 thirteenth consecutive year, General Sir John Kotelawala Defence University organizes its International Research Conference (KDU IRC 2020), and this year it is held on the theme 'Holistic Approach to National Growth and Security'. It is with great pleasure and honour, the organizing committee extends its greetings to all of you taking part in KDU IRC 2020. Holding the KDU IRC 2020, under the patronage of the Vice Chancellor, amidst many challenges encountered throughout the year, was memorable experience for me, and I believe that the organizing committee was able to accomplish a very successful mission.

KDU IRC 2020 is a tremendous opportunity for 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 and Computing to present their research to fellow scholars, professionals and students.

Interestingly, the theme of KDU IRC 2020 is dedicated to the national growth and security, and it reflects the prime concerns of contemporary Sri Lanka as a nation and researches based on a holistic approach towards the national growth and security would enhance the quality in all aspects in a timely manner. In this backdrop, the esteemed speakers of all plenary sessions and research presenters of all technical sessions will cater to the same objective.

Finally, I would like to extend my best wishes to all the authors, participants and the organizing committee of KDU IRC 2020, and I encourage all of you to enjoy the KDU hospitality during these two fruitful days.

#### Dr. L. Pradeep Kalansooriya

Dr-Eng, MSc, BSc, MIEEE, MCSSL Conference Chair

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## **ORAL PRESENTATIONS**

#### Airline Maintenance Cost Optimization through Spare Parts Inventory Control

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Aircraft maintenance is a key factor which has a direct impact on the value and airworthiness of aircrafts and plays an important role in strategic decision making which adjusts the economic performances. Managing spare parts efficiently through proper inventory controlling is critical for airlines to minimize total expenditure of maintenance and as a result, it has been persuasive to work further in detail on spare parts inventory controlling and optimization. The above process is followed to cater to the airline production planning and better scheduling of work which can drastically minimize the maintenance cost. The research commences with studying what special practices are used to calculate demand for inventory and corresponding stock levels for the MRO activities. A comprehensive study is done on methods used to optimize spare parts inventory and efficient demand forecasting. The models presented throughout this research work are derived by studying the behavior of landing gear spare parts inventory controlling of an aircraft and can be applied to other systems' spare parts inventory controlling too. An area of interest that has emerged is that of Rotatable, Repairable, Consumable, and Expendable spares, which presents scope for research. With the current forecasting methods and the help of the historical data, the proposed inventory controlling policies in this research consider the reliability concerns and forecast demands depending on spare parts data from two directions: "lead time" and "mean demand". Hence, the optimum order number of units and the ideal order period can be derived to understand the total minimization of expenditures, which result in a systematic optimization in the way of inventory control.

Keywords: Aircraft maintenance, Inventory controlling, Cost optimization

## An Enumerative Constraint Planning Framework for Airline Engineering Manpower Cost Optimization

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This paper discusses the formulation of a general enumerative constraint planning model relevant to different aspects of airline engineering workforce planning dimensions, observed in the contemporary flight line operations. However, it is to be understood, this is a general theoretical framework that needs to be custom-tailored to suit the diversified operational scenarios discussed therein.

Initially, evidential coherence of pre-studied literature was comprehensively analyzed in ascertaining, the problem and to formulate the manpower optimization problem in a detailed but generalized manner. The primary data elements are classified enlightened by said findings, and subsequently, relationships and the constraints related to data elements are formulated in a sequential manner. It is followed by a discussion of the expected objectives and an employee-centered general model with the objective of direct or indirect cost optimization. In addition to the model's capacity in workforce capacity optimization, it also could be used effectively for other objectives such as employee welfare enhancement and skill based equal workload distribution. The general model signifies the complete aviation workforce planning problems from mediocre to prodigious cases.

*Keywords*: Enumerative constraint programming, Workforce Scheduling, Aviation management

#### Conceptual Design of Boom Mounted Inverted V-Tail for a UAV

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Long endurance surveillance drones are preferred in both military and meteorological applications. Designers aim to enhance vehicle aerodynamics in view of increasing endurance by introducing methods of drag reduction. This research aims to enhance the performance of an existing UAV widely used in Sri Lanka for surveillance, reconnaissance, and other military operations. The UAV is propelled by a pusher type propeller, behind which lies a twin boom-mounted H-tail for the stability. The propeller wake from the propeller creates a continuous turbulent flow on the tail surface, resulting in higher profile drag. A design is proposed to replace the tail section with an inverted V-tail configuration with sufficient clearance from the immediate propeller wake. The new design resulted in a reduction of approximately 21% of the total wetted area. CFD simulations were carried out to analyze aerodynamic parameters of the reconfigured aircraft, where a reduction in drag was observed. The static longitudinal static stability is assessed and found to be within the acceptable limits. The final design shows a significant improvement in the performance of the aircraft in terms of range and endurance.

*Keywords:* Drag reduction, Endurance, Inverted V-tail, Endurance, Longitudinal Stability, UAV

## Multifunctional Agriculture Drone for Sowing and Planting for Paddy Cultivation

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In Sri Lanka, the main crop is considered as paddy and most of the approaches relating to the field are still underdeveloped, especially when it comes to paddy sowing and planting. Farmers are still using traditional methods like random sowing, manual paddy planting using humans, and using paddy transplanter machines. These are very time consuming, inefficient methods requiring much labor. Therefore, the respective design project is designed and fabricated as a multifunctional automated agriculture drone to ease the sowing process and paddy planting of paddy cultivation. Higher efficiency and performance effectiveness, lesser time consuming and fatigue aspects, and cost-effectiveness are the key aspects of the project. The drone is controlled with GPS linked with mission planner software. Through radio signals, the drone and phone communication are linked with a mobile application which gives authority to take control of the drone according to the desired requirements of the user. Two different attachments are included for the sowing and planting process. Since they serve two different purposes, they cannot be attached and operated simultaneously. However, they are designed in such a manner that they could be attached to the drone using a single linkage. These attachments were made of light PVC material because reducing weight is an important factor with drone applications. The drone consists of 8 motors and can carry 2kg payload. Designed flying time is between 10 minutes and 15 minutes. With the sowing process, the drone is designed to carry more than 600g of seeds in a single flying time and it will cover more than 50 m<sup>2</sup> of area. Affordability, safety, and userfriendly operation ability are the most realistic and important factors which were considered when designing and they influence the present-day Sri Lankan agricultural forum and prospects.

Keywords: Multifunctional agricultural drone, Automated system

# Effect on Water Quality due to Residential Development – A Case Study on Kolonnawa Canal

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Due to the increasing number of residential buildings in Colombo and its suburbs, the wastewater volume generated and discharged by them will also increase. It would affect water bodies and would eventually lead these water bodies to be heavily polluted. As the canal network which is a part of the surface drainage system in Colombo works to drain out the floodwater from Colombo to the sea and Kelani river while providing and receiving water from urban wetlands, their water quality should be properly monitored and controlled.

This study attempted to measure surface water quality in the Kolonnawa canal, find out the Grey Water Footprint and analyze the effects caused by the domestic wastewater discharged into the Kolonnawa canal and its marsh. This study is conducted by using water quality parameters including pH, Temperature, Dissolved Oxygen, Biochemical Oxygen Demand, Total Dissolved Solid, Electrical Conductivity, Salinity, Resistivity, Chemical Oxygen Demand, NO<sub>3</sub>-N, and PO<sub>4</sub>-P. The study aims at finding the Grey Water Footprint by collecting 3 sets of samples from 8 locations at 10-day intervals. Test results indicated that Dissolved Oxygen, Biochemical Oxygen Demand, and Chemical Oxygen Demand as downgrading water quality parameters showcasing major differences from allowable water quality standard values. GWF is calculated as 131.25 m<sup>3</sup>/s which is a considerably high discharge rate which could only be achieved in flood situations. According to the water quality results and site investigations, it was concluded that the Kolonnawa canal receives a considerable load of pollutants from its sub-catchment, and domestic originated greywater is a major contributor.

**Keywords**: Grey Water Footprint, Water Quality, Colombo Canal System, Kolonnawa Canal

**KDU IRC 2020** 

#### Proper Management of Quarry Dust that is Generated in Crusher Plants as Waste

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Quarry dust is the by-product produced due to the crushing procedure of the stone crushing industry. The unavailability of a proper disposal method to this quarry dust, is a huge problem faced by crusher plants. If this quarry dust can be used as a useful product, it will be a good solution for this issue. Quarry dust might be able to use as a substitute material for natural sand in preparation of cement mortar. In this research, a new cement mortar with an adequate quantity of quarry dust as a partial replacement of natural sand was designed. The effect of partial replacement of natural sand with quarry dust on the strength of cement mortar was studied. Here 1:5 cement: mortar mixture with 0.5 water: cement ratio was used as the standard test specimen and another five test specimens were tested by varying the quantity of quarry dust from 15% to 55% out of total sand volume at 10% intervals with varying water: cement ratio from 0.51 to 0.55 at 0.01 intervals with the increment of the quarry dust quantity respectively by keeping cement quantity and temperature constant. The cement mortar exhibits excellent strength with a 45% replacement of natural sand with quarry dust with water: cement ratio 0.54.

Keywords: Quarry dust, Cement mortar, Natural sand

## Analysis of Air Pollution Trend and Identification of Possible Transboundary Influence: A Case Study of Colombo, Sri Lanka

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Air pollution is a disastrous environmental problem that the world is facing now. According to WHO, the South Asian region is plagued by air pollution and its effects since the region consists of multiple developing countries. In the Indian sub-continent, several air pollution hot spots are identified over the years. In the local context, transboundary pollution was observed on several occasions from changes in pollution levels with regard to changes in Monsoons but comprehensive studies into recognizing these sources of transboundary pollution or its effects on Sri Lanka are yet to be conducted. This study uses long term air pollution data available from the Automated Air Quality Monitoring Station (AAQMS) in Colombo, Sri Lanka to analyze the pollution trend and identify general directions of possible transboundary pollution hot spots are used to conduct correlation analysis and provide evidence of possible transboundary pollution originating from these locations in Sri Lanka's perspective.

Keywords: Air Pollution, Air Quality, Colombo, Sri Lanka, Transboundary Pollution

## Optimum Locations Suitability: Analysis for Tsunami Warning Centres

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More than 35,000 lives were lost due to the Tsunami disaster, which occurred in 2004. That time, early warning towers had not been established to warn people before this kind of a disaster occurred. After the disaster, 77 early warning towers were established in the coastal area of the country. Geographic Information System (GIS) can be identified as a tool that has the capability of providing the most recent and accurate information which is necessary for making the most suitable decisions for a problem. Moreover, a mapping system has been developed for storing, analyzing, modifying, and displaying spatial data of any place that exists in the entire world. GIS has become a very useful tool that can be used in vulnerability and hazard assessments. A research-based GIS Analysis has been done to find out the optimum locations for the Tsunami early warning towers located in between the coastal line of Matara and Dickwella. It has identified as the most vulnerable area for a future Tsunami disaster and has analyzed the coverage of the existing Tsunami towers. Finally, a comparison between the optimum locations and the existing locations has been done and the areas which have no protection from a future Tsunami disaster within the area subjected to the research have been identified.

Keywords: Optimum location, Tsunami Early Warning Tower, Vulnerable areas

## Analysis of the Fire Effectiveness of Medium Calibre Indirect Fire Naval Weapon System

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'Oto Melara' 76/62mm Compact Single Mounting Weapon system is the largest caliber one and only fire control radar coupled weapon system Sri Lanka Navy possessed with by 2019. Yet, this could not effectively used during war time due to prolong defects and its effectiveness aslo not analyzed by any means. Analyzis or the prediction of the effectiveness of a particular weapon system before operational use, is an important aspect. This process is mainly based on analzis of possible static, dynamic error sources and certain environmental parameters related to firing ground; integrated through a calculation model. Calculation of Single Shot Hit Probability (SSHP) is used in this study for analyzing the fire effectiveness of the said weapon system through a Matlab based calculation model. This model is based on what practiced by PLA Navy (Naval University of Engineering) and considers errors in the Observation equipment, Fire Control, Servo systems, Ballistic Materiological errors and Dispersion errors for predicting the distribution of shots. SSHP of the system against various targtes of large and smaller size kept at various ranges, bearings from the firing ship is considered for the analysis and hitting the target is considered as a kill, due to the effect of the 76mm High Explosive ammunition. Military personnel in the Gunnery field and decision makers would be benifitted with this study by enhancing the knowledge on sources of firing errors and how to predict the effectiveness of a weapon system without choosing the costly method of analzing actual firing records.

Keywords: Weapon System, Errors, Effectiveness

#### Design of a Wind Propelled Planning Hull Craft for Shallow Water Operation

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During recent flash floods, Sri Lanka Navy rescue teams met with many circumstances where they could not use their Dinghies even with short tail Out Board Motors (OBM) due to submerged obstacles at unprecedented depths. Therefore, designing a planning craft with rescue capability deemed a national necessity. This study explains the designing of a wind-powered planning hull craft to operate in shallow waters during natural calamities like flood situations to move where there are stagnant water masses with uncertainly small depths. A speed boat with performance such as gaining top speed, achieving acceleration timing, turning characteristics, course keeping ability at top speeds, etc. are quite challenging, which measures the overall performance of the boat. A preliminary analysis of the issue was made by the naval engineers who were attached to the Sri Lanka Navy (SLN), where the case study was done collecting data after a series of visits to flood-affected areas. The size of the common alleyways in flood-affected areas and their general flood height and the depths were calculated and hence the size of the required boat with maximum allowable draft has been determined. Since the lesser capabilities of the SLN to finish a hull with required hydrostatic data seems costly, a hull with required features was determined and purchased to match a suitable engine and a wind propeller with a suitable steering and protection mechanism. Therefore, the purpose of this exploration was to research and design a lightweight flat bottom Fiberglass hull craft propelled by air for carrying out rescue missions during floods. Finally, a subsequent study was conducted of hydrostatic and hydrodynamic forces, positioning of the center of gravity (CG), engine matching, and propeller matching to the hull. The newly designed airboat is distinctive, and it can be operated at a wide range of both steady and moving waters.

Keywords: Airboat, Sri Lanka Navy, Out Board Motors, Offtrol Vessels, Centre of Gravity.

## Designing a Low-Cost Brackish Water Reverse Osmosis Plant to Eliminate Chronic Kidney Diseases of Unknown Etiology (CKDu) from Sri Lanka

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Chronic Kidney Disease of unknown etiology (CKDu) is a major catastrophe in the health sector in the North Central province of Sri Lanka as it disables the kidney function. The main cause for the CKDu has not yet been identified though many scientists believe that a number of certain drinking water quality parameters have changed due to the contamination of water sources by agricultural activities. Therefore, the government of Sri Lanka has introduced a Brackish Water Reverse Osmosis (BWRO) plant to provide safe drinking water for the impacted community. However, this purified water supply project could not achieve expected standards due to the high cost of imported BWRO plants. Therefore, Sri Lanka Navy (SLN) engineers carried out a feasibility study to design a low-cost BWRO plant in a house with the utilization of local expertise to enhance the number of units in a rapid time frame to enhance the supply of safe drinking water for the affected community to avoid the further prevalence of CKDu in Sri Lanka.

*Keywords:* Brackish Water Reverse Osmosis, Membrane, Chronic Kidney with Disease unknown etiology, Safe Drinking Water, Sri Lanka.

## Development of a Robust Dynamic Damage Control Simulator

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The art of 'Damage Control' has been part of a seafarer's professional expertise from the time immemorial. The utility of effective damage control as well as the disastrous consequences of lack of it, in modern Naval combat, was once again very painfully reminded during the Falklands War in 1982. Consequently, the discipline of 'Damage Control' underwent some of the most radical changes as part of the lessons learned exercise at the end of this war. The resultant overhaul of the damage control system onboard Naval ships envisaged wide-ranging improvement in many facets of naval warfare ranging from basic outlook towards damage control to rudiments of ship design itself. However, the most significant part of this process was to train the basic human response, in the face of a catastrophe, from essentially a crisis management exercise to a systematic application of resources. Needless to say extensive and realistic training forms the cornerstone of this evolution of transforming damage control from the chaotic response into a symphony of 'right actions' in this endeavour; while the technology bridged the gap between available and desirable, simulators helped in recreating realistic scenarios under a controlled environment to extract maximum benefits of training (Valera and Soares, 2007).

Keywords: Damage Control, Battle Simulation, Crew Competency

## A Comparison of Nonlinear Material Models Used in Pavement Response Modelling

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The numerical modeling of pavement responses is very much influenced by the structural properties of the pavement. The structural properties are modeled by material models. A clear understanding of pavement responses with respect to the material models is necessary to evaluate the accuracy of prediction. This paper aims at investigating the application of inverse modeling techniques to find the material parameters of three different models using Repeated Load Triaxial test data. The method of estimating material parameter values is based on least-squares regressions, coupled with a finite element technique. Computations were performed using ABAQUS in MATLAB platform. The results of the computations are compared to each other. Numerical simulations and comparisons show a good agreement between estimated values (modulus, strain, and stress deflection) obtained using three different models.

Keywords: Pavement response, Finite element modelling, USDFLD, UHYPEL.

#### Energy Absorption Capacity and Impact Energy of Rubberized Concrete

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Disposal of used tires is a critical environmental issue in Sri Lanka. Rubberized concrete is one of the solutions introduced by the researchers to minimize the quantity of waste rubber. These studies discovered that rubberized concrete is an ideal alternative for lightweight concrete. However, they further revealed that the compressive strength of concrete degrades with the addition of rubber. Further, the durability of rubberized concrete is still questionable. However, due to the energy absorption capacity of rubber, rubberized concrete has the potential of possessing a higher energy absorption capacity. This property of rubberized concrete along with the lightweight will make rubberized concrete an ideal alternative for applications such as road barriers. Hence, this study focuses on exploring the static and dynamic energy absorption characteristics of rubberized concrete. Mix designs for grade 25 concrete were done while partially replacing fine aggregate by rubber crumbs at proportions of 5%, 10%, and 15%. . The energy absorption due to static loads were measured from the plate test while impact energy, energy absorption and shock absorption due to impact loads were calculated from the artificial athlete test. The experimental results show that the compressive strength and density of rubberized concrete reduce as the percentage of rubber increases. The low density of rubberized concrete can be used to make lightweight concrete. However, significant improvement in shock absorption, Static energy absorption capacity, impact energy, and energy absorption capacity can be seen. Due to high energy absorption against dynamic loads, the rebound force gets decreased. Therefore rubberized concrete can be used in structures that are prone to impact to create less impact on the object which collides with the structure. These characteristics make rubber concrete ideal for rigid roadside barriers, foundation pad for machinery, railway buffers, and bunkers where the energy and shock absorption are more important than the strength

Keywords: concrete, rubber, fine aggregates, absorption capacity

## Evaluating the Influence of Countdown Timers at Signalized Intersections on Red-Light Running

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Among many road rule violations that occur at intersections, one of the major issues is red-light running (RLR) at signalized intersections. RLR violations have a high potential of resulting in a crash. These crashes might vary from damage only crash to a fatal crash. Signalized intersections can sometimes have Countdown timers (CDTs). Hence, it is very important to identify, whether the intersections "with countdown timers" or "without countdown timers" are safer. With that objective, this research used a cross-reference study. Two intersections with CDTs and one intersection without a CDT were selected for the study. The number of vehicles that pass through the intersection and the number of RLR violations was counted in all those intersections. An illustrative study was first carried out to understand the trend in RLR violations. Then, Paired Sample *t*-tests were done done using IBM-SPSS- to identify any statistical significance of the effect of CDTs. According to the findings, RLR violations were in descending order in the total left-turning movements in the following order: Maliban intersection (A1), Golumadama intersection (A2) then Bellanthota intersection (B1). On average, RLR violations on the right turning movement at A2 intersection with CDT were observed to have a greater percentage than A2 intersection without CDT. However, A1 with CDT got a lesser RLR violation percentage in right-turning movements than the B1 intersection without CDT. About the through traffic movement, both the A1 and A2 intersections got lower RLR percentages than the B1 intersection. Hence, it can be said that having a CDT is affecting the RLR violations and its effect differs for the movements.

Keywords: Red-Light Runnings, Countdown timers, Intersection safety

# Evaluating Driver Speeding at Traffic Signal Lights During the Amber Time: With and Without Countdown Timers

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At the onset of amber color indication, drivers must decide whether to stop or cross a signalized intersection. In literature, there is enough evidence indicating that a significantly high number of crashes that occur at signalized intersections are of vehicles entering the intersection during amber and red-light indications. However, such findings cannot be stated for Sri Lanka with the lack of details in the crash records. With that gap of knowledge in the local literature, this study investigated how countdown timers (CDTs) impact on the speeding behavior of drivers. With that aim, the objective of this study was to examine driver speeding according to the distance to stop line (DSL) with the presence an absence of countdown timers (CDT). Two intersections with CDTs and one without a CDT in Colombo, Sri Lanka were considered for data collection. The number of vehicles that are speeding at the onset amber, were considered during a peak hour. These values were obtained for the intersections with and without CDTs as well as for Peak and Off-peak conditions. It was found that the dilemma zone was within 15m to 30m from stop line for intersections with CDTs. Results showed that the presence of a CDT showed no significant impact on the number of vehicles that went speeding at the onset of amber, and it was around 22 veh/ 100 cycles. On the other hand, there was a 35% reduction in the number of speeding vehicles per signal cycle during the off-peak hour with the absence of a CDT.

Keywords: Amber time, Dilemma zone, Intersection safety, Countdown timers, Speeding

#### Elephant Intrusion Detection, Deterrence and Warning System ("Tusker Alert")

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The Human-Elephant Conflict (HEC) is a serious socio-economic problem in Sri Lanka. Many methods including traditional electric fence systems to novel technological approaches are being used to minimize the HEC. Each method has its limitations, complications, and disadvantages. To prevent and overcome them, a wireless sensor network-based detection system combined with a warning system, and an artificial bee sound-based deterrence system was proposed in this research. With the help of PIR and infrared sensors, intrusion can be detected, while by emitting recorded bee sound, deterrence can be accomplished. By combining those two aspects with a communication network, a warning system was developed to alarm relevant authorities such as the wildlife department, railway authority, and police stations through SMS alert system, mobile app, and warning light system while a database is also being updated regarding the intrusions which can be used for further analysis and predictions. Application of the system covers wider aspects of detecting and warning of elephant intrusions such as on village forest boundaries, rail tracks, and on roadsides (possibly on expressways) with a tested and proven result of 92% detection rate from controlled environment testing.

Keywords: Human-Elephant Conflict, Detection, Warning, Wireless Sensor Network

## Design and Fabrication of an Automatic Ruler Printing Machine

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Automation has been popular among most manufacturing and production systems due to improved efficiency, high production rates, and low wastage. The project was focused on designing and fabrication of an automated ruler printing machine for the stationery item manufacturing industry. The main objective of this research was to fully automate the twelve-inch ruler printing mechanism which was currently based on manual production methods. Due to the drawbacks of the existing ruler printing processes of Sri Lanka, the mechanism was proposed to be automated in order to minimize the consumption of human labor and time while improving safety, production hours, and production rates of the manufacturing process. The research was focused on automating the basic functions of the ruler printing process such as loading, unloading, cleaning, printing, and packing to reduce human involvement in the process. Thus, the proposed method focuses on the rotary indexing mechanism to synchronize all the functions of the manufacturing process to support the continuous loading and unloading of rulers. It was designed to increase the rate of production by printing four rulers at once while saving the cost of labor by reducing human involvement and by automating the main functions of the manufacturing process. The research was focused on introducing an online packing section and inbuilt ink drying mechanism to reduce the work in process (WIP) and lead times during production while improving the accuracy and efficiency of the process by using a compact design.

Keywords: automated ruler printing machine, screen printing, loading, unloading

# Software Interface to Log High-Speed Data Acquired from a Stress-Strain Measuring System

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The jumping performance of a frog is determined by several characteristics of the frog. A system is developed to record the dynamic reaction force response of a striped marsh frog inserted on a platform in the propulsion phase of the jumping cycle. To record dynamic response, simultaneous data acquisition and high-speed data recording is necessary. This research paper discusses how the development of the software interface to log high-speed data is done using C. The primary objective of the system is to collect data simultaneously in a highspeed data rate. ADS1299 Analogue to Digital Converters (ADCs) is used and coupled with three strain gauges attached to the three axes of the platform. The ADC sampling is controlled by a microcontroller, and data is transferred to the PC using the serial port. The Graphical User Interface (GUI) of the software application is capable of reading, saving, retrieving, and plotting data. Besides, the software is capable of static load-based calibration and taring. The developed system is capable of recording the dynamic ground force response of an object inserted on the platform using the developed software interface. The primary objective, collecting data simultaneously at high speed, is achieved with a maximum data rate of 980 SPS. An additional option is given to calculate the jumping angle of the frog using the resultant reaction force.

Keywords: High-speed data Acquisition, Simultaneous sampling, Force platform

## Performance Comparison of Solid Tires and Non-Pneumatic Tires Using Finite Element Method: Application to Military Vehicles

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Tire technologies are growing rapidly due to the high demand for applications in harsh environmental conditions. Solid and non-pneumatic (NP) tires are utilized in such conditions as transporting excessive loads, operating on rough surfaces, agriculture, construction industries, and for military applications. These tires experience high stresses and excessive deformations due to sudden impacts and heavy loads. These factors are not easy to analyze experimentally due to complex experimental setups and high cost. Hence, the following study is focused on the characteristic comparisons of solid and NP tires by developing three dimensional (3D) Finite Element (FE) models under static and dynamic conditions. Initially, two FE tire models are developed for an equal size of solid and NP tires. To obtain material behavior of the tires, the suitable hyper-elastic material models are required and those are selected using a curve-fitting approach. Experimental data are compared with numerical results to validate the developed models. The validated models show good agreement with experimental models. The static numerical results of the validated model show that high stresses are located in the base section of the solid tire. For NP tires, the spokes and shear layer bear the stresses more than the other rubber sections. Moreover, curb impact is conducted for both tires by changing tire impact velocity. Results show that the NP tire experiences higher impact stresses than the solid tire.

*Keywords*: Curb Impact Simulation, Hyper-Elastic Materials, Nonlinear Numerical Modelling, Non Pneumatic Tire, Solid Tire

#### Design of Pressure Sensing Circuit to Measure Pressure Distribution of Patient's Foot

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The design of the pressure sensing circuit and related parameters are discussed in this paper. A significant portion of the world's population is plagued by diabetes. It can deteriorate the organs of the body at a very high rate leading to fatal conditions, one of them being foot ulcers. The ulceration can lead to a choice between amputation of infected limb/s and loss of life. Deterioration of nerves causes the protective sensation to decrease with time. This causes high tensions in certain areas of the skin of feet due to poor judgment of weight distribution which in turn causes the tissues to thin off and be torn layer by layer, resulting in ulcers. While prevention is better than cure, those who already suffer from and those who are recovering from such an ordeal would benefit very much from a handy device that can sense pressure distribution since it would help guide the patient to correct his or her gait movements accordingly. It would also be useful in the selection of footwear since footwear can also cause a change in gait. The idea is to build a prototype component that can measure and display the foot pressure of key points of the foot during gait at an affordable cost to a majority of the Sri Lankan population.

Keywords: Foot Pressure Sensor, Low cost, Foot ulcers

## Development of a Semi-Automated Device to Lift and Transfer Bedridden Patients

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Transferring bedridden patients from one flat surface to another, i.e. from a bed to a stretcher or laboratory/theater bed, is one of the crucial activities carried out in healthcare facilities. It is a physically challenging task with many concerns on patient's safety and comfortability. None of the existing methods used for that task provides an effective solution. Hence, this study aims at providing a mechanism to transfer bedridden patients with greater safety and comfort while reducing human involvement.

The study was carried out in four phases. Initially, data collection was carried out to identify a variety of methods, devices used for patient transferring both locally and globally. Further, a survey was done to identify the main factors affecting when performing a transfer by interviewing all stakeholders of the activity including doctors, nurses, attendants and lab technicians. Secondly, the design phase was completed. Thirdly, the designed device was fabricated and finally, it was tested to refine and improve further. The developed design is a semi-automated device that needs only one operator to operate. When using it, the patient's orientation is not required to change, and no human effort is needed. All the lifting and transferring movements are matched to standards given by WHO. The machine was tested using real-size dummies as the patient and feedback were obtained from a variety of medical staff involving with patient transferring. Qualitative data collection was done on performance. As per the feedback on testing, the device is capable of providing a safe, comfortable, and less physically demanding mechanism to transfer bedridden patients.

Keywords: Patient transferring, Automation, Electro-mechanical device, Safety

# Real-Time Vision-Based & Optimized Pedestrian Crossing Control System

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As per the National Council for Road Safety, more than 900 fatalities have been reported due to vehicle collisions on or near pedestrian crossings during the past 10 years within Sri Lanka. However, only minimal research have been carried out so far to improve the safety conditions of pedestrians. This research focuses on developing a system utilizing image processing to obtain the real-time data of a group of pedestrians at crosswalks and determining an optimal time frame for a certain group of pedestrians to cross the road at a given period. This study concludes on the requirements to optimize the timing of the existing push-button based signaling system. A mobile-based app is also developed to assist drivers to be incorporated with the proposed signaling system to enhance the end-effect. Extensive trials prove that the proposed system would ensure pedestrian safety and minimize or even prevent reckless road collisions within crosswalks.

**Keywords:** Pedestrian Safety, Image Processing, Road Traffic, Pedestrian group density, Vehicle queue density.

## Design and Development of a Vision-Based Tomato Maturity Detection and Sorting System

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In this article, we present an automated sorting method to sort ripe and unripe tomatoes. The main objective is to reduce the time consumed for manual sorting, thereby ensure the desired quality of tomatoes, which are to be sold in the supermarkets. It involves a conveyor system and a camera box, which consists of a high-quality digital video camera. Tomatoes are made to pass through the camera box, which then captures the images of each tomato and processes them to determine whether the tomato is of the desired ripe level based on a specific image processing algorithm. Furthermore, it facilitates sorting the tomatoes by their sizes calculated based on the radius of the tomato image.

The successful development of this project leads to an increase in productivity at supermarkets since ripe tomatoes can be easily sorted and a count of good and rejected tomatoes can be given as real-time feedback to the farmers. Apart from that, a web-based data logger is also created to monitor the tomato count from anywhere. For demonstration purposes, we have constructed a prototype of the suggested system. The average level of accuracy in this design has been calculated as 97.78 %. Several further developments can be made on this system to improve the sorting mechanism, and then it can be used for sorting various types of fruits and vegetables efficiently.

Keywords: Digital Image Processing, Machine Vision, Vision-based sorting

### Effect of Size and Position of Pinholes on Transformer Core Loss

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This paper presents the investigation of the variation of core loss due to the effect of pinholes in the transformer core which is used to stack the core sheets in a step lap pattern. A three-phase distribution transformer with a rating of 160 kVA, 11 kV/ 415 V has been selected for the investigation. The transformer model was developed using Solid Works software and examined for the no-load loss using finite element analysis software ANSYS Maxwell. Simulation results were obtained for different pinhole sizes and positions. The flux variations in the core, with and without pinholes are analyzed. Based on the core loss, the optimum pinhole diameter and positions are determined. The analysis shows that the hysteresis loss is not significantly affected by the pinholes while the eddy current loss has an effect from pinhole diameters. Analyzing the results, the optimum pinhole diameter is determined as 6 mm, corresponding to an increased loss of under 1% of the loss. Results show that placing the pinholes where the flux distribution is a minimum, reduces the core loss. The results of the analysis are planned to be implemented in an actual distribution transformer.

Keywords: transformer core, core loss, core stacking, step lap, pinhole

## Intelligent Security Robot for Warehouse Security ("WATCHMATE")

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Robots are already playing a major role in human life. With the development of technology, various types of robots have been built up to be applied in different fields. i.e., security, healthcare, education, military, etc. With the current security condition in Sri Lanka following the explosions which occurred in several places in the country in the recent past, security has become the most important factor helping the civilians to continue their daily routine. To ensure the security of places, security personnel play a vital role. Since they are aided by the CCTV camera system, if there is some unauthorized incident, the only action which can be taken is only by the security team. Hence, they risk their lives to ensure maximum security. However, as the cost of life cannot be redeemed, an option to reduce the damage that may happen to security personnel must be thought of. The present research focuses on a machine-based solution for this, and this system is named WATCHMATE. It is an intelligent system that can act as an assistant to the security guard in the detection and neutralization of an intrusion with a remote control.

Keywords: Motion detection, Security, Intelligent system, Remote control

## Design and Implementation of a Remote-Controlled Reliability Analysis and Energy Management System

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The electricity distributed to any house, school, or industry comes from either Ceylon Electricity Board or Lanka Electricity Company (Pvt.) Ltd. Electricity is bought from LECO or CEB by its consumers under various criteria decided and defined by the Public Utilities Commission of Sri Lanka. These tariffs shall determine the cost to be paid for electricity by each consumer. Usually, due to faults within the consumer's electrical system within his or her property, the cost they have to pay is not the number of units that they consumed. This could be due to a faulty meter or even losses within the factory due to its machines. Power quality decreases due to many faults like this and also due to inductance. Therefore, they will have to pay for more than the units they have consumed. To overcome this, we could constantly monitor the system and bring about necessary solutions to fix it as soon as possible. However, doing this manually is tiring and requires the workers to constantly keep measuring the necessary parameters like current, voltage, power, frequency, and power factor. In almost all factories some machines will still be running idle when they are actually not used. This project aims to develop an online energy monitoring system that can read data from the supply to factories and also machines and then display them on an online application. This will also have the ability to notify on a phone or another app to remind someone to switch off or on any machine. Also, the project aims at carrying out a case study to have a thorough understanding of the factory Randhi International (Pvt.) Ltd., to help in deciding on what solution should be put forth to decrease power loss in any factory the user considers. These guidelines are presented as a case study and will be developed into a generalized guide.

Keywords: Energy Management, Energy Monitoring, Loss Calculation

#### Experimental Study on Tissue Characterization using S Calculation

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Scientists have theoretically shown that there is a relationship between the size and shape of the scatterers (s) and the bandwidth of the power spectrum  $(2\sigma)$ obtained from ultrasound echoes (RF echoes). The purpose of this work is to conduct an experimental study to analyze how this s calculations can be utilized in tissue identification. A heterogeneous tissue structure (bovine kidney) and a comparatively homogeneous tissue structure (bovine liver) were investigated. Five kidney and liver samples were taken into analysis and data were taken at 80 positions each. Average values turned out to be in the range of 1-2, which complies with the literature. The experimental error was calculated as 0.342.

Further, average and variance of the s values were calculated, and considering the results of error calculation, it is evident that "average values of s" cannot be used to differentiate two tissues. However, when the "variance of s" of these two tissue samples was considered, it can be observed that the variance of s can be used as an identifier of two tissue samples. Homogeneity of the scatter size and shapes cause a higher variance in bandwidth, which leads to higher variance in s. Hence, s variance can be identified as a successful tissue identifier.

Keywords: tissue identification, ultrasound, RF echo,



# **POSTER PRESENTATIONS**

KDU IRC 2020

# Design of DC-DC Converter for ESP8266 Based IoT Sensor Nodes

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In this article, we present a design of an improved DCDC converter for low power Wireless Sensor Node using IoT. New research shows that the main drawback of future wireless sensor networks is energy storage, collection, and processing. WSNs are installed in remote locations and are powered by photovoltaic panels and batteries. In both cases, the power supply is variable. A DC-DC converter is a device that adjusts the source output voltage of a load. In this research, we have designed a DC-DC converter for ESP8266 based sensor nodes powered by a battery. We have simulated the DC-DC converter using MATLAB by adding several protection and controlling features. This includes a PID controller for transient stability. This model output gives high-efficiency DC power supply with a very low ripple rate. Practically most of the failures in electronic devices occur due to power supply failures. This is the best solution for sensor nodes with long-lasting life span.

Keywords: DC-DC Converter, IoT, PID Controller, Sensor Nodes

# **Electrical and Electronic Waste Management in Sri Lanka**

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E-waste or electrical and electronic waste is one of the fastest-growing waste in the world and this problem affects Sri Lanka as well. E-waste will become an emerging issue in the near future because the estimated e-waste generation in 2021 is 0.09 million tons in Sri Lanka. E-waste contains valuable compositions that have economic value when it is recycled correctly. Unfortunately, Sri Lanka has not improved in e-waste recycle and e-waste management. Therefore, the objectives of this research were to find out different types of e-waste generated in Sri Lanka, identify different compositions, develop an application for hazardous non-recycled composition and develop mathematical models for the weight of the composition of e-waste. The study was based on data collected from e-waste collectors. The research project reveals that the hazardous, nonhazardous, recyclable, non-recyclable composition in the selected devices are; 1G mobile phones (0.5kg), 2G mobile phones (0.235kg), 3G mobile phones (0.155kg), 4G mobile phones (0.145kg), Tv (14kg), laptops (2.3kg), computers (9kg), A/C machines (34kg), refrigerators (135.5kg), fluorescent bulbs (0.185kg), and washing machines (34kg). Average weight has to be considered because of the different types, different models, different brands for the same device. Mercury is the only non-recyclable hazardous composition in these devices. The results of this research revealed the ten compositions (mercury, plastic, copper, aluminum, cadmium, silver, gold, palladium, steel, and lead) found in e-waste and how to calculate them. The study reveals the amount of weight of compositions that can be found in e-waste and which compositions can be affected by the environment. The proper e-waste management system is needed to minimize e-waste generation. E-waste recycling is necessary but should be conducted in the proper manner.

Keywords: e-waste, the weight of compositions, simulation modeling

#### Remote Controllable Multi Weapon Mounting Sentry Platform ("SEKHMET 19")

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This design could be basically used for a military camp/base or high security building sentry point. For any attack or security breach, sentry points are usually vulnerable. Usually in Sri Lanka, soldiers stay at sentry points with their gun. They observe their surrounding by their naked eye. All the threats usually target sentry points and begin attacking soldiers who are at sentry points. But, because of our design, Enemy will not have any soldier to aim and kill. This can obviously save soldier's life as well as surprise enemy and disappoint at the same time. The enemy cannot identify the remote-control gun operation mechanism and location since the weapon platform and remote controller are at two different places. This design itself can achieve higher performances and results when continuous firing take place because no human is physically operating and therefore inhibiting human fatigue. Remote controllable multi weapon mounting sentry platform is basically a weapon mounting platform which can be controlled using a remote. Therefore all the controlling signals are transmitted through the cables by using real-time cameras which are mounted to weapon and weapon platform. Operator gets better observation with higher details simultaneously. This gun controlling system can be used using two or more operators. Under proper and relevant command, remote controller could be coupled to the main station of a specific military camp and even controlled from the main station for emergency situations. Also, the weapon platform is capable of mounting multiple type of platforms or weapons according to the basic dimensions of the weapon and its requirement. SEKHMET 19 is designed to mount and hold similar ranged machine guns. Cost effectiveness is also a major factor for Sri lanka Military when it comes to our design and it also could be altered according to the working environment.

Key words: LMG, RPD

## Evaluating the Efficiency of a Traffic Signal Light over a Traffic Policeman

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The overall effect of traffic is considered to be high, at most of the intersections when they are controlled by traffic signal lights during peak hours. This causes lengthy queues and user inconveniences at intersections. Traffic police officers also control some of the intersections during peak hours in order to reduce this queue length and waiting time. The objective of this research was to determine the relationship between the queue length formed and vehicular delay at peak hours when the intersection is controlled by traffic signal lights and traffic policemen. Data were collected in two four-way intersections at Kanatta road / Dudley Senanayake Mawatha and Golumadama intersection. When the queue length was considered by 5-minute time intervals, the number of vehicles in the queue was higher with traffic signal control, compared to a police-controlled intersection. Further, per signal cycle queues were also counted in the said two scenarios. The observed values were furthers tested using the Contingency Table analysis (Chi-square test) to assess whether the effect is statistical significance. Results showed that queue lengths and the number of waiting hours were higher when the intersection was controlled by traffic signal lights compared to a traffic policeman. However, per cycle waiting time was significantly higher when controlled by policemen. Therefore, when a singleuser point of view, the intersection delay may seem higher when controlled by a traffic policeman. However, the overall delay at the intersection is lesser with the police control.

Keywords: Traffic Signal Lights, Traffic Policeman, Intersection delay

#### The Environmental Compatibility in Cement Manufacturing Industry, Galle, Sri Lanka

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With the fast development of the infrastructures in Sri Lanka, the country has undergone impulsive industrialization in the last few decades. As a result, cement has gained its highest demand inside the country. Starting from the preproduction stages the whole cement manufacturing process affects the environment, especially the air quality. During cement manufacturing stages, ambient air quality is changed because of various particulate matters and gaseous pollutants such as PM10, PM2.5, SOX, NOX, and COX, etc. This study has investigated the air quality within two selected cement manufacturing plants in Galle, Sri Lanka, mainly focusing on the cement dust particle concentrations and noise levels by dividing them into several zones. For more accurate readings two conditions were considered operational and non-operational, considering the methods and procedures of a specific zone. The gaseous pollutants are mostly negligible for cement factories in Sri Lanka since the raw materials are imported from other countries. The behaviour of the dust particle concentrations with four selected external parameters, the distance, temperature, wind speed, and humidity was evaluated. Most of the time PM2.5 concentration is lesser than PM10 concentration at a moment. Clinker yards give the highest contribution to the air contamination levels in selected cement factories. Roller press mill contributes highly for the noise levels in the respective factories. All these conclusions depend on the distance, and when the distance has reduced, the effects from the contaminations also reduced. PM 2.5 particle that can travel under the relevant circumstances for this particular factory conditions is 287.22m and for the PM10 particles, the maximum distance is 297.82m

Keywords: Cement manufacturing, Dust concentration, Noise levels

## Waste Minimization for Small Airlines by Using Safety Management System Concepts

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The detrimental effect of the aviation industry comes with its environmental damage, which has inevitably yet significantly increased over the years. Much research is conducted on demoting the environmental damage caused by air pollution, sound pollution, waste pollution, and hydrological pollution. This research aims to develop a system that may reduce and moderate the waste production by the prevention of waste production, which can be done by amplifying a waste management system using scientific methodology and the minimization of waste production through waste type formation reduction. The concepts of safety management due to its inherent qualities of a comprehensive system top to the bottom management system, a comprehensive study of safety in all aspects, can continuously improve. Furthermore, the organizational commitment from the top management to the bottom is substantial. As in the rest of the world, the aviation industry of Sri Lanka is also mounting at a rapid speed. This research was conducted as a case study of a small aviation industry organization. However, the waste management process of the Sri Lankan aviation organizations have not been given proper consideration to mitigate or prevent the immense waste production. In numerous research studies that have been conducted, the method for managing certain types of waste produced by aviation organizations was discussed. Henceforth, further research developed a waste management system that includes four annexes that can be used for the prevention and minimization of all types of waste produced by the aviation organizations in Sri Lanka.

Keywords: Waste, Safety, Environment, Hazardous Aviation, Management

## The Digitalization of Sri Lankan Healthcare: An Analysis of Potential Robotic and Technological Applications for COVID-19 Management

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Covid-19 has placed nations globally in a precarious position. Superpowers struggle to tackle the spread with countries such as China, India, and the United States of America reporting large scale patient detection. This has further led to the crippling of the economy, job loss, and reduced quality of living. With many experts comparing it to the great depression of the early 1900's the potential damage to countries such as Sri Lanka based on reduced exports and impacted job markets is devastating.

Another key influencer is the health risk to each nation from an un-contained COVID spread. In the following paper, the author explores the possibility of using robotics and technology to aid COVID 19 management and further enhance the medical industry within Sri Lanka. The suggested robotics applications and technology usage focus on combatting short-term risks and creating a sustainable platform for future risk management. Aspects such as disinfection, patient support, and drug distribution are high-risk aspects where human to human transmission of viruses is high. As such, the following paper looks into government/private sector-led medical platform introductions, treatment changes, and digital medicine introduction to ensure that the country grows amid COVID-19 and achieves long term sustainable growth through the usage of modern medicine delivered on a digital medium.

Keywords: Health care, COVID-19, Best practices

## Controlling Parked Vehicle Interior Temperature Using Renewable Energy

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A parked vehicle cabin can be treated as a nearly closed volume. So, when an automobile is parked under sunlight the solar radiation heats the interior to extensive temperatures of above 60°C. These extreme temperatures reduce the cabin thermal comfort of the occupants, especially until the automobile's in-built cooling system brings the temperature to a comfortable level. The extreme temperatures in the cabin have also led to several heatstroke victims and even deaths of occupants in parked automobiles. These extreme conditions also degrade cabin materials. This research focuses on developing partly portable cooling equipment based on the vapor compression refrigerant cycle that is powered by solar energy for a car cabin.

The equipment was sized for a Suzuki Wagon R – 2015 automobile, based on the local heat loads that were gained in this research. Also, two Computer simulations were done to determine the cabin conditions with and without the designed equipment. Further verifications of these results were done by testing a prototype of the design.

The results from computer simulations and test results both confirm the reduction in cabin temperature to below 44°C. Further developments are necessary for this model to make the parked car cabin completely safe for occupants. With the current results gained using the prototype developed, the car cabin thermal comfort has increased by a huge margin, where the temperature has reduced from above 60°C to below 44°C. This paper focuses on the simulation segment of the research conducted.

Keywords: Heat distribution, Cabin cooling, Simulation

