

# Abstracts



# ICACT 2019

International Conference on Advances in Computing and Technology

*"Making the World Smart, Autonomous and Sustainable with Advancements in Computing and Technology"*



Faculty of Computing and Technology  
University of Kelaniya  
Sri Lanka



# International Conference on Advances in Computing and Technology (ICACT – 2019)

*“Making the world smart, Autonomous and Sustainable with  
Advancements in Computing and Technology”*

29<sup>th</sup> July 2019

## Conference Proceedings

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Faculty of Computing and Technology  
University of Kelaniya  
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## Message from the Vice-Chancellor



It is with great pleasure that I extend my warm wishes for the 4<sup>th</sup> International Conference on Advances in Computing and Technology (ICACT 2019) organized by the Faculty of Computing and Technology, University of Kelaniya. The resounding success of the last ICACT conferences organized by this upcoming faculty must have provided tremendous impetus in extending the depth and the breadth of the coverage of the research discussions this year.

The theme adopted for this year, “Making the world smart, autonomous and sustainable with advancements in computing and technology” is a timely theme which has attracted the attention within local as well as global context.

In recent years, technological advances have led to new frontiers in many fields including quantum computing, robotics, artificial intelligence, nanotechnology, biotechnology, Internet of Things (IoT), 3D printing and autonomous vehicles. Computing and Technology are the two key domains that makes a direct contribution to this digital and technological revolution, especially in the context of Sri Lanka which has embarked on a journey to create a knowledge-based economy. Further, these revolutions have led to many new advents in the field of education by shifting conventional boundaries surrounding the learning process. Blended and Online learning, Technology Enabled Learning, Smart classrooms, Flipped Classrooms are widely used in the global context and are currently being introduced to the local system. In such a context, we are privileged to have the CEO and Founder of Moodle, Dr. Martin Dougiamas as the Keynote Speaker of the ICACT 2019.

ICACT 2019 organized by the Faculty of Computing and Technology, University of Kelaniya provides an excellent platform connecting these two key domains and thereby promote multi-disciplinary research that can contribute to the socio-economic development of Sri Lanka. I am confident that the deliberations in this conference would not only contribute to the body of knowledge, but would also present innovative ideas that could be put into practice in the near future. I wish every success for the conference.

**Professor D M Semasinghe**

Vice Chancellor, University of Kelaniya, Sri Lanka

## Message from the Chairman of the Research Council, University of Kelaniya



It is with great pleasure that I issue this message on the occasion of the 4<sup>th</sup> International Conference on Advances in Computing and Technology 2019 (ICACT-2019) organized by the Faculty of Computing and Technology, University of Kelaniya.

I'm positive that ICACT 2019 will provide a platform for all the presenters and participants to present novel and latest developments in the fields of Computing Technology, Science and Engineering Technology, and Education Technology. I am confident that the participants of this conference who are researchers, engineers, scientists, academics, and representatives of industry will take part in the sharing of knowledge and ideas as well as nurture international research collaborations. Further, it is our privilege to have the Moodle Founder Dr. Martin Dougiamas as the Keynote speaker of the ICACT 2019 and I hope this will be of enormous help for our academics to enhance the quality of Teaching and Learning process in the University.

In conclusion, I wish to congratulate the Dean, staff, and the organizing committee of ICACT 2019 of the Faculty of Computing and Technology for organizing this international conference with the aim of improving the research culture in the University of Kelaniya and wish ICACT 2019 every success.

**Senior Professor N.P. Sunil Chandra**

Chairman of the Research Council, University of Kelaniya, Sri Lanka

## Message from the Dean of the Faculty of Computing and Technology



It is an honour to greet all the attendees to the International Conference on Advances in Computing and Technology (ICACTION 2019). The conference is organized by the Faculty of Computing and Technology (FCT) of the University of Kelaniya. The theme of this year's conference is "Making the world smart, autonomous and sustainable with advancements in computing and technology".

This year's conference provides opportunity for computing and technology experts from Sri Lanka and abroad to focus on smart and sustainable solutions for the current socio-economic challenges faced by the human beings. In the global context, rapid advancements in fields such as robotics, artificial intelligence, nanotechnology, biotechnology, and Internet of Things (IoT) have already enhanced the productivity and efficiency of numerous industrial processes. However, in the local context, a sound dialog between researchers and industry experts is required to utilize the advances in the above fields to provide smart and sustainable solutions for the current challenges faced by the local industries. I hope that this conference will play its role in enriching the participants' knowledge as well as encourage their contributions to national development through productive collaborations with the local industries.

Furthermore, the latest innovations in digital technologies have opened up new advents in the field of education shifting the boundaries in the traditional learning process. E-Learning approaches such as Blended and Online learning, Flipped classrooms are of enormous importance in catering our current students who are named as "digital natives" or "Millennials". Herein, we are truly honoured to have Dr. Martin Dougiamas, Founder of Moodle as the Keynote speaker of ICACTION 2019. I hope the experience and the knowledge gained through the workshop and the key-note speech will positively contribute for the enhancement of Teaching and Learning process.

The FCT established in 2015 is the youngest faculty of the University of Kelaniya and the most vibrant with well qualified academics with proven track record in research and teaching. The aim of the faculty is to promote collaboration among diverse academic disciplines and empower academics, professionals and students to achieve the highest quality in their teaching and learning as well as research activities. For the 4<sup>th</sup> consecutive year the FCT is able to hold ICACTION 2019 due to the research conducive environment which is promoted by the Vice Chancellor, Chairman/Research Council, Deans, Heads of departments, academic, and non-academic staff of the University of Kelaniya. I greatly admire their support and hope that it will continue throughout the years to come.

I would like to take this opportunity to express my gratitude to our sponsors for their support and contributions for the success of ICACTION 2019. I also wish to thank the organizers and all

who gave their time and effort for their diligent work. I trust that our international delegates will have a wonderful time in our paradise island, experience the warm hospitality and feast on our delectable cuisines. Finally, I wish all participants a productive conference and hope that you will seize the opportunity offered through ICACT 2019 to network and build new collaborations as well as to develop and expand each research to achieve the highest possible outcomes.

**Dr. Gamini Wijayarathna**

Dean, Faculty of Computing and Technology, University of Kelaniya, Sri Lanka

**Keynote Speaker – Dr. Martin Dougiamas, *Founder and CEO of Moodle Project*****Biography**

Dr. Martin Dougiamas is the founder, CEO and chairman of the Moodle project, with multiple post-graduate degrees in Computer Science and Education and two honorary doctorates (from Spain and Belgium). He continues to focus on researching how technology can support teaching and learning in open and human ways, especially when it supports the UN’s sustainable development goals.

**Keynote Abstract****Title: Technology’s Role in the Future of Education**

Moodle is the most-used “learning management system” - software that creates a private interactive website, filled with tools to make online classrooms full of resources and activities, with tools for managing and assessing students. This can be used to augment face-to-face classes as “blended learning” or it can be used to implement fully-online degrees as a “virtual university”.

Since it was first created in 1999 it has become a platform on which over 60% of higher education institutions around the world now depend on for their online interactions with students, with hundreds of millions of users and thousands of developers. It’s used in all sectors: primary and secondary schools; huge Open Universities that have 2 million active students; boutique training companies and large corporates for internal training.

A key reason for this is the fact that Moodle is open source software, with a strong global open source community and values, which enables academic users to engage with and support the

project in a number of ways. But this alone was not enough: there are countless great projects in the online graveyard. The second major reason is that Moodle is a sustainable open source project that supports itself with a unique business model around services that works in harmony with what Moodle users need.

Moodle Pty Ltd, the Perth-based company at the heart of Moodle, has been steadily expanding the platform with further products and projects to augment the basic LMS: including Moodle Apps, MoodleCloud SaaS, MoodleNet social network, Moodle Workplace corporate training, a Moodle Educator Certification curriculum and MoodleMoot user conferences around the world. All of these fit together to produce a full Moodle Learning Platform.

Moodle is part of a global movement towards Open Technology, which seeks to act against a worrying trend of large global companies that are trying to “take over” education infrastructure using proprietary tools that remove control from our public and private institutions, exploit student data, and profit excessively from our education systems. Moodle’s latest initiative is an annual conference in Barcelona called OpenEdTech.global which brings together everyone interested in Open Education Technology to work on creating total open education solutions for the future.

Dr. Dougiamas will explain the journey of the Moodle project, its increasing relevance in the context of today’s technical, political and social environments, as well as outlining some solutions to the challenges that all of us are facing in the future.

**Dr. Martin Dougiamas**  
**Founder and CEO of Moodle**

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# Frontiers in Computing Technology

## 3D Visualization of Human EEG Signals

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The brain is the most important and the most complex human organ that is responsible for all the functions that we do in our routine life. Moreover, the brain consists of millions of neurons that utilize electro-chemical signals to transmit information to other parts of the body. Whenever a neuron triggers an electrical impulse to another neuron, it generates electricity, referred to as an EEG wave that can be measured by a sensitive device. Using such brain patterns, it is possible to identify normal day-to-day human behavior. The brain commences its work before birth and works continuously until death during which brain waves are constantly generated according to what we perceive from the environment. By analyzing brain wave patterns, we can predict and identify valuable information on human or animal health. For examples we can monitor coma and brain death in human or animals, various effects of drugs on sleep disorder, day-to-day life human behavior, post-traumatic stress disorders (PTSD), etc.

In the experiments conducted, we took the potential differences between the respective channels to identify the variations in brain wave data among the individuals. We used linear interpolation to generate 3D views of the potential data between the locations where the electrodes were placed. A color code is then applied to indicate the range of potential values projected on the human skull. High frequency components were observed near the right parietal and right occipital lobes of the brain. Significant variations were not observed near the frontal or the left region of the brain for a specific activity.

The proposed project will introduce a technique to visualize human brain waves in 3D over the skull that will enable us to interpret how these brain waves are associated with various regions on the human brain.

*Keywords: brain waves, cross correation, neurophysiology, EEG signals*

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# Automatic Motion Artefacts Recognition in Resting ECG/EKG to Identify Failed Tests using Machine Learning

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Although an ECG is able to identify certain heart diseases, an uninterrupted and a clear signal is essential to accurately diagnose any abnormalities in the heart functions. Obtaining such a crisp ECG is a challenging task due to several artifacts such as motions because muscle movements are inevitable even in resting ECGs due to medical conditions such as anxiety, Parkinson's disease and body tremors. In addition, skin stretching too, produces electricity that disturbs the potentials involved in an ECG. There are numerous experiments have been conducted to find effective and efficient motion artifact removal methods from ECGs. In this study, we use cleaned and disturbed ECGs to implement more effective and efficient method to remove motion artifacts and evaluation mechanism for ECGs.

The first stage of the proposed technique involved gathering more than 500 ECGs having 12 leads data from public sources available on PhysioNet online database. These data contained cleaned ECGs and disturbed ECGs of healthy and unhealthy patients. The data set is cleaned to remove noise and undesirable effects such as baseline wander. A technique based on multi-resolution thresholding is used to recognize and remove motion artifacts and further, the Savitzky-Golay filter is used to reduce the mean squared error of this process.

In the second stage, a convolution neural network (CNN) is implemented on the cleaned ECG dataset. Initially, datasets of 12 leads are shuffled under two categories: with and without noise. These shuffled images, numbering more than 36,000, are then categorized for training, validation and testing of data with and without motion artifacts.

Results indicate a 98.7% accuracy in predicting whether a given ECG can be used or not by examining more than 500 cleaned ECGs.

*Keywords: ECG signals, motion artifacts, heart rate, heart attack*

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# Predicting the Movement of All Share Price Index using Neural Networks

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All Share Price Index (ASPI) measures the movement of share prices of all listed companies in Colombo Stock Exchange (CSE). Accurate prediction of stock indices is important in investment decision making and it leads to higher profits. The objective of this study is to predict the movement of ASPI of Colombo stock exchange with a higher accuracy. Artificial neural networks were used to achieve this objective. Both quantitative and qualitative factors affecting the movement of ASPI were considered for forecasting. In this study, data of ASPI including open index, close index, volume and foreign exchange rate (USD/LKR), crude oil price were considered as quantitative factors and socio-economic condition of the country, political situation and activation of foreign investors were considered as qualitative factors affecting ASPI. The data has been collected through web scraping from news web sites and download relevant stock data csv files. In this research natural language processing techniques were used for textual analysis. With the advance development in the computational power in the computers and more advance machine learning algorithms and approaches such as deep learning, new algorithms are developed for forecasting time series data by scholars. In this research, feedforward neural network and recurrent neural network (RNNs) with LSTM were applied to predict future directions of ASPI. Different ways of maintaining LSTM state and effect of using a fixed number of time steps on LSTM were investigated and extensively compared the prediction performances with feedforward network which uses the historical stock data, exchange rate, crude oil price and sentimental score as inputs. The feed forward neural network model which was identified as the best model among all considered models is capable of predicting the direction of ASPI with 77% accuracy. This model is useful for investors to make decisions in stock market investments and additionally this model can be extended to predict other stock markets.

*Keywords: ASPI (All Share Price Index); Sentimental Analysis; Neural Networks*

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# Global Positioning System Based Real-Time Traffic Monitoring System for Minneriya National Park

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Located in the North Central Plains of Sri Lanka, Minneriya National Park is an ideal eco-tourism location. Annually during the dry season, August to September herds up to 300 elephants get attracted towards the Minneriya reservoir. Due to the large elephant herd that visits the reservoir throughout the year, mostly in the dry season, Minneriya National Park has become a large visitor attraction.

The increasing visitor attraction to witness the elephant gathering in the banks of Minneriya Reservoir has caused adverse effects to the sensitive ecological areas, disturbing the natural habitats. The high number of visitor attraction has caused difficulties in the systematic management of safari rides in the park.

The main objective of this project is to design and develop an android app that tracks the location of vehicles entering the park based on GPS data. The geo-location history of safari jeeps is updated in Firebase Real-Time Database. The park administrators are provided with a web-based system that consists of a customized map that shows the real-time location of all vehicles inside the park. Also, using Firebase Cloud Messaging facility, administrators can message the safari jeep drivers real-time and redistribute the vehicle traffic.

Geo-fences are implemented in the app that marks protected zones. It indicates to the drivers that they are sensitive ecological areas and enter and exit to the areas are marked by an app notification. The app also shows the other safari vehicles in its proximity and the jeep drivers can have an idea of the real-time vehicle traffic.

When implementing the app traffic data of 20 vehicles were collected and identified that grassland habitat occupied the maximum number of vehicles. There were concerns regarding network battery drain. It can be minimized by changing the CPU frequency when the app is inactive in run time.

Through this real-time traffic monitoring system, the park administrators can easily manage and redistribute safari jeep traffic and improve the behavior of safari jeep drivers eliminating disturbance caused to flora and fauna of the national park due to increased vehicle traffic.

*Keywords: Android; Traffic Monitoring; GPS; Geo fences*

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# Identification of Papaya Fruit Diseases using Deep Learning Approach

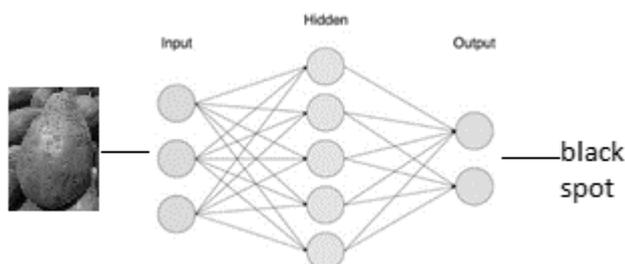
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The diseases are a major problem faced by all the farmers including fruit farmers. It is a threat for large farmlands because these diseases spread throughout the land and make the fruits inedible, which at the end impact badly on the farmer's income. Hence early disease detection is very important for the farmers to prevent or to control the propagation of the diseases. The traditional method of fruit disease detection and identification is naked eye observation. Even if this method is sufficient for a home gardener, it is a very inefficient one that requires experience and expertise. As a solution for this problem several computerized approaches are being developed using Machine Learning and Image Processing techniques in the recent researches. In our proposed work, we considered Papaya fruit, as it is a very popular fruit cultivation in Sri Lanka. In this study we have implemented a computerized model for papaya disease identification using Convolutional Neural Network (CNN). Among various diseases of papaya fruit, anthracnose, black spot, powdery mildew, phytophthora and ringspot were chosen. These are commonly found in Sri Lankan papaya cultivation. We have collected diseased images using a digital camera in normal conditions from papaya farms. Some of the images were found from the publicly available images on the internet. Then we have trained a deep CNN for these images. The network is able to classify images into five major papaya diseases. The system can finally identify the disease once a new image fed to it. The model performed ~92% of classification accuracy for new images. With compared to previous research done using Support Vector Machine (SVM), there is an increase of ~2%. Furthermore, it could be seen that the Black Spot disease was identified very easily by the model. Powdery Mildew was the most difficult disease to recognize. The results of this study reveal that this method is an accurate, reliable and efficient where it could be useful as an aid for expertise.

*Keywords: Machine Learning; Convolutional Neural Network; Fruit Diseases*



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# Behavior & Biometrics Based Masquerade Detection Mobile Application

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Mobile phone has become an important asset when it comes to personal security since one's mobile is now a virtual safe for that person. This is due to the sensitivity of the details which are stored in these devices. To protect the information inside a mobile phone the manufacturers use conventional technologies such as password protection, face recognition or finger print protection. Nevertheless, it is clear that these security methods can be bypassed by several other techniques as shoulder surfing, finger print or face recognition by pass with 3D printing. Due to these concerns post authentication is an increasingly discussed topic in the security domain. However, there are very few applied researches done on the post authentication of mobile platforms. In order to protect the phone from an unauthorized user a novel method is proposed by the authors. The aim of the research is to detect the illegitimate user by monitoring the behavior of the user. In order to detect the behavior four main parameters are proposed. Namely, Key stroke dynamics using a customized keyboard, location detection, voice recognition and App usage. Initially machine learning is used to train this mobile application with the authentic user's behavior and they are stored in a central database. After the initial training period the application is monitoring the usage comparing it with the existing data of the legitimate user. Another unique feature is the inbuilt prevention mechanism which is designed to be executed when an illegitimate user is detected. The entire storage content will be encrypted and a current location alert along with a captured photo of the intruder will be sent to a pre-defined account of the real user in a cloud platform. The real user can log into the account remotely and obtain the phone's location and the photo of the intruder. Furthermore, this application is proposed as an inbuilt application in order to avoid the deletion of app or uninstallation of the app by the intruder. With this proposed post authentication application "AuthDNA", a user is able to protect sensitive information of the mobile device in case of theft and bypassing of initial authentication.

*Keywords: Machine Learning; Authentication; Encryption; Voice recognition; Cloud Storage.*

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# Comparative Analysis between K-mean and EM Clustering for Investigate Appropriate Algorithm for Landslide Risk Evaluation

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Irregular development activities on mountains and inadequate attention to construction aspects have led to increasing of landslide and sustaining damages to lives and properties. Within the study area, nearly 3275 sq.km of the area expanded over the Ratnapura District; and is to be highly prone to land sliding of 2178 sq.km. Landslides transpired in many regions of this area, and nearly 90 deaths have reported by National Research Building Organization (NBRO), Sri Lanka. If the suitable investigations were performed at the right time, most of the landslides could be predicted relatively and accurately. The main objective behind this of study is to evaluate the landslide risk levels to discover the real extent, timing and the intensity of landslide processes in Ratnapura district, such knowledge will present vital benefit to government officials, and the general public to avoid landslide hazards and mitigate the losses. Clustering Approaches can be used to developed the Risk Analysing model using actual data. This method was based on K-mean and Expectation Maximization (EM) Algorithms by concerning triggering factor; rainfall and causative factors; slope angle, elevation, and intensity. Such data were collected and applied to the Clustering algorithms. In this study, comparing the multiple Clustering algorithms and investigate the most appropriate risk evaluation approach where it can be used to advance hazard monitoring, early warning, and disaster mitigation. The results indicate that EM clustering algorithm showed accuracy over 84% with the highest speed. The highest accuracy over 92% was acquired by the K-means algorithm, but it was more time-consuming than EM algorithm. Therefore, this research proposed that an EM clustering has a strong capability to fit for the Landslide risk evaluation and producing a more relevant and accurate prediction of the landslide vulnerability within the study area.

*Keywords: Clustering; K-mean; Expectation Maximization (EM)*

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# Scalar and Multi-Scalar Addition Chain in Elliptic Curve Cryptography

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Cryptography is a mathematical based technology that ensure the security of communications in the presence of malicious adversaries. Nowadays, cryptography deals with designing of algorithms, protocols and systems to secure transfer of information. The Elliptic Curve Cryptography (ECC) is a main branch of the public key cryptography (asymmetric cryptosystem) which was introduced by Neal Koblitz and Victor Miller in 1985. Higher speed, the efficiency of using power, bandwidth and less storage are some advantages of ECC. The strength of ECC is based on the inability of determining the scalar  $k$  of the scalar multiplication  $kP$ , where  $P$  is a point of an elliptic curve in finite field and it is known as the Elliptic Curve Discrete Logarithm Problem (ECDLP). Hence, the scalar multiplication is the central operation of ECC. Since most of the efficient and secure exponentiation methods (i.e. double-and-add, triple-and-add methods) depend on the secret scalar or exponent, an attacker may reveal the secret information through the side channel analysis (side channel attack). Simple Power Analysis (SPA) is a type of side channel attack that an attacker retrieves secret key by observing the power consumption traces. One way to overcome this problem is the use of doubling free addition chain since it results a fixed sequence of operations, and an attacker cannot detect any information through SPA. Therefore, we have implemented a new methodology that is more secure and reasonably efficient, a doubling free simultaneous addition chain involving Lucas pattern to compute the scalar and multi-scalar multiplication.

*Keywords: Elliptic Curve Cryptography, Simple Power Analysis, Doubling-free Addition Chain*

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# MLP Model Approach for Driver Fault Identification

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The issue of the traffic accident has gain attention of the globe which has been a major challenge for the sustainable development of transportation and traffic. Crashes are events which occurred by involving different components: Driver, road, environment. Driver identification is directly connected to taking advanced actions on the road accident. Prevention of the road accident is the primary concern and necessary legal actions must be taken for the responsible party of the accident. In order to accurately predict the driver fault regarding an accident, this study aims to identify whether the driver is fault for the accident or not, by using a Multilayer Perceptron (MLP) model. The proposed model accurately predicts the driver fault while ensuring the accuracy of the decision. Proposed Multilayer perceptron model has achieved an accuracy of 97.77% with the accident data. To compare the results of the model, Decision Tree, Linear classifier and DNN classifier has used. Comparative results revealed that the most accurate model as the Multilayer perceptron approach. Necessary sensitivity analysis regarding the MLP was performed to find the best MLP model. Results revealed that by using 500 epochs with RMSprop accuracy was increased. T – Test was performed with 0.05 accuracy level for the selected methods and MLP method outperformed the other techniques. The research will provide the information needed to guide the relevant decision-makers in adopting suitable measures to prevent and to reduce the accident rate.

*Keywords: Multilayer Perceptron (MLP); DNN classifier; Decision tree; Linear classifier.*

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## The Study on the Factors Influencing to Customer Adaption of E-Banking in Sri Lankan Banks

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This study attempts to examine the factors affecting to customer adoption of E-banking in Sri Lankan Banks. E-banking provides many services for their customers. Convenience, speed, efficiency, effectiveness are advantages of E-banking on the customer's hand. Bank considers it as it holding customer and reduce paper works. Through this observation, researcher found factors of people adopt to E-banking and after that Banks can address to those factors and promote it. So they will be able to speed their E-banking market. On the other hand, Customer will get more benefits of E-banking. This study is based on positivistic paradigm hence deduction method is used as reasoning approach and used quantitative techniques. The data for this study is used primary and secondary data to analyze the database and give an opinion. Primary data was collected from customers from five registered commercial banks by using a questionnaire which is a type of Likert scale form. Secondary data was collected by the annual reports (2017) of commercial banks. As the sample of this research, the researcher selected 163 E-banking customers of five registered commercial banks. The researcher has used usage of E-banking as dependent variable and attitude, subject norms, perceived behavior as independent variables. In this study, researcher used descriptive statistics for the determinants of customer adoption of E-banking. The study is used correlation analysis to investigate any relationship between attitude, subject norms, and perceived behavior with the Usage of E-banking. According to the Correlation Analysis, the values of 0.865, 0.689, and 0.688 at 0.000 levels respectively depict the positive relationship between usages of E-banking. The study is used Multiple Regression Analysis to assess the impact of factors influencing to customer adoption of E-banking. According to Regression Analysis, the study reveals that the attitude, subject norms and perceived behavior impact positively to usage of E-banking. This research is significant to all the banks to take their decisions to satisfy their customers. Moreover, by proceeding those decisions banks can achieve their financial targets.

*Keywords: Attitude; Subjective norms; Perceived behavior*

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# A Trust based Advanced Machine Learning Approach for Mobile Ad-hoc Network Security

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Mobile Ad-hoc Networks (MANETs) are one of the types of Wireless Ad-hoc Networks which consist of autonomous mobile nodes connected wirelessly. These are self-configured, less-infrastructure networks which are having highly dynamic topologies due to the frequent link changes in the network including the addition of new nodes, removal of existing nodes and etc. Because of this dynamic nature, various issues regarding the reliability of the communication and other security threats such as malicious attacks occur in MANETs. Since 'Trust' is the major factor which reliability and the security rely on, enhancing the trust in a MANET ensures that the security of the network environment is achieved. Over the recent past decade, a plenty of researches have been done in the related area including approaches of Machine Learning, Swarm Intelligence, Mobile Agents and Probabilistic Models. When comparing the different properties of each approach such as memory, computational power, flexibility to topology changes, the accuracy of results and cost, applying machine learning techniques has been efficient and accurate in providing results. Among Machine learning approaches reinforcement learning gains a more suitability for applied in mobile ad hoc networks since it gives more accurate results due to the ability to capturing the dynamic behaviour easily as well as no need for historical data to give predictions where it can give predictions on newly joined network nodes also. And when selecting the best algorithm because of the physical distribution of MANET information, an algorithm which has the ability to be distributed among the nodes has to be chosen. Instead of considering direct and indirect trust separately, it is recommended to apply a hybrid trust approach which aggregates the trust values. Hence, considering all this information the future research work is planned to be launch in the area of machine learning; specifically, in the area of reinforcement learning according to the analyzed results of early work. Therefore, this research work is proposing to develop a trust computational model, which uses an advanced machine learning mechanism to predict the trust value of each network node.

*Keywords: Mobile Ad-hoc Networks, Malicious Attacks, Nodes, Trust*

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## LaSi Spell: Language Agents for Sinhala Spellings

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A Spell Checker is a tool which can be used as a learning tool for any language learner because meaningful words are created through correct spellings. It's an essential part of several computer softwares such as web browsers, word processors and others because spelling of words gives their correct meaning. Sinhala is a language which contains so many spelling rules, while there are few spell checkers that have been developed for this language. Multi-agent systems are capable of handling the complexity of the real world problems through its emerging features including communication, coordination and negotiations. This paper presents the design and implementation of a multi-agent-based spell checker, named LaSi Spell, which is implemented through the MaSMT framework. It consists of sub-ordinary agent systems namely corpus agent, rules agent, GUI agent, custom agent and internet agent. LaSi Spell, a desktop application, has been implemented through Java and is capable of running on Windows. The LaSi Spell has been incrementally tested and has shown encouraging results in its performance.

*Keywords: Multi-Agent System; MaSMT; Sinhala Spelling rules*

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# An Application of Artificial Neural Networks to Predict the Milk Yield of a Typical Dairy Farm in Sri Lanka

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It is quite interesting that milk and dairy products play an important role in a healthy, balanced diet thus contributing to certain indispensable nutritional benefits. Hence, the need for dairy is crucial, which means dairy farms provide a vital necessity to the people in both rural and other areas across the country. Therefore, accurate forecast of milk yield is important for dairy farmers to utilize and optimize their production process. The present study is aimed at using Artificial Neural Networks (ANN) for predicting the milk yield of a dairy farm by considering the potential factors that affect the milk production. Further, it is important to note that this dairy farm has kept records of the daily milk yield, the amount of food given to cows, and weather condition. Data from January 2016 to June 2018 were used for the study. In this regard, a feedforward neural network (FFNN), non-linear auto regressive neural network (NAR), and a non-linear auto regressive exogenous neural network (NARX) were fitted. Analysis was done using Matlab software and all three implemented models took around 30 seconds for execution. While all the three models exhibited quite strong model performances, the NARX model exhibited prominently outstanding results. The best forecasting performance was shown by the NARX neural network which contained one hidden layer with five neurons having saturating linear transfer function. Normalized Mean Squared Error (NMSE) was 0.0247 for the overall model while the Mean Absolute Error (MAE) value was 6.6245.

*Keywords: Dairy; Neural network; Milk yield; Factors*

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## Content in Box - Extending Moodle

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Aim of this research is to propose a systematic way to share Moodle-based learning materials such as video to remote schools that have limited Internet access. This has become a need in Sri Lanka. Because, serving multimedia contents over the internet is heavily limited by bandwidth and the link speed and this is a common problem everywhere, especially in the rural areas where the penetration of the Internet is very limited. On the other hand, the use of Multimedia has become an inevitable practice in classrooms. Further, self-paced learning has become a focal point in recent time. The government has also taken initiatives to promote self-learning and has invested a lot in setting up the environment and developing content for self-paced learning. In addition, there are studies in the region show that the use of multimedia content would increase the performance of students in national examinations. Shortage of school teachers in remote schools is also another serious issue. On the other hand, now there are several computer laboratories around the nook and corners of the country which are rarely utilized. Some of these laboratories have the Internet, however, students are usually not permitted to use the Internet due to the concern of Internet data cost. Aki.coach has been developed as an online course delivery platform for secondary education in Sri Lanka. To break the obstacles in taking this school level, a portable Aki box is introduced. This box will act as an integrated Content Delivery Network using squid proxy for Moodle. The box comes with all the video and the bandwidth consuming content. If this box is plugged to a laboratory, all the students can do self-paced learning using video and other materials. However, when students access a newly updated video, it will be downloaded via the Internet and stored in the Aki box. Students can also do an online examination. More importantly, students can continue their activities when going home. However, the content will be served from the main server when they access from home which students will feel any differences. Aki box has a Moodle installation which will periodically update the main server. Even if there is an Internet problem still the content can be served from the Aki box and the data will be synced when there is an internet connection. Moodle is altered to always get the video and other bandwidth consuming content from the squid cache if it is available. Now, this box is piloted in one location and soon it will be made available to other schools.

*Keywords: Moodle; e-Learning; Aki.coach; content delivery*

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# An Unsupervised Machine Learning Approach for Churn Prediction

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Customer churn is one of the critical issues faced by the firms nowadays. Telecommunication industry is no exception to this rule. In this industry, keeping the existing subscriber (customer) is more valuable than acquiring a new subscriber (attracting new customers costs approximately 5 times higher than retaining the existing customers). Therefore, predicting the attrition behavior of customers in advance is a significant task. This behavior has triggered most of the researchers to focus on developing the churn prediction model in several industries. Anyhow, in most of the time supervised machine learning techniques have been incorporated in this regard. But in here, an unsupervised machine learning approach has been proposed. A local telecommunication company can be approached for the purpose of conducting this research. Around 10,000 postpaid subscriber details with 20 attributes have been obtained and analyzed during this research. Further, Principal Component Analysis (PCA) and K-means clustering algorithm have been utilized with the intention of reducing the dimensionality between features and to find the churners and non-churners respectively. The results obtained from the PCA have revealed that, 16 principal components which represent all the 20 features are considered as most important aspects to cover the entire data. Moreover, totally 6 clusters have been generated and some particular features that tend to show high contributions were identified during the principal component analysis have been analyzed towards each cluster. The proposed approach has finally revealed that out of the 6 clusters three (3) representing 4888 are churners and the other three (3) representing 5112 are non-churners. It could be ensured that, this approach would assist the future researchers to have a promising start for combining the unsupervised technique with the supervised one.

*Keywords: Churn; Unsupervised Machine Learning; Principal Component Analysis; K-Means Clustering*

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# Analyzing the E-Learning Satisfaction Factors Among University Students' in Software Engineering Domain

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E-learning has become popular within science faculties in Sri Lanka involve access to computers and significant knowledge of information technology. E-Learning provides a Web-based learning platform with a representative and more flexible framework which could support learning and teaching. E-learning provides various services that are customized by the students' needs, knowledge, expertise, and experience. This study focused on the undergraduates' analyzing the eLearning as an effective tool. , this study focused on analyzing the e-learning satisfaction factors among university student's in the software engineering domain at the University of Kelaniya, Sri Lanka. This research aimed to provide a set of factors to be well-thought-out when an E-learning activity is planned and proposed to E-learners in the university of Kelaniya, Sri Lanka. The linear regression techniques were used to test the proposed research hypotheses. The technique run with online course satisfaction as the dependent variable, perceived usability, perceived quality, perceived value and computer self-efficacy as the independent variables. This study was based on a total sample of 150 students who are following Software Engineering degrees in the university Kalaniaya Sri Lanka. Point toward the results, that the effectiveness of e-learning is related to how confident students are while using the computer and the web-based learning software. The results of the study indicate that developers need to consider self-efficacy issues while developing e-learning systems.

*Keywords: E-learning; Online learning; Student satisfaction*

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# Use of Image Processing as an Alternative to Manual Traffic Counts

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Intelligent Transport Systems are essential to achieve efficient and effective traffic management system in the Sri Lankan context. Quality and accurate traffic data are essential in analyzing, visualizing and for future prediction of traffic. We used deep learning based real-time object detection YOLOv3 to traffic surveillance. The research focuses on identifying best camera orientation for better accuracy, transfer-learning of Sri Lankan Vehicles categories into classes, classified vehicle counts using video processing and compare accuracy and efficiency of image processed vehicle classified counts with that of manually collected data. Videos are captured in 1080p @ 60fps at an angle of  $\Theta = 0^\circ$  and  $\Theta = 15^\circ$  in different heights. Use 500 vehicles in each category to train and 500 vehicles in each category for evaluation. This study intends to apply image processing and Deep Learning based real-time object detector to capture different vehicles classification in order to solve the existing traffic problem in Sri Lanka.

*Keywords: Image Processing; YOLOv3; Traffic Counting; Vehicle Classification.*

# Frontiers in Science and Engineering Technology

## Development of a Solvent System for Effective Leaching of Extractable Proteins in Dipped Product Surfaces

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Allergic conditions caused by natural rubber latex (NRL) proteins have become a vast problem in the natural rubber latex industry. Leaching is one of the protein removal methods which have been used in the industry. The objective of this study was developing a leaching solvent system to remove surface NRL proteins from dipped product surfaces using urea and sodium dodecyl sulphate (SDS). In this research NRL samples were prepared and leached using 4 different solvent systems namely distilled water, urea, SDS and a mixture of urea and SDS. At a time, one sample set (3 latex sheets to triplicate the results) was leached in previously mentioned solvent systems for a particular time and then washed with flowing water. Nine sample sets were used for the study. One sample set was kept without leaching. After leaching, Attenuated Total Reflectance Fourier Transform Infrared spectroscopy (ATR-FTIR) was used for qualitative determination of remaining surface protein content and modified Lowry method was used for quantitative determination of surface proteins. Antigenic proteins on sample surfaces were quantified using enzyme linked immunosorbent assay (ELISA) which is determined by reactions between specific NRL antibodies and NRL antigenic proteins. Without leaching, the average remaining extractable protein content was above the detection limit ( $> 200 \mu\text{g/g}$ ). Therefore, water leached sample set was used as the control. When the urea concentration in leaching was increased, the removal efficiency of surface proteins was higher when a mixture of urea and SDS was used compared to when urea alone was used. This was observed in all the concentrations of urea: SDS ratios used. The maximum removal efficiency (74.36%) was observed for the leaching solvent mixture containing urea: SDS ratio 3:1. This could be due to the fact that both urea and SDS influence in deproteination and that increases the solubility of extractable proteins. In addition, ELISA suggested that after leaching, the antigenic protein content was below the detection limit for all the solvent systems used. However, since the removal of extractable protein content was maximized when mixture of urea and SDS was used it is expected that the antigenic protein content might also be further reduced compared to other solvents used.

*Keywords:* Natural rubber latex; surface proteins; allergic; leaching

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## Investigation of Lead Concentration in Road Dust Samples in Kiribathgoda Area, Sri Lanka

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Heavy metal contamination has become one of the major problems in metropolitan cities all around the globe. Kiribathgoda area in Sri Lanka is one such hot spot. Anthropogenic activities have resulted in the increment of heavy metal levels in the earth's crust. Analysis of outdoor dust is a useful technique to determine the heavy metal content in an urban area and thereby predict the extent of air pollution. This could open opportunities to relate the threat for human health by such toxic heavy metals in an unhealthy environment. This investigation was carried out by selecting a section from the main road of Kandy-Colombo in Kelaniya area. Ten sampling sites were selected and samples were collected as triplicates for three consecutive months. Their pH level and organic matter content were tested. Also, concentration level of the heavy metal Pb was determined using atomic absorption spectroscopy. The preliminary factors that favor the persistence of heavy metals in the environment were investigated and analyzed. It was observed that slightly acidic (pH  $5.89 \pm 0.41$ ) dust favor Pb deposition. The Pb content was found to be fluctuating around 22.01-84.52 mg kg<sup>-1</sup>. A good positive correlation (Correlation Coefficient 0.878) was observed in between Pb- Organic matter. It was evident that Pb exists in the environment for a very long time but their escape from nature is very slow. Hence it is necessary to study and understand the health risks associated with heavy metal toxicity on future studies developing from the findings of this research that will benefit the mankind.

*Keywords: Lead; Toxic; Correlation; Organic*

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# A Pragmatic Approach to Enhance the Economic Viability of the Road Construction Industry in Sri Lanka by Integrating Lean Construction Concepts.

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The interconnection of activities required for the design and construction of building and infrastructure involves the interplay between people, technology, situations, and decisions. It requires the astute coordination of labor, materials, and plant to realize the planned progress of work. Minimizing waste and maximizing value while continuous improvement is the concept of lean. Lean construction has proven to be an alternative for such improvements so as to satisfy the client by creating customer value. Through its origins in the Toyota Production System, lean is now applied as an innovative way to manage the design and construction of projects with the use of tools which address project constraints, such as complexities and uncertainties, among others. This research is an effort to implement lean construction concept to the Sri Lankan road construction industry.

Research approach involved the use of primary data, collected from Questionnaire survey and semi-structured interviews with qualitative and quantitative mixed type research. The foremost objective was to optimize the cost, quality and time in road construction with the application of lean construction concept and identify most important lean tool among 5S, Construction process analysis, just in time, Value stream mapping, Kanban and last planner and adapted to road construction industry. Finally, the aim is to identify the most important lean construction tool for road construction improvement.

*Keywords: Lean construction concept; Road construction; Toyota production system*

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## Reduction of Color, COD, and BOD<sub>5</sub> of Treated Leachate Using an Activated Coconut Charcoal – Fired Clay Brick System

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Removal of color from waste water by activated carbon is a common practice and studies have also been done with fired clay bricks. Nevertheless, no studies have been carried out to evaluate the removal of color by a combination of activated carbon (CC) and fired clay bricks (BR). The present study was therefore, planned to evaluate the potential of the combination of CC (activated by ZnCl<sub>2</sub>) and BR for the removal of color, chemical oxygen demand (COD) and five day biochemical oxygen demand (BOD<sub>5</sub>) of the treated leachate discharged from sanitary landfill located at Dompe, Gampaha, Sri Lanka. CC was impregnated with 0%, 5%, 10%, 15% and 20% ZnCl<sub>2</sub> and activated in an oven at 200°C afterwards. The activated CC – BR systems were prepared in PVC pipes with the ratio of 1:0 (T1), 0:1 (T2-T6), 1:1 (T7-T11), 1:3 (T12-T16) and 3:1 (T17-T21) BR particles and CC respectively. Leachate was filtered through the prepared systems at flow rate of 1L/hour. Color, COD, BOD<sub>5</sub> and pH of filtrate were measured. Percentage reductions of parameters were first subjected to arcsine transformation and then to One-Way ANOVA in MINITAB 14. Tukey's pair wise comparisons were also carried out to identify significant differences of parameters among different percentages of activated carbon. Results revealed that 20% ZnCl<sub>2</sub> impregnated CC and BR at 1:0 system showed the highest percentage of color (>90%) and COD (>85%) reductions. CC - BR at 1: 1(CC activated by 20% ZnCl<sub>2</sub>) (T-11) and CC - BR at 3: 1(CC activated by 20% ZnCl<sub>2</sub>) (T-16) showed the highest percentage of BOD<sub>5</sub> (more than 95%) reduction. After 5-hour filtration, 20% and 15% ZnCl<sub>2</sub> impregnated CC and BR at 1:0 system showed pH lower than 6. The lowest pH was observed from 20% ZnCl<sub>2</sub> impregnated CC. The study concludes that CC impregnated with high amount of ZnCl<sub>2</sub> has a great potential to remove the color of leachate. Thus, the present study recommends the combination of 20% ZnCl<sub>2</sub> impregnated CC: BR at 3:1 ratio as the most suitable combination for the removal of color, COD and BOD<sub>5</sub> of the biologically treated leachate.

*Keywords: Activated carbon; fired clay bricks; ZnCl<sub>2</sub>; treated leachate*

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# Use of Processed Tea Waste Powder and Fiber in Improving the Properties of Rice Husk Ash Filled Compressed Stabilized Earth Blocks

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Rice husk ash (RHA) and processed tea waste (PTW) are major agricultural wastes. A recent study has shown that 7.5% of soil can be replaced with RHA in Compressed Stabilized Earth Blocks (CSEBs) due to its pozzolanic properties. Since PTW shows good pore-forming ability, the present study was planned to determine whether there is a potential to improve pore properties of previously upgraded CSEBs by replacing soil with PTW powder or fiber. The mixing percentage of soil, cement and RHA was 86.25: 6.25: 7.50 in the previously upgraded block. Five types of CSEBs of 300 mm x 150 mm x 100 mm (L x W x H) were manufactured by replacing 0% (Control- BC), 3 % (B3), 5% (B5), 7% (B7) of soil by PTW powder and 3% (BF) of soil by PTW fiber. The suitability of properties of raw materials were tested prior to manufacture CSEBs. Mechanical properties of manufactured CSEBs were tested. Data were subjected to One-way ANOVA followed by Tukey's pair wise comparison in MINITAB 14. The values were compared with SLS 1382: 2009 and British standards. The dry and bulk densities and weight reductions of PTW incorporated blocks (B3, B5, B7 and BF) showed significantly higher reductions ( $p < 0.5$ ) than that of Controls. B3 showed the highest compressive strength ( $3.8 \text{ Nmm}^{-2}$ ) except Controls. In addition, B3 also showed the lowest surface erosion (pitting depth = 0 mm and pitting rate =  $0 \text{ mm min}^{-1}$ ) and the highest durability (Slake durability Index = 90). In addition, B3 showed the lowest loss on ignition (12.5%) and the percentage weight reduction (6%) except controls. According to SL standard 1382 part 1: 2009, only blocks BC and B3 were suitable for construction of walls (Grade 3). In addition, B3 was also suitable for external walls compared to control blocks. When compared with the British standards, only BC was suitable for load bearing walls for two storey houses. Considering all aspects, 3% of PTW powder incorporated CSEBs with 7.5% of RHA can be recommended for single story buildings and for external use in places where PTW is highly abundant.

*Keywords: RHA; PTW; Pozzolanic properties; Pore-forming ability*

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## Potential Use of Selected Macrophytes Based Constructed Wetlands for the Treatment of Landfill Leachate

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Phytoremediation using constructed wetlands (CWs) is widely practiced for the removal of contaminants in landfill leachate. The present study was planned to assess the potential of floating macrophytes (*Eichhornia crassipes* and *Pistia stratiotes*) and emergent macrophytes (*Typha angustifolia* and *Chrysopogon zizanioides*) in improving the quality of leachate discharged from a Sequencing Batch Reactor (SBR) system located at Dompe sanitary landfill, Gampaha, Sri Lanka. The batch type CWs were arranged to identify the suitable dilution of leachate (as 0%, 25%, 50% and 75%) for the optimum plant growths. Based on the preliminary investigations, the potential of improving leachate quality by (ia) *E. crassipes* (T<sup>50</sup><sub>1</sub>) (ib) *T. angustifolia* (T<sup>50</sup><sub>2</sub>) and *C. zizanioides* (T<sup>50</sup><sub>3</sub>) at 50% dilutions and (ii) *T. angustifolia* (T<sup>0</sup><sub>4</sub>) and *C. zizanioides* (T<sup>0</sup><sub>5</sub>) at 0% dilution were assessed in continuous flow CWs. Water quality parameters including temperature, pH, electrical conductivity, turbidity, BOD, COD, TSS, phosphate, ammonium nitrogen, nitrate, sulphate and color were tested once in five days for 40 days period. Results were subjected to One-way ANOVA followed by Tukey's pair wise tests in Minitab 14. Two sample t-test at 95% CI was also applied as required. With respect to controls, percentage reductions of measured parameters increased in wetlands having either floating macrophyte, *E. crassipes* or selected emergent macrophytes. Nevertheless, among the emergent plants, *C. zizanioides* [(T<sup>50</sup><sub>3</sub>) and (T<sup>0</sup><sub>5</sub>)] showed the highest performance in improving leachate quality followed by *T. angustifolia* [(T<sup>50</sup><sub>2</sub>) and (T<sup>0</sup><sub>4</sub>)] at both dilutions. Although *E. crassipes* (T<sup>50</sup><sub>1</sub>) showed higher percentage reductions of the selected parameters at 50% dilutions, this is not recommended as leachate dilutions are impractical in CWs. *P. stratiotes* has proven unsuccessful in the present study. Therefore, among the plant species selected, *C. zizanioides* that performed at 0% dilution could be recommended as the best plant for the remediation of leachate draining from SBR system.

**Keywords:** Phytoremediation; MSW leachate; Emergent macrophytes; *Chrysopogon zizanioides*; *Typha angustifolia*

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## Comparing Geant4 Simulated and TALYS-1.8 Code Evaluated Cross-Section Data for 4.438 MeV Gamma ray Line of $^{12}\text{C}$

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In present, Monte-Carlo transport code plays a major role in developing detectors, particularly the Geant4 Monte-Carlo code due to its versatility and flexibility for different applications. Although, the Geant4 has been an invaluable tool for the development of devices, the discrepancies in prompt gamma cross-section data for prominent elements of human body has been reported in the range of proton therapy (50 -250 MeV). Even though, the binary cascade model has been suggested in proton therapy range, the problems with prompt gamma production cross-section have been reported. The aim of this study is to compare Geant4 simulated and TALYS evaluated prompt gamma cross-section data of 4.438 MeV photo peak of  $^{12}\text{C}$  to identify the inconsistency in the cross-section data. TALYS is a nuclear reaction study software which can be used to simulate nuclear reactions in the energy range of 1 keV to 200 MeV. The Geant4 model of AFRODITE detector system has been modeled to mimic the iThemba LABS AFRODITE detector system. The Geant4 AFRODITE model was validated using three standard gamma emitting sources ( $^{60}\text{Co}$ ,  $^{137}\text{Cs}$ , and  $^{152}\text{Eu}$ ). The absolute detector efficiency of the Geant4 AFRODITE model also was determined. In the cross-section measurement simulation study,  $10^{12}$  proton histories were used to collide the carbon and mylar target in the proton energy range of 66 – 125 MeV. The same procedures were performed experimentally using AFRODITE clover detector system. Further, TALYS 1.8 code was used to simulate the proton interaction with carbon target in the range of 5 to 150 MeV. As with the 4.438 MeV cross-section data comparison, there is a significant inconsistency between Geant4 simulated and TALYS simulation and also with experimental data set. To improve the accuracy of Monte-Carlo simulation study, more experimental cross-section data and the evaluation of proper physics models of Geant4 Monte-Carlo transport code in proton therapy range are future need.

*Keywords: Geant4 Monte-Carlo transport code; TALYS; Prompt gamma production; Proton therapy*

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## Sorptive Removal of Lead (II) from Aqueous Solution using Value Added Tea-Waste Biochar Produced Under Different Temperatures.

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The removal of lead from aquatic systems using biochar (BC) derived from tea-waste was evaluated. The customized in-house method of BC production was incorporated slow pyrolysis at 300 °C (300BC), 500 °C (500BC) and 700 °C (700BC). The different BC types were subjected to a nitric acid modification and magnetization. Results showed reduced adsorption capacities for nitric modified BC. Batch sorption experiments were conducted to evaluate the effect of pH, equilibrium time, associated kinetic models and the thermodynamic basis of lead uptake. For both Non-Modified Biochar (NBC) and Magnetized Biochar (MBC), an acceptable fit for the pseudo second order kinetic model with regression coefficients greater than 0.998 justified a chemisorption process. The dominant mechanism for 700BC can be considered as pore filling together with  $\pi$  electron sharing between the graphene rings and lead whereas sorption on 300BC was governed by electrostatic interactions. Adsorption isotherms modeled were Langmuir, Freundlich, Sips, Redlich- Peterson and Toth, out of which the results were seen to best fit Langmuir and Sips models. A maximum Langmuir capacity of 57.80 mg/g and 48.61 mg/ for 700NBC and 700MBC were obtained respectively. Positive enthalpies and free energies indicated a non-spontaneous and exothermic sorption. Magnetic modification decreased sorption capacities by 15.86 % but led to the easy removal of biochar after the sorption.

*Keywords: Biochar; magnetization; Nitric modification; Sorptive removal*

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# A Novel Technique to Digest Biochar for Metal Analysis

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Biochar (BC) is a low cost carbonaceous adsorbent material widely used for the removal of toxic metal ions from aqueous systems due to their highly porous nature and presence of various functional groups. Depending on the feedstock used to produce these carbonaceous materials, the trace metal content may vary. Various digestion techniques have been incorporated to analyze the metal content of BC though a proper method has not yet been established. This study was focused on finding a suitable method to totally digest the carbonaceous material and to evaluate the matrix effect. Both open vessel and microwave digestion methods were carried out for BC derived from tea waste, king coconut husk, Douglas fir and steam activated coconut shell biochar (CSBC) using mixtures of 69% nitric acid (NA), fuming nitric acid (FNA), 98% sulfuric acid (SA) and 30% hydrogen peroxide (HP) and their turbidity were measured. Lowest turbidities for open vessel digestions were observed for SA/HP mixture for low-temperature pyrolyzed BC with no external heating (2.04 – 7.90 FNU). Microwave digestions provided satisfactory turbidity levels for NA, NA/SA mixture, FNA and FNA/SA mixture for all types of carbonaceous material (1.58 – 20.97 FNU). The matrix effects were compared using cadmium, copper, lead and zinc using flame atomic absorption spectrophotometry. Digestion mixture containing only fuming nitric acid showed the lowest matrix effect for cadmium (1.2) for CSBC and copper (2.4) for CSBC while the mixture containing only nitric acid shows lowest matrix effect (7.6) for zinc with respect to Douglas fir BC. Recovery study confirmed the suitability of FNA as a suitable digestion mixture incorporated with microwave energy.

*Keywords: Biochar; Digestion; Matrix effect; Turbidity; Recovery*

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# Study of the Effect of Incorporating a Preconditioning Step for the Adsorption of Methylene Blue from Water by Douglas fir Biochar

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Three major kinetic processes governing adsorbate uptake by an adsorbent such as biochar (BC) has been defined as external mass transfer, intraparticle diffusion (IPD) and mass action. In the usual methodology of batch adsorption, where the solution containing the adsorbate is directly introduced to the dry biochar, the entire pore space may not be accessible as the pore interior is not well hydrated. The presented work evaluates the effect of incorporating a preconditioning step where the BC is shaken with a selected organic solvent as a means of hydrating the hydrophobic pore interior. It is followed by its equilibration with de-ionized (DI) water to replace the preconditioning solvent. The process provides a BC with hydrated pores with a 'sample like' solvent. Solvents utilized for preconditioning were methanol (MEOH), acetone (ACE), acetonitrile (ACN) and DI followed by equilibration with DI. Sorption characteristics of pre-conditioned BC (PBC) was compared with that of non-preconditioned (NBC). The adsorption process was not significantly influenced by pH variations and the predominant sorption mechanisms were concluded to be  $\pi$ - $\pi$  electron donor acceptor (EDA) interactions and pore filling. Adsorption capacity showed a stochastic dependence with increasing contact time for the preconditioned biochar in contrast to the NBC. Both PBC and NBC fitted well with the PSO behavior. Sorption capacities for all PBC were lower than NBC which can be attributed to pore blockage. In contrast to NBC, a clear rate determining step was not observed by the intraparticle diffusion model for PBC. Though the Freundlich isotherm model was fitted well by the NBC, the PBC sorption did not fit into the isotherm models studied such as Langmuir, Freundlich, Temkin, Sips and Redlich- Peterson. An enhancement in kinetics for DI PBC was observed at the compromise of ill-fitting isotherm patterns and uptake behavior.

*Keywords: Douglas fir Biochar; Methylene Blue; Preconditioning; Kinetic mechanisms*

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## Soil Degradability of Food Wrapping Polythene Films Manufactured from PLA, PBAT and LDPE

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Food wrapping polythene films manufactured from different virgin materials have become a major environmental concern at present as these films take much time for the complete degradation in the environment. This study assesses the soil degradability of films manufactured from *poly-L-lactic acid* (PLLA) (28%) + dimethyl ester (38%) + starch (26%) + auxiliaries (8%) (F001), poly-lactic acid (PLA) (F002), poly butylene adipate terephthalate (PBAT) (F003) and *low-density polyethylene* (LDPE) (F004) in natural soil. The tensile strength, elongation, moisture and water absorption of manufactured films were analyzed at the beginning of the experiment. Half of the manufactured films was immersed in food waste contaminated water and buried at 10 cm depth in soil. The other half was also buried without processing at the same depth in soil. The study was carried out for four months. Percentage degradability was calculated after 02- and 04-month intervals and by using weight losses as a representative parameter of the degradability. Results revealed the significantly highest tensile strength and elongation from manufactured F004. In addition, manufactured F004 showed the significantly lowest water absorption and moisture content ( $p < 0.05$ ; ANOVA). Nevertheless, the highest percentage degradability (94%) in soil was observed from F003 followed by F002 contaminated with food waste. Moreover, the results showed a poor degradation ( $< 1\%$ ) of films manufactured from F004. The results further revealed that the films contaminated with foods degraded more than films those haven't contaminated with foods. Therefore, the present study concludes that food wrapping polythene manufactured from PLA and PBAT showed a significant degradation potential within four months whereas films manufactured from LDPE did not show a remarkable degradation within the same time duration.

*Keywords: PLA; PBAT; LDPE; Soil degradability*

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# Establishing Embodied Carbon Coefficients for Building Materials in Sri Lanka

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Buildings are identified as a major energy user and carbon emitter throughout their lifecycle. Carbon emission associated with energy consumption and chemical processes of material production is termed as 'embodied carbon'. Material production stage or cradle-to-gate building lifecycle includes processes of raw material extraction, transportation and material production which are responsible for about 20-40% of building lifecycle carbon emission. As embodied carbon of building materials highly vary with raw material quality, energy sources and production technologies, development of embodied carbon coefficients in the specific context of a country is necessary. Currently, Sri Lanka lacks such data inventories. This study was aimed at establishing embodied carbon coefficients of commonly used building materials in Sri Lanka. The process is made up of 3 stages; scoping, data collection and calculation. The data were collected through on-site surveys of material production facilities. In determining embodied carbon coefficient of a building material, aggregation decomposition hierarchy method was used. The embodied carbon coefficients obtained in the study were compared with values given in Inventory of Carbon and Energy (ICE) database. As the linkage between material production, energy use and carbon emission is dependent on many country specific factors, differences in values can be observed. A country-specific database ensures reliability and accuracy of building carbon emission studies. The process of establishing material embodied carbon coefficients should be standardized and data should be collected throughout the country so that computed values will represent national averages. This study will lead to future development of an embodied carbon coefficient database in the context of Sri Lanka, which will be useful in assessing embodied carbon of building materials and identifying appropriate strategies for mitigating embodied carbon of Sri Lankan buildings.

*Keywords: Building material; Cradle-to-gate; Embodied carbon coefficient; Sri Lanka.*

# Frontiers in Future Education

# High Fidelity Simulation in Undergraduate Medical Curricula: Experience of Fourth Year Medical Students at a Sri Lankan Medical Faculty

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Application of theoretical knowledge to management of critically ill patients is a challenging task faced by medical undergraduates where opportunities to learn clinical skills with regard to management of emergencies are few. High fidelity simulation (HFS) is widely used globally as an adjunct to clinical practice enabling students to learn clinical skills in a safe environment. However, research in the use of HFS in Sri Lanka is minimal. The purpose of this study was to explore the response of medical undergraduates to a high-fidelity simulator (HFS) in the context of management of emergencies. A pilot group of 30 fourth year medical students underwent a high-fidelity simulator session. They completed a self-administered evaluation, which included both open and close ended questions and participated in a focus group discussion post-simulation. Descriptive statistics were employed to analyze the responses to close-ended questions and the responses of the focus group discussion and open-ended questions were analyzed for recurring themes. All participating students responded to the evaluation. Students rated the simulation-based learning experience with high positivity. The self-competency of 29 (96.6%) students had increased following the sessions. The session provided a safe learning environment to all students. 19 (63.3%) students felt it helped put theory into practice while 21 (70.7%) students identified it as good practice for internship. 25 (83.3%) students wished to participate in more sessions. 17 (56.6%) students commented on the realistic nature of the experience. This study confirmed findings of previous studies conducted using HFS among medical undergraduates, confirming that the students highly valued high-fidelity simulation and find the opportunity to apply theoretical knowledge to practice in a safe environment. A high-fidelity simulator is a valuable learning tool in undergraduate medical education.

*Keywords: Simulation; high fidelity; Medical students; Competency*

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# Study on Virtual Learning Environment System in the Field of Construction Technology - A Sri Lankan Universities Perspective

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In order to maintain a good relationship in teaching and learning activities among students and university academic staff, a system called Virtual Learning Environment (VLE) can be used. A VLE system was designed among the students and university academic staff members in the field of Construction Technology in Sri Lankan universities to encourage a positive approach in knowledge achievement and to support active learning within the university. This study was carried out to analyze the factors influencing the VLE system and to explore the relationship between the students and university academic staff members on the VLE system. The factors influencing VLE were identified through the literature review and the interviews which were conducted among the university academic staff and the industry experts. A paper-based questionnaire survey was carried out among the students and university academic staff members who used the above created VLE system in the field of Construction Technology in order to measure the severity of the factors influencing the VLE system. There were 40 nos. of responses from the students and 14 nos. of responses from the university academic staff members received. The respondents were requested to indicate their level of contribution on various factors in the survey questionnaire with a 5-point Likert scale. The Relative Importance Index (RII) was calculated for each factor. The severity of each factor was identified based on its RII value. The factors were ranked based on their severity and Spearman's rank correlation coefficient was calculated. It was found that there was 48.4% of positive degree of agreement between the students and university academic staff on the factors influencing VLE in the field of Construction Technology. The students stated that time saving, infrastructure, collaborative learning, frequent feedback, sustainability and flexible learning are the most significant factors influencing the VLE system, where the university academic staff members identified that collaborative learning, time saving, frequent feedback and infrastructure are the most significant factors influencing the VLE system in the field of Construction Technology from Sri Lankan universities.

*Keywords: Virtual Learning Environment; ConstructionTechnology Stream; Sri Lankan Universities*

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# Integrating Technology into Undergraduate Classroom; Student-led Video Production as an Effective Instructional Strategy

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In the current world context, successful integration of digital technology and education theory has led to new advents of teaching and learning. Current students, termed as “Digital natives” have grown up in a multi-media simulated world and are highly competent in adopting to new technologies and therefore, it is importance to utilize technology enabled pedagogical approaches to invoke students’ interest and engagement. Further in the current socio-economic context, it is of enormous importance to enhance students’ generic skills such as self-directed learning, critical thinking, problem-solving, collaboration and cooperation in addition to the domain-specific knowledge and skills. Utilizing digital technologies in the tertiary education can be named as a valuable approach to address above challenges. In the past decade, using digital videos in the teaching and learning have become an emerging instructional strategy, mainly being used in the content delivery. However, there is only a limited number of studies that have been conducted focusing on learning through student-produced digital videos. Current study focuses on investigating student-led video production as an effective active learning instructional strategy. Study was conducted as a part of an Engineering Technology degree program and students (N=72) were asked to create videos (10-15 minutes) to educate their peers on given topics in the course content. Then they were given the opportunity to teach their peers using produced videos. Students’ perception on the activity was evaluated using surveys and its’ impact on the learning process was evaluated through an in-class quiz and was compared with previous quizzes. Majority of the students (> 90 %) had agreed that the activity helped them to understand subject matter better and improved their confidence, communication skills, team work skills and technical skills. Further, according to statistical testing it was proved that the average mark (57 %) for the quiz after the activity was higher than previous quiz (39 %) proving that the activity has a direct impact on students learning. In conclusion, it can be stated that student-led video production has a vast impact as an instructional strategy which enhances students’ competence, generic skills as well as the subject knowledge and thereby enhance the quality of tertiary education.

*Keywords: Active learning; Technology; Student-led videos*

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