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ASURS 2018

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MESSAGE FROM THE VICE CHANCELLOR

As the Vice Chancellor of the Rajarata University of Sri Lanka, I have the pleasure in sending this congratulatory message for the consecutive second year to mark the 2nd Annual Undergraduate Research Sessions of the Faculty of Applied Sciences 2018.



Role of universities is to generate new knowledge through research. It is the responsibility of both academic staff and students to engage in research and to make the knowledge seekers aware of the output of their research. This is the most integral contribution that can be made to the stakeholders who invest in the university education.

I understand that students who are about to complete their degrees in the areas of Biology, Chemistry, Computing, Physics, Mathematics and Health Promotion have engaged in testing and exploring some of the thoughts they had during the course of studies are now ready to make presentations to elaborate their findings.

In this endeavour, staff who were behind the students and guiding them for methodical research is appreciated very much and the initiatives taken by the Dean of the Faculty of Applied Sciences, the Chair of Research Sessions and the organizing committee are also admired herein.

I take this opportunity to congratulate forty-one students who make deliberations in the Research Sessions 2018 and I wish this endeavour every success.

Prof. Ranjith Wijewardana
Vice Chancellor
Rajarata University of Sri Lanka
Mihintale

MESSAGE FROM THE DEAN

It is a great pleasure for me to write a message for the second Undergraduate Research Sessions organized by the Faculty of Applied Sciences. This symposium provides an opportunity for the final year students of our faculty to present their completed research projects.



Our effort is all about creating big thinkers, researchers and leaders for the future with soft skills who can explore the world with new knowledge and creativity. I believe that ASURS 2018 will be a good platform for students to disseminate their novel research findings and to exchange ideas with eminent researchers. I am confident that this event will foster a strong culture in research and development and increase the enthusiasm in science among undergraduates.

As the Dean of the Faculty of Applied Sciences, it is my privilege to congratulate the undergraduates who are taking part in this invaluable occasion. Furthermore, my sincere appreciation goes to the Chair representing all the members of the organizing committee and the editorial board of the faculty for the untiring efforts they made in making this a reality. I would like to place a special thank you to the Vice Chancellor of Rajarata University of Sri Lanka for his moral and financial support in completing this event successfully.

Finally, let me warmly welcome all paper presenters, reviewers, evaluators, panel chairs and all the participants.

I wish you all a successful, productive, interactive and a memorable event.

Dr. Sriyani Wickramasinghe
Dean of the Faculty of Applied Sciences
Rajarata University of Sri Lanka
Mihintale

MESSAGE FROM THE PROGRAM CHAIR

On behalf of the organizing committee of the 2nd Annual Applied Sciences Undergraduate Research Sessions 2018, I am pleased to welcome you to the Undergraduate Research Sessions organized by the Faculty of Applied Sciences of the Rajarata University of Sri Lanka. It has been a great honour and privilege to serve as the Chair of ASURS 2018. The main objective of ASURS 2018 is to provide our final year undergraduate students with a professional and an academic conference platform to present their research findings and for potential initiation of their research careers. Studies have



shown that undergraduates who participate in research and have presented their findings in academic colloquia are better communicators and more effective leaders. ASURS 2018 portrays high quality research work carried out by our undergraduate students under the guidance of their supervisors in the fields of biology, chemistry, computing, health promotion, mathematics and physics. I congratulate all the students and their supervisors for working tirelessly to produce research of high standard. This represents the commitment of the academic community of the Faculty of Applied Sciences towards fostering a culture of scientific research and dissemination.

This event may have not been possible, if not for the cooperation rendered by Prof. Ranjith Wijewardana, the Vice Chancellor of the Rajarata University of Sri Lanka. I cannot forget the guidance and cooperation given to us by the Dean of the Faculty of Applied Sciences, Dr. Sriyani Wickramasinghe. Moreover, I take this opportunity to thank the Head of the Department of Physical Sciences, Dr. Uthpala Dahanayake, Head of the Department of Biological Sciences, Dr. Rajnish Vandercone, Head of the Department of Computing, Mr. N. S. Weerakoon, Head of the Department of Health Promotion, Mr. Duminda Guruge and the Deputy Registrar of the Faculty of Applied Sciences, Mr. N.C.S. Senaka for their support in making this event a success. I would also like to thank the evaluation panels and special guests for sacrificing their precious time to grace this event. Most of all, my sincere thanks go to the students and their supervisors for contributing their work to ASURS 2018. I would like to extend my most sincere congratulations to the authors and speakers for a job well done. The editorial services provided by the editor in chief, Dr. Lalith Senarathna and the editorial board are also highly appreciated. I would also like to extend my appreciation to the subject coordinators for their dedication and diligence in coordinating with the students and the editorial board. I would also like to express my heartfelt gratitude to the non-academic staff of the Faculty for their commitment towards making this event a success. Last but not least, I would like to thank the outgoing program Chair, Dr. Kanishka Ukuwela for the valuable guidance given to us and the organizing committee for their tremendous effort and undying commitment towards making this collaborative effort a fruitful one.

I hope you have a successful and an intellectually stimulating day.

Dr. Kaushalya Premachandra
Program chair
ASURS 2018
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Rajarata University of Sri Lanka
Mihintale

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ABSTRACTS

BIOLOGY

Detection and Quantification of Aflatoxin B1 in Corn and Corn-Grown Soils in the District of Anuradhapura

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Aflatoxin B1 contamination is a global health problem. The toxin has a negative impact on human health by impairing long-term physical and cognitive development as well as indirectly resulting in malnutrition and reduction of food value. In Sri Lanka, Anuradhapura is the main agricultural district and corn is one of the major field crops grown in the area which has been identified to be associated with aflatoxin B1 contamination. Weather conditions such as drought and poor farming practices in this area may have led to favourable conditions for the build-up of aflatoxin B1 in the soil and, thereby contaminating the corn kernel. This study was undertaken to detect and quantify aflatoxin B1 in corn and corn-grown soils in the district of Anuradhapura. Corn ($n = 60$) and corn-grown soil ($n = 60$) samples were randomly collected from 20 minor-scale corn-grown fields with three random replicates. Then each sample was prepared for the enzyme-linked immunosorbent assay (ELISA) technique according to the manufacturer's instructions. Absorbance was measured at 450 nm using a Thermo-Scientific Multiskan™ GO microplate reader (USA). Though 20 ppb is the poisonous or deleterious level for corn consumption according to the FDA, there were toxin contaminations up to 60-70 ppb in the corn kernel while majority of soil had 350-400 ppb of aflatoxin B1 concentration. Fifteen corn samples had exceeded the acceptable level while 22 samples were free of aflatoxin contamination. Furthermore, corn kernels obtained from Nachchadoowa, Saliyapura, Rambewa, Kebithigollewa, Mihinthale, Horowpathana, Kahatagasdigiya, Palugaswewa, Thirappane and Maha Vilachchiya had exceeded the acceptable level. However, corn samples obtained from Madatugama was free of aflatoxin contamination. In addition, corn samples from Kekirawa, Eppawala, Mahailuppallama, Thambuththegama, Rajanganaya, Thalawa, Sravastipura, Punewa and Galenbindunuwewa were contaminated with aflatoxin B1 did not exceed the acceptable level. Thus, the results show that aflatoxin B1 is not habitually distributed throughout Anuradhapura district. In addition, aflatoxin B1 concentrations in corn kernel were relatively smaller than corn grown soils, however, it increased with soil aflatoxin B1 concentration in the soil. According to the non-parametric correlation tests, it appears that there is a significant relationship between corn kernel and corn-grown soil aflatoxin B1 levels (Kendall's rank test: $p \leq 0.03$; Spearman's rank correlation test: $p \leq 0.01$). Based on these results, it is recommended that aflatoxin contamination should be controlled through good farming practices in the Anuradhapura district.

Keywords: Aflatoxin, Anuradhapura, enzyme-linked immunosorbent assay, corn, soil

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Enhancement of Immunity and Growth of Goldfish with Three Medicinal Plants, Turmeric (*Curcuma longa*), Ginger (*Zingiber officinale*) and Komarika (*Aloe vera*)

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Spread of diseases is one of the major constrains in aquaculture as the pathogens can spread fast in water to infect fish. *Aeromonas* is a bacterial pathogen, which affects growth and survival of fish. Furunculosis and haemorrhagic septicaemia are two main diseases caused by *Aeromonas salmonicida*, *Aeromonas hydrophyla* and *Aeromonas veronii*. Objectives of the present study were to determine the growth performance and immune responses of goldfish infected with *Aeromonas* sp. when fed with turmeric, ginger and komarika.

Seven experiments were designed with 3 replicates each with a stocking density of 50 fish (3.00 ± 0.18 cm and weight 5.02 ± 0.17 g). Goldfish were fed with six test diets which contain 0.5% and 1.5% komarika, 0.5% and 1.5% ginger and 2% and 3% turmeric separately while a control group was fed with normal diet for a period of sixty days. Length and weight of fish were measured at the commencement and end of feeding period.

Ten healthy goldfish fed with test diets were infected separately by injecting intraperitoneally with *Aeromonas* sp. using 5.8×10⁶ CFU/ml. As control experiments, only saline was injected to 10 fish whereas another group of 10 fish was injected with *Aeromonas* sp. The survival time period was recorded to determine the immunity enhancement. Condition factor, specific growth rate (SGR) and weight gain was taken as growth parameters. Data were analysed using linear regression analysis and one way analysis of variance.

Mean survival time period of 0.5% and 1.5% komarika, 0.5% and 1.5% ginger and 2% and 3% turmeric were 226 ± 13.52, 313 ± 16.55, 193 ± 8.14, 250 ± 14.06, 213 ± 9.84 and 248 ± 7.05 minutes respectively, while 126 ± 4.21 minutes for normal diet fed fish. Survival time period was higher in goldfish fed with three plant diet than that of normal diet. Highest survival time period, 313± 16.55 minutes was recorded in fish fed with 1.5% komarika. Saline injected goldfish showed 100% survival rate which indicated that there was no effect due to injection procedure. Highest weight gain (130.13 ± 7.46) and SGR (1.36 ± 0.06) recorded with 1.5% komarika. There was no significant difference ($p < 0.05$) among condition factor in all feeding experiments. Regression analysis of length-weight relationship exhibited a positive allometric growth for the fish fed with komarika whereas isometric growth was shown in fish fed with turmeric.

It can be concluded that komarika, ginger and turmeric enhance the immunity and promote the growth of goldfish. Komarika is the best immunostimulant and growth promoter among the tested medicinal plants.

Keywords: Medicinal plants, *Aeromonas* sp., immunity enhancement, growth performance

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Antifungal Activity of Plant Extracts and their Potential Use in Cosmetics Against Dandruff Causing Yeasts

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Yeasts in the genus of *Malassezia* are known to cause dandruff and other associated skin conditions. Currently available treatment options for management of dandruff are based on synthetic chemical constituents, which have certain limitations and also are unable to prevent recurrence. Research has indicated that the commercially available anti-dandruff products differ in their effectiveness. The objective of the current study was to isolate and characterize fungal species that cause dandruff, and to find out satisfactory combination of plant extracts to control dandruff and to find out the effective minimal inhibition concentrations (MIC) of the best combination of herbal extracts to be used in cosmetics. Of the 15 human participants in the study, seven had fungal dandruff. Flakes of collected dandruff were cleared using a standard procedure and the presence of yeasts were observed for the confirmation of fungal dandruff. Isolation of yeasts was carried out by using Dixon and Sabouraud Dextrose Agar medium. Dandruff causing yeast isolates were identified following a flow chart based on biochemical tests after conducting a preliminary survey. *Malassezia furfur*, *Malassezia obtusa* and *Malassezia pachydermatis* were identified as dandruff causing yeasts in the samples. Antifungal effect of 15 plant extracts and seven commercially available essential oils were screened as potential sources of anti-dandruff herbals. The MIC of each effective extract and essential oils were determined. After identifying extracts and essential oils that inhibited yeasts, the effect of different combinations of extracts and oils were studied. The most suitable combination of plant extracts was developed based on lethal dose 50% (LD₅₀) and effective exposure time. Antimicrobial agents of plant extracts were separated, checked by bioautography using *Malassezia* spp. Toluene: ethylacetate: formic acid (3.3:0.8:0.2) and ethylacetate: acetic acid: formic acid: water (10:1.1:1.1:2.6) were the common solvent systems used for separating components of the plant extracts by thin layer chromatography (TLC) and the R_f values were used for identifying bands of the active components. The MIC values of *Terminalia chebula*, *Terminalia bellirica* and *Phyllanthus emblica* was 0.15 g/ml while *Hibiscus rosa* was 0.1 g/ml and *Allium sativum* was 0.05 g/ml which was depicted by the diameters of the inhibition zones closer to that of the positive control, miconazole (2.0 cm). Additionally, the efficacy of some commercially available hair oils was tested by considering the lipophilic nature of dandruff causing yeasts. Brungamalakathailaya, coconut oil and Neelyadithailaya were identified as growth promoters of *Malassezia* spp. When comparing the performance of diffusion methods, well method had the better performance (mean values; well = 0.91 cm > disk = 0.70 cm). When detecting the antifungal effect of commercially available essential oils, diffusion was higher at the presence of Peg40 Hydrogenated Castor oil ($p \leq 0.05$). Clove, peppermint, rosemary and thyme had the highest antifungal effect out of seven essential oils. The best combination was found out using Kruskal-Wallis rank sum test ($p \leq 0.05$). The questionnaire survey revealed that participants who did not take a proper care of their hair had a higher chance of having fungal dandruff. Instead of synthetic treatment options, herbal treatments can be used because herbal extracts also gave better MIC values as the positive control.

Keywords: *Malessezia* spp., lethal dose, MIC, antifungal, scalp microbiome

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Role of the Vetiver (*Chrysopogon zizanioides* L.) and Arbuscular Mycorrhizal Fungi in Reclamation of Degraded Soil

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Most of the forest plantations such as *Pinus* and agricultural lands such as tea plantations are prone to soil degradation. Alterations of soil chemical and biological properties associated with *Pinus* plantations and the tea cultivations might negatively affect the soil quality even in adjacent secondary forests. Vetiver (*Chrysopogon zizanioides* L.) is a grass of the family Poaceae that can be used for soil reclamation of degraded lands. This enhanced soil ameliorating ability of vetiver might be associated with the higher colonization of arbuscular mycorrhizal fungi (AMF) and amended with organic manure and biochar. Therefore, this study was carried out to evaluate the ability of vetiver to reclaim degraded soil in *Pinus* and tea plantations and an adjacent secondary forest with AMF. The pot experiment was carried out at Panwila, Central Province of Sri Lanka, where the three sites were selected for soil sampling. Soil was collected randomly from two different depths of 0-10 cm and 15-25 cm, from three different vegetation types, such as *Pinus* plantation, tea plantation and adjacent secondary forests at Panwila, in the wet zone of Sri Lanka. The pot experiment was carried out as a three-factor factorial design with four replicates. Soil of the three vegetation types in two depths was used as respective controls. The four treatments were soil with 20% (w/w) biochar, soil with 20% (w/w) organic manure, soil with native AMF and soil with 10% (w/w) biochar and native AMF. Vetiver plants of approximately similar size and age was selected and one plant was transplanted in each pot. Soil chemical and biological parameters and plant growth parameters were determined initially and after three months of growing vetiver. Soil from a forest patch of the Knuckles mountain range which is subjected to similar climatic conditions as Panwila, was tested for soil parameters and was used as the reference for healthy soil in statistical analysis. It was found that different treatments were significantly different ($p < 0.05$) for soil pH, electrical conductivity, soil microbial activity, bacterial count, fungal count, plant dry root and dry shoot mass, yield and percentage AMF colonization ($p = 0.001$). However, the treatments were not significantly different for soil total organic carbon and microbial diversity ($p > 0.05$). Thus, it can be concluded that the application of vetiver with or without tested amendments improved the soil chemical and biological properties in degraded soil comparatively to the healthy soil of Knuckles mountain region. Furthermore, with the amendments of AMF, biochar and organic manure, some soil biological properties of degraded soil in tested vegetation types improved more than the reference soil. Therefore, the role of vetiver on degraded lands are quite independent with respect to the vegetation type and application of vetiver with the AMF, biochar and organic manure is an effective soil reclamation strategy.

Keywords: Soil degradation, *Pinus* plantation, *Chrysopogon zizanioides* L, Arbuscular mycorrhizal fungi, soil reclamation

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Seed Ecology of Three Medicinally and Ecologically Important *Strychnos* (Loganiaceae) Species from Sri Lanka

Muthuthanthirige D. L.^{1*}, Wijetunga W. M. G. A. S. T. B.¹ and Jayasuriya K. M. G. G.²

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Seed germination phenology is important in conservation of plant species as many of the plants regenerate through seeds, naturally and easily. *Strychnos* species in Sri Lanka offers an opportunity to study the germination ecology as there are eight species of this genus in Sri Lanka distributed in different forest ecosystems. Thus, we aimed to study seed germination ecology of three medicinally and ecologically important *Strychnos* species in Sri Lanka; *Strychnos potatorum* L.f., *Strychnos nux-vomica* L. from dry mixed ever green forests which are considered vulnerable and *Strychnos benthamii* C. B. Clarke from wet lowlands and montane regions which is considered as a near threatened species in the 2012 National Red List. Fresh seeds of *S. nux-vomica*, *S. potatorum* were collected during peak fruiting season (early January to late March) and *S. benthamii* at the end of May to June 2018. Seed moisture content (SMC %) was determined by an oven dry method by heating to 120°C for 3 hours. Control germination tests were conducted for two samples containing four replicates of six seeds and from each species, seeds were incubated on moistened tissue papers (with distilled water or GA₃) in Petri dishes at 25°C under light/dark conditions (12 hr/12 hr) or in complete darkness in controlled incubators. Then the effect of different temperatures (25 and 32°C) on seed germination and gibberellic acid (GA₃) concentrations (100 and 500 ppm) were evaluated. Embryo length to seed length ratio (E:S ratio) of fresh seeds, seeds just after radicle emergence and seeds before shoot emergence was studied at 25°C. Sensitivity of seeds for desiccation was determined using 100 seed method. The moisture content of *S. nux-vomica*, *S. potatorum* and *S. benthamii* at dispersal was 42, 35 and 46% respectively. *Strychnos nux-vomica* and *S. potatorum* seeds incubated at 32°C firstly showed radicle emergence after 34 and 59 days respectively while *S. benthamii* took only 11 days at 25°C. There was a significant difference in germination of seed samples treated with GA₃ in *S. nux-vomica* and *S. potatorum* ($P < 0.001$), while there was no effect of GA₃ treatment on *S. benthamii* seeds ($P = 0.300$). The growth of embryos of *S. nux-vomica*, *S. potatorum* and *S. benthamii* was increased by 38.24, 34.48 and 25.49% soon after radicle emergence indicating that seeds of the three study species had morphophysiological dormancy. There was a considerable delay of 76, 74 and 45 d to shoot emergence in radicle emerged seeds of *S. nux-vomica*, *S. potatorum* and *S. benthamii* respectively indicating epicotyl morphophysiological dormancy. Hundred seed test for desiccation sensitivity of *S. nux-vomica* and *S. potatorum* revealed that seeds could tolerate desiccation, while *S. benthamii* did not survive after desiccation. The ecological importance of seed dormancy and seed storage behaviour and results of the control factors of timing of germination, germination responses to different germination conditions and survival of seedlings play vital role in both *ex-situ* and *in-situ* conservation when handling seeds of these species for restoration and commercial propagation programs.

Keywords: Desiccation sensitivity, epicotyl morphophysiological dormancy, Loganiaceae, *Strychnos*, seed storage

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Crispr/Cas Based Gene Editing of *Tga 10*, in *Oryza sativa* L. Var. Nipponbare**Perera M.A.E.G.^{1*}, Bandara M. M. K.², Herath V.³ and Bamunuarachchi T.C.²**¹*Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka*²*Department of Bio Process Technology, Faculty of Technology, Rajarata University of Sri Lanka, Mihintale, Sri Lanka*³*Department of Agricultural Biology, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka*

Abiotic stresses can negatively affect growth, development, yield, seed quality and nutritional values of plants. To ensure food security, high productivity and quality, there is a necessity to develop crop varieties that are resilient to stresses. However, engineering crops against abiotic stresses have always been a challenge as this character is controlled by multigenes. With gene editing, it is possible to regulate the expression of genes associated with abiotic stress in crop plants to understand resistance development against unfavourable conditions. CRISPR/CAS9 system is the most promising gene editing tool in recent history and it allows to edit particular genes of interest with high accuracy and precision. The purpose of the study was to knockout the regulatory gene (*tga10*) which is associated with controlling abiotic stress of *Oryza sativa* L. var. Nipponbare. Domains of *tga10* were identified using the simple modular architecture research tool (SMART). CRISPR-P v2.0 tool was used to generate gRNAs against these domains. The selected gRNA was cloned into gRNA entry plasmid pRGE31 and transferred to *E. coli* DH5 α strain selected by tetracycline. This step was followed by isolation of the DNA from the selected colonies which were later transferred into liquid media supplemented with tetracycline. Rice calli were obtained from the tissue culturing of Nipponbare seeds on MS medium supplemented with 2.5 mg/l 2-4-D and 0.5mg/l Kinetin and incubation in the dark for 3 weeks. Friable calli obtained from the cultures were electroporated at 1.8Kv, 200 Ω and 25 μ F with isolated DNA from *E-coli* cells. Transformed calli were selected on MS supplemented with tetracycline. RNA was extracted from transformed calli and subjected to cDNA synthesis and qPCR was performed with specific primers for *tga10* to study and compare the expression levels.

Keywords: CRISPR-CAS9, abiotic stress, CRISPR-P v2.0, *tga10*, Nipponbare,

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Effect of Root Wash of *Panicum maximum* as an Inoculum on the Performance of Selected Crop Plants

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In nature, the microbial community around the rhizosphere is diverse and these rhizosphere microorganisms can affect positively or negatively on host plant growth and development. Plant growth promoting rhizobacteria (PGPR) are the soil bacteria inhabiting the rhizosphere that promote plant growth and development by various mechanisms. Hence, the rhizosphere can be developed to enhance crop productivity. These naturally occurring beneficial rhizobacteria have the potential to be developed as a bio-fertilizer. Bio-fertilizers are important in nutrient management and sustainable agriculture as an alternative to chemical fertilizers. In this study, the effect of the rhizosphere microorganisms of the weed, *Panicum maximum* on the performance of the selected crop plants and the potential of root wash of *P. maximum* as a bio-fertilizer were investigated. First a sample of root wash was taken from the young weedy plant *P. maximum*. To observe the effect on plant growth, plant pot experiments and the field experiments were done using three selected crops *Capsicum annuum* var. MI, *Capsicum annuum* var. Bull nose and *Solanum melongena* with five treatments; Bio-fertilizer, cow-dung, root wash, root wash with cow dung and water as control. Growth parameters of the plants such as plant height (cm), number of branches, flowers, fruits, days taken to flower and days taken for the appearance of fruits were measured at three-day intervals and the plants were uprooted after three months to measure the average root length (cm). Nitrogen and phosphorus levels of soils in which the uprooted plants were grown were measured by the Kjeldhal method and spectrophotometric method. The chemical and physical parameters such as pH, electrical conductivity, nitrogen level (%) and phosphorus level (in ppm) of the initial and final soil were determined. The purpose of these analyses was to compare the levels of parameters with the initial levels and to assess the degree of the effect caused by the treatments on the nutrient level of the soil. Isolation and characterization of rhizosphere microorganisms from root wash of *P. maximum* was done in nutrient agar media and potato dextrose agar media. The bacterial isolates, from the root wash included *Bacillus* sp., *Pseudomonas* sp. and *Staphylococcus* sp. while the fungal isolates were *Penicillium* sp., *Rhizopus* sp., *Oidiodendron* sp. and *Geotrichum* sp. According to the overall results of both pot experiment and field experiment, statistical analysis showed that there was a significant effect on the host plant growth and development by the root wash treatment ($P < 0.05$). Moreover, the study revealed that the root wash treatments have increased the nutrient levels of both pot and field soils. The study further demonstrated that the treatments had variable effects on different host plants. Thus, these bio-inocula may be developed as a bio-fertilizer, which could be used to enhance the plant growth and development. Further studies, however, should be carried out to evaluate the efficacy of developed bio-inocula as a bio-fertilizer.

Keywords: Rhizosphere, plant growth promoting rhizobacteria, bio-fertilizer, nutrients, soil.

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Phosphorus and Cadmium in Soil, Roots and Seeds of Maize (*Zea mays* L.) as Affected by the Application of Phosphorus Fertilizers and Soil Amendments

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Phosphorus (P) is an essential element for plant growth and metabolism that renders no chance to compensate it by any other element, due to its involvement in many important plant metabolic processes. P fertilizers contain cadmium (Cd) as a contaminant at levels varying from trace amounts to high and therefore, can be a major source of Cd to agricultural systems. Through accumulation in crops, Cd can enter the human body resulting severe health issues. Therefore, investigation of the contribution of different types of P fertilizer on the P uptake by plants together with Cd was the main focus of the study. Thus, the present study was designed to assess the impact of application of Eppawala rock phosphate (ERP) and triple super phosphate (TSP) as P fertilizers and different soil amendments including arbuscular mycorrhizal fungi (AMF), biochar, compost and dolomite on P and Cd uptake, growth and yield responses in maize (*Zea mays* L.). The field trial was carried out at Field Crops Research and Development Institute at Mahalluppallama. Randomized complete block design was employed with three replicates. Control plots were established without adding P fertilizers. Rock phosphate and TSP with four types of amendments, which included compost, biochar, dolomite and AMF inoculants, were used separately as different treatments. Phosphorus content of maize roots and seeds were quantified using dry-ashing technique, while available soil P was detected using Olsen method. Amounts of accumulated Cd in maize roots, seeds and soil were also detected using atomic absorption spectrophotometry. Results indicated that available soil Cd and total accumulated root and seed Cd amounts were significantly higher ($p < 0.05$) in TSP added treatments with and without amendments compared with ERP added soil. Considering soil available P, root and seed P, there was no significant difference observed in different treatments of TSP and ERP added treatments. A similar phenomenon was also observed in growth and yield parameters with both fertilizers added and with the added amendments ($p > 0.05$). There was no colonization of AMF in maize roots in TSP applied soil while 25-60% of colonization was recorded with ERP. Higher amounts of water soluble P present in the soil of TSP added treatments must have inhibited the AMF colonization thereby increasing the Cd content in maize seeds. AMF colonization increased with comparatively low soil available P in ERP added treatments. The tested organic amendments of compost and biochar reduced the soil available cadmium and hence reduced the root and seed Cd. Therefore, it can be concluded that TSP can be effectively used as a substitute for ERP as a source of P in maize soils with the addition of AMF, compost and biochar to further increase the effect.

Keywords: Phosphorus, cadmium, triple super phosphate, Eppawala rock phosphate, *Zea mays* L.

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Efficacy of Selected Plant Extracts as Anaesthetic Agents During Handling and Packing of *Oreochromis niloticus* (Nile Tilapia) and *Cyprinus carpio* (Koi Carp)

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Fish face various stress conditions during transportation, capture and handling procedures, which makes significant effect on their productivity and survival. Anaesthetic agents are used in aquaculture to overcome the stress. Use of plant extracts as anesthetics reduce the risk of health impact on fish and humans and it would be an important avenue to improve the sustainability of aquaculture and the ornamental fish industry. This study was focused on evaluating the efficiency of *Derris scandens* (kalawel), *Tephrosia vogelii* (fish-poison bean) and *Barringtonia racemosa* (medella) as anaesthetics during handling and transportation of food fish, *Oreochromis niloticus* and the ornamental fish, *Cyprinus carpio*.

Fresh samples of plants were collected during dry season and extracts were prepared. Three experiments were conducted and the experimental design was complete randomized block design with three replicates for each treatment analysed using one-way ANOVA. First and second experiments were focused on induction time, recovery time and water quality parameters when handling and packing of fish with different concentrations of plant extracts. Third experiment compared the effect of plant extracts with MS222 and clove oil.

Oreochromis niloticus exhibited the lowest induction time periods for *T. vogelii* which was 7.31 ± 1.59 minutes at 1.25ml/l during handling and 7.39 ± 1.22 minutes at 1.25ml/l while packing. The lowest recovery time periods during handling were 20.33 ± 1.13 min at 0.25 ml/l and packing 19.41 ± 1.5 minutes at 0.25 ml/l was also shown for *T. vogelii* by *O. niloticus*. The highest induction time and recovery time periods for *C. carpio* were exhibited for *B. racemosa* with 77.29 ± 1.61 minutes at 45ml/l and 130.37 ± 0.77 minutes at 49ml/l respectively.

Although there was a change in water quality parameters in the experiment, temperatures ranged between 27.40 to 29.49 °C and pH ranged between 7.25 to 7.71, all of which were within the acceptable range for fish survival and growth.

The anaesthetic properties observed in *T. vogelii* were similar to concentrations of clove oil at 3ml/l and MS222 at 65ml/l. Induction time and recovery time of *D. scandens* and *B. racemosa* was longer than that of clove oil and MS222.

Anaesthetic properties of *T. vogelii* and *D. scandens* were capable of sedating the fish. *Tephrosia vogelii* was identified as the most effective anaesthetic agent which is effective at a dosage of 1.25ml/l. *Barringtonia racemosa* can be categorized as a slow anaesthetic agent as it exhibited longer induction and recovery time duration and it could be used when transporting fish.

Keywords: Anaesthesia, packing, induction, recovery

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CHEMISTRY

Effect of Gamma Irradiation on Fatty Acid Composition and Rancidity in Edible Oils

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The safety and shelf-life of food products can be enhanced by modern food processing techniques such as irradiation. This study was carried out to investigate how the gamma irradiation effects on fatty acid composition and oxidative stabilities of nine edible oil types including coconut oil, corn oil, sunflower oil, vegetable oil, soybean oil and four types of fish oils including cod liver oil, commercial fish oil, tuna oil and thilapia oil. The irradiation was done at 15 kGy, 30 kGy, 45 kGy, 60 kGy and 75 kGy levels using Cobalt-60 radiation source at Sri Lanka Gamma Center.

The oxidative rancidity of oil samples was tested by peroxide value (PV), thiobarbituric acid value (TBA) tests and free fatty acids (FFA). The fatty acid profiles were determined by capillary column gas chromatography.

The lowest and the highest PV were shown in coconut oil (0 meq/kg) and vegetable oil (10.54 meq/kg), respectively. All the samples showed their highest PV at 15 kGy doses while the lowest PV for 75 kGy doses. The TBA values of fish oils were higher than plant and vegetable oils. The highest TBA value (270.37 nmol/g) was shown in thilapia oil irradiated with 15 kGy dose. The lowest TBA value (2.41 nmol/g) was reported in control sample of coconut oil.

None of the edible oils showed a detectable level of free fatty acids in both control and 15 kGy sample sets. However, vegetable oil and coconut oil showed small amount of FFA when treated with 30 kGy and 45 kGy doses. All the oils were shown free fatty acid content in 60 kGy and 75 kGy sample sets except corn and sun flower oils which didn't show any FFA in both control and irradiated samples.

The fatty acid profiles of treated oils showed considerable stability during irradiation. Oleic acid (C18:1 ω -9) was the most abundant fatty acid in vegetable oil (43.78%) followed by tuna oil (24.84%), thilapia oil (30.79%), commercial fish oil (15.80%) and cod liver oil (15.74%). Linoleic acid (C18:2 ω -6) was the highest abundant fatty acid in corn oil (50.00%), sunflower oil (48.75%) and soybean oil (52.79%). Lauric acid (C12:0) is the highest abundant fatty acid in coconut oil (43.55%). Considerable amount of docosahexaenoic acid (C22:6 ω -3) was recorded in tuna oil (18.89%), commercial fish oil (10.06%) and cod liver oil (10.22%). Eicosapentaenoic acid (C20:5 ω -3) was recorded in tuna oil (5.01%), commercial fish oil (8.19%) and cod liver oil (8.29%). However, gamma irradiation between 15 - 75 kGy did not show a significant effect on the fatty acid composition of any edible oils, indicating good stability during the irradiation processing.

Keywords: Gamma irradiation, fatty acid profile, peroxide value, thiobarbituric assay

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Separation of Calcium and Magnesium from Electro-Coagulated Sludge by Chemical Precipitation Technique

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Higher levels of calcium and magnesium in water cause major public health problems and significant industrial issues. The present study deals with electrocoagulation (EC) technique for removal of calcium and magnesium ions from different composition of synthetic water samples and separation of calcium and magnesium from electro-coagulated sludge. Separation of Ca^{2+} , and Mg^{2+} ions was attempted by means of beneficial reuses of electro-coagulated sludge for sustainable and economical sludge management. By taking the advantage of the differences in solubility, Ca^{2+} and Mg^{2+} ions in sludge were selectively separated by adjusting the pH. EC setup was composed of $15\text{ cm} \times 30\text{ cm} \times 15\text{ cm}$ EC reactor consisting of $13.5\text{ cm} \times 28\text{ cm} \times 0.4\text{ cm}$ sized two aluminium electrodes as anode and cathode separated by 1 cm from each other.

2L volumes of four different synthetic water samples were employed for EC process of which. The concentrations of Ca^{2+} , Mg^{2+} and Na^+ ions in the synthetic water samples of CaCl_2 , MgCl_2 and NaCl were 200 ppm in each. The synthetic water sample which contains $\text{CaCl}_2/\text{MgCl}_2$ mixture was prepared by adding 200 ppm of Ca^{2+} and Mg^{2+} ions. All EC processes were carried out in batch mode at pH 11.0 under a constant current of 3.00 A for 30 minutes. The sludge formed was characterised by X-ray diffraction spectroscopy (XRD) and Fourier transform infrared (FTIR) spectroscopy. In the present work, atomic absorption spectroscopy was used to measure the initial and residual concentration of Ca^{2+} and Mg^{2+} ions in filtrates that obtained from EC processes. In the separation stage, the pH of the EC-sludge that obtained from the $\text{CaCl}_2/\text{MgCl}_2$ mixture was adjusted to 1.0 with 3 M H_2SO_4 and Ca was precipitated as CaSO_4 , leaving Mg^{2+} in the solution. The filtrate obtained after separation of CaSO_4 was treated with 1 M NaOH , until pH reached 12.0 at which $\text{Mg}(\text{OH})_2$ precipitated.

The products were characterised qualitatively by XRD analysis. Removal efficiency of Ca in CaCl_2 synthetic water sample and Mg in MgCl_2 synthetic water samples were 57.04% and 99.99%, respectively. Removal efficiencies of calcium and magnesium in $\text{CaCl}_2/\text{MgCl}_2$ mixture were found to be 60.80% and 99.95%, respectively. The recovery of Ca and Mg from the sludge was 65% and 90%, respectively. Considering the removal efficiencies in this study, EC process can be suggested as an effective alternative technique for calcium and magnesium removal as well as suggests that conditions employed favoured for recovery of calcium and magnesium from electro-coagulated sludge.

Keywords: Electrocoagulation, calcium, magnesium, separation, atomic absorption spectroscopy, Fourier transform infrared, X-ray diffraction

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Multi-Residue Quechers Method for Analysis of Pesticide Residues in Rice in the Anuradhapura District Using LC-MS/MS Technique

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Pesticides are widely used in paddy cultivation in Anuradhapura, a district where chronic kidney disease with unknown aetiology (CKDu) has become a serious public health issue. This study presents the development and validation of multi-residue method for determination of the 29 pesticide residues in rice collected from the Anuradhapura district. The extraction and clean-up of pesticide residues were performed using a modified QuEChERS followed by liquid chromatography tandem mass spectrometry (LC-MS/MS) with electrospray ionization positive mode (ESI+). Method validation was performed by means of accuracy, precision, selectivity, linearity, limits of detection (LOD) and limit of quantification (LOQ) values.

The working range of the method was 0.005-0.1 mg/kg with six concentration levels at 0.005, 0.01, 0.025, 0.05, 0.075 and 0.1 mg/kg, respectively. Linear regression coefficients (R^2) were above 0.98 for all pesticide residues. Accuracy was assessed using three fortification levels and was found to be acceptable (70-130%) for 29 pesticides residues. The method had good precision and the relative standard deviations (RSD) were considered for recoveries at each spiked level were below 19%. LOD and LOQ varied from 0.002-0.02 mg/kg and 0.002-0.03 mg/kg, respectively. The selectivity of the method was assessed using quantifier to qualifier ratio.

The validated method was effectively applied to assess the pesticide residues of 60 rice samples collected and 50% samples were contaminated with pretilachlor, propanil, 2-Methyl-4-chloropenoxyacetic acid (MCPA), fenobucarb (BPMC), carbosulfan, deltamethrin, diazinon, fipronil, phenthoate, chlorpyrifos and tebuconazole. However, pesticide residual values of all the tested pesticides were less than the national or the Codex MRL except for pretilachlor. In addition, two samples contaminated with carbosulfan above the maximum residue level- European (EU MRL) were detected. BPMC was the mostly detected pesticide residue with range of 0.003-0.01 mg/kg. According to statistical analysis, significant contamination of pretilachlor ($p = 0.005$) was detected in Mihintale and the average residual levels were above the default EU MRL level. Chlorpyrifos ($p = 0.003$), which was a banned pesticide, was detected in Ipalogama, and diazinon ($p = 0.001$) was detected in Thalawa, however the average residual levels were below the national and the Codex MRL's.

The highest number of contaminated samples was detected from Nuwaragam Palatha East and Nochchiyagama areas, while Galenbidunuwewa, Kahatagasdegiliya and Horowpothana indicated the least contaminated samples throughout the entire study area. From the experimented samples, 43% exceeded or were equal to the EU MRL's. Hence, the findings of this study highlight the immediate requirement of a regular monitoring system for pesticide residues in rice in order to formulate a strong national policy on safer use of pesticides in paddy cultivation in Sri Lanka.

Keywords: Pesticide residues, rice

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In House Test Method Validation for Determination of Chloride Content in Waste Sludge Sample

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Inorganic form of chlorides is generally found in industrial waste. In Sri Lanka, these waste are destroyed by high temperature kiln which is used in cement companies. Feeding of high concentrated chloride containing waste products causes the cyclones to become coated and blocked, resulting in costly shutdowns for cleaning of the equipment. This study focused on developing a more accurate chloride testing method for the hygroscopic iron sludge produced as an industrial waste.

The methods employed for the determination of chloride content were Volhard titration, chloride analyser (Metrohm, 877 Titrino plus), XRF (X-ray florescent spectroscopy), inductive couple plasma optical emission spectroscopy (ICP- OES) and Mohr titration. ICP analysis of acid digested sample showed the presence of iron (36 – 41%), silicon (9 -15%), aluminium (14 -18%), zinc, and sulfur (0.07 – 0.08%). Heavy metals such as Hg, Pd, Cd, As and Cr were not detected in the sample. XRF analysis yielded 4.25% of chloride while chloride analyser showed a vast fluctuation between 5 - 11% for the different mass of waste sample presumably due to non-uniformity of the samples and the presence of interference of ions such as ferric, chromate and dichromate. Therefore, chloride analyser is not an accurate testing method for quantifying chloride content in waste samples. Volhard titrimetric analysis of acid digested sample gave a constant average chloride content of 18%. In contrast, Volhard titration carried out with alkali fused sample yielded a higher amount of 63.65% chloride. Therefore, further insight into other methods is required for accurate measurement of chloride in these types of sludge samples.

Keywords: Chloride, Volhard titration, chloride analyser, industrial waste

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Performance Evaluation of Electrocoagulation Process for Removing Hardness from Tube-Well and Tap Water at the Faculty of Applied Sciences and Extraction of Aluminium from Electro-Coagulated Sludge

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Hard water causes many problems in domestic and industrial water usage. The demand for high quality water is increasing day by day. The electrocoagulation (EC) is an environmentally friendly technique compared to other conventional water purification methods. The objective of this study was to investigate the efficiency of EC process in removal of hardness in tube-well and tap water by in situ generation of electro coagulant Al^{3+} ions, using an Al anode. EC process was performed on water samples collected from tube well and tap water at the faculty premises.

Tube well and tap water samples were electro-coagulated for 30 minutes under the 0.5 A, 1.0 A, 1.5 A, 2.0 A and 2.5 A currents. Initial and final concentrations of Ca^{2+} and Mg^{2+} were measured using atomic absorption spectroscopy (AAS). Sludge formed after 30 minutes of operation was analysed by X-ray diffraction (XRD) and Fourier transform infrared (FTIR) spectroscopy. $\text{Al}(\text{OH})_3$ was isolated as an value addition for the process from electro coagulated sludge by controlling the pH of the sludge solution using H_2SO_4 and NaOH. The precipitate of $\text{Al}(\text{OH})_3$ was analysed using XRD and FTIR.

The total hardness in tube well and tap water was found to be 807.05 ppm and 677.10 ppm per CaCO_3 respectively. The maximum hardness removal efficiency of 90.49% and 89.29% was obtained at pH 7.0 for tube well and tap water respectively. Final pH of the water was maintained constant in all processes. Al^{3+} ions in the sludge were precipitated as $\text{Al}(\text{OH})_3$.

The optimum current density of 2 mA/cm^2 was found in the removal of Ca^{2+} in both tube well and tap water systems. Increased current density, made no significant change in removal of Ca^{2+} . However, removal efficiency of Mg^{2+} highly depended on the current density. The removal efficiency increased with the increase of current density. Highest removal efficiency of Mg^{2+} was observed at 8 mA/cm^2 current density. Continuous flow reactor can be used instead of the batch reactor to accelerate the efficiency. According to the study, EC is an efficient, cost effective as well as environmentally friendly process to remove hardness from hard water. Hence this method can be potentially used to remove hardness of water to produce safe drinking water especially in areas such as Anuradhapura, Polonnaruwa and Jaffna where water hardness in high.

Keywords: Hardness, electrocoagulation, sludge, removal efficiency

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Investigation of FTIR Spectral Data Correlation Between Technical Standards and Product Formulations of Selected Pesticides

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Fourier Transform Infrared (FTIR) spectrometric analysis is a proven method for rapid and direct identification of functional groups of materials. Most of the pesticides exhibit intense absorption peaks in the 4000–400 cm^{-1} region of infrared spectrum. Today, the use of counterfeit and illegally sold pesticides have been a rapidly growing problem in Sri Lanka. To address this problem, high performance liquid chromatography (HPLC), gas chromatography (GC), and gas chromatography-mass spectrometry (GC-MS) related separation techniques are widely used by regulatory agencies to assess the quality and quantification of pesticides. However, those methods have limitations such as lengthy testing time, cost of chemicals and labour for implementing controls for these products. The main objective of this work was to employ Fourier transform infrared -attenuated total reflection (FTIR-ATR) method to determine the correlation and to develop a quantification method based on Beer-Lambert law. The main advantages of this method are rapid testing, cost effectiveness and no sample pre-treatment is required.

In this work, a linear graphing method was used to identify the FTIR correlation between selected technical standards and formulation products of pesticides. Method of standard addition was employed for the analysis of the technical standard of diazinon. Simple Beer's law and TQ analyst[®] software with peak location were used to quantify the product formulation of tebconazole, nicosulfuron, flubendiamide and bis-pyribac sodium using technical standards of them. OMNIC[®] software was used to develop a finger print library of the pesticides.

Linear graphing method of analysis showed higher slopes for the technical standards of the selected pesticides than the product formulations. In the standard addition method, spectrums of diazinon technical standard were overlaid using OMNIC[®] software. It was found that the slope of the linear graph is dependent on the concentration of the technical standard for selected peaks. Thus, the OMNIC[®] search library developed by this research provided the information regarding counterfeit and illegally sold pesticide samples. This library opens the possibility of FTIR spectroscopy to identify the unknown pesticide samples.

It was found that the spectrum or data acquisition methodology and spectrum conversion to linear graph requires attention for guaranteeing the quality of the outputs. Also, environmental conditions and impurities caused for the spectral changes and associated slopes. The study revealed that slopes of the linear graphs provide the information on quality or the purity of the pesticides. The utility of TQ analyst[®] software and simple Beer's law method, for the quantification of pesticides was not successful in terms of precision, accuracy and linearity which have to be solved by attempting different methods available in TQ analyst[®] in further research.

Keywords: Fourier transform infrared, attenuated total reflection, pesticides, product formulations, standard addition, Beer-Lambert law, TQ analyst[®], OMNIC[®]

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COMPUTING

Real Time Accident Vehicle Detection and Tracking System Based on IOT

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The technology of motor vehicles has been developed to a higher level and many other safety measures have been taken to minimize the risk of road traffic accidents. However, according to world health organization (WHO), more than 1.25 million people die from road accidents every year. Most deaths occur due to the unavailability of emergency medical services. Therefore, the number of deaths due to road traffic accidents can be reduced with the availability of real time emergency services. Moreover, the availability of real time emergency service can increase the chance of survival of victims and reduce the suffering time from injuries.

The advanced development of communication and navigation technologies and their implementation in various phases of incident management can significantly reduce the consequences of incident events such as congestion, delay, pollution and especially dangerous secondary incidents.

This study proposes an automatic vehicle accident detection system using Arduino based vehicle accident alert system. When an accident occurs for a moving vehicle in which the smart device is been installed, it detects the accident and reports to the pre-defined contacts. In addition, the longitude and latitude information of the vehicle accident zone is also obtained through GPS. The main objective of this study is to reduce the number of deaths occurring and further damages caused for victims due to the late announcement of accidents. This can be achieved by providing them a proper emergency service.

Hence, in this study we developed a pre-installable smart device, which can help to detect the vehicles meet with accidents by sending an automated short message service (SMS) to the predefined numbers. Global positioning system (GPS) and global system for mobile communication (GSM) technologies are used in developing the device. Through GPS, the exact location of the vehicle on the map can be identified. GSM stores important mobile numbers to convey messages whenever an accident occurs. Validation of this method was carried out by placing this device in a toy car and checking the ability of sending automated messages to pre-defined numbers by making artificial accident like movements.

This method can be improved to detect the condition of victims by improving the system by connecting cameras. Furthermore, this technology can be used for anti-theft vehicle detection and tracking systems as well.

Keywords: Tracking system, automatic vehicle, accident, detection, Arduino

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Modeling the Optimum Way to Motivate Computing Undergraduates According to the Knowledge Level

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In general, students possess different levels of knowledge and motivation. Different methodologies such as personalized and adaptive e-learning tools, interactive and play based learning, collaborative activity based learning, etc. can be used to motivate students in the learning process. Although e-learning is considered as one of the elements that affect the motivation of students, finding the best e-learning tool which is able to perfectly motivate students with respect to their knowledge levels is not an easy task. Hence, unavailability of a proper mechanism which aids lecturers in selecting the best way to motivate students of different knowledge levels is identified as an issue in the field of e-learning. This study proposes a novel adaptive testing tool as a motivator to the student which can be used by the teacher as a supporting tool in selecting the best possible way to motivate the student according to their levels of knowledge.

An assignment was given after conducting a lecture to evaluate the performance of the students. Depending on the student performance, they were categorized into three levels as basic, intermediate and advanced. Using formative evaluation, the tool can provide ongoing feedback to students in order to improve their learning ability. The tool can be used as a motivating tool in learning management systems (LMS) which will enhance the performance of the students and encourage them in their learning activity by providing guidance, support and materials.

Furthermore, recent studies have proposed a supporting tool for teachers in selecting the best method of motivating students with respect to their knowledge level.

Three different e-learning tools in Moodle (workshop, lesson & forum) and our proposed adaptive testing model are considered as motivational methodologies. A comparison among above methodologies was carried out through the supporting tool, to select the best way of motivating students in each level. Data under selected variables, which are generated from the features of existing and designed systems were analysed using algorithms that are developed based on descriptive statistics. Supporting tool recommends the teachers the best motivating tool to be used for each level.

Testing of the designed model and the supporting tool was conducted as a pilot study using randomly selected thirty-six 3rd year undergraduates of Rajarata University of Sri Lanka. The testing involved conducting formative assessments in human computer interaction subject, to verify the progress and reliability of the proposed solution. Second pilot study was conducted using the same cohort of students and Likert scale questioner was used to qualitatively assess the results obtained from the former pilot study. The results showed that the motivator tool we proposed reaches 66.66% level of accuracy and proved that the methodology can be used by any teacher to motivate students of different levels of knowledge.

Keywords: Knowledge level, adaptive testing, e-learning, supporting tool, motivation methodology, descriptive statistics

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Plant Seedling Image Classification

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The process of recognizing plant seedling is of crucial importance to agronomists, farmers and to researchers. This process can be automated by analysing the images of the seedlings. Therefore, plant seedling classification is one of the most important applications in computer vision. The use of computer vision techniques for visual object recognition, in general, has increased tremendously with the emergence of deep learning.

The main objective of this research was to develop a model to classify plant seedling images using a deep learning approach. The model was developed based on a database of images of approximately 5700 unique plants belonging to 12 species at several growth stages provided by the Aarhus University Signal Processing Group, in collaboration with the University of Southern Denmark. Recent studies suggest that convolutional neural networks (CNNs) is the preferred deep learning technique for image classification tasks due to its advanced feature representation capability and faster computation feasibility. In this study, a sophisticated CNN model was proposed to classify a given image into one of the 12 plant species considered in the image database. The architecture of the CNN consists of 2 convolutional layers, 2 max-pooling layers and one dense layer with 500 neurons. The output seedling image class is decided through a softmax function in the output layer. Rectified linear units (ReLU) were used as activation functions in the convolutional layers. The parameters of the model are fine-tuned specifically for seedling image classification. The layers, learning parameter and dropout rates of the CNN were decided through experiments.

The model was evaluated with the image database using the cross-validation technique. The model showed a promising average accuracy of 70% for 12 seedling classes. The model was trained for 50 epochs. Furthermore, the developed CNN model was integrated into a lightweight mobile application which can classify a seedling image taken from the camera of the mobile phone. The implementation was carried out using Tensorflow python library and final mobile application was deployed on Flask python microframework. The proposed model can be further generalized to include more plant species.

Key words: Image recognition, deep learning, convolutional neural network, Softmax, tensorboard,

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Stress Prediction Through Facial Expression Using Convolutional Neural Networks

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Stress is one of the major and common problems faced by many people in the modern society. It is obvious that everyone has experienced stress at least once in their life. Among the many reasons for stress, the high workload can be considered as the primary reason. In other words, stress can be caused by the unbearable pressure on an individual due to the nature of the working environment and office work.

This research mainly focuses on the work place related stresses which people experiences. People who are under stress can be recognized due to their unusual behaviors compared to a psychologically healthy person. There can be situations where the stress is not visible to the outside world. However, our study focuses on the stress which is visible to the outside world. In general, it is known that people under stress show relatively more negative feelings or emotions when compared to a normal person. Therefore, this study focuses on the negative emotions which are visible from the face. Face is the universal way of identifying moods or emotions of a person. Researchers have categorized facial expressions using 6 basic emotions. They are happiness, surprise, anger, disgust, sadness and fear. However, no direct connections are demonstrated in between facial expressions with emotions and stress.

This study identifies facial expressions without distracting them. The proposed concept was designed and developed as a web-based system which uses the web camera to capture images and YOLO face detection technology to detect faces of people. An algorithm to recognize stress levels, was developed by using convolutional neural network (CNN) model. This algorithm uses the negative and positive emotions visible through their face. The CNN model was trained by using the Ferplus dataset which was developed by Microsoft. Testing was carried out with the participation of 50 subjects. They were asked to use the system and feedback were obtain from them. As per the feedback, this CNN model showed 98% accuracy in detecting positive emotions such as happiness and surprise and 76% accuracy in detecting negative emotions such as anger, disgust, fear, sadness and neutral. Stress was monitored from these emotions and the stress level was identified using the number of detections of negative and positive emotions of the face. The system showed 69% accuracy in detecting stressed and non-stressed situations. Accuracy can be improved by considering minor emotions visible through faces. Hence it can be concluded that stress can be identified by monitoring the facial changes and negative and positive emotions visible though face.

Keywords: Stress, Emotions

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Web Server Performance Based Dynamic TTL Value Calculation Method for Domain Name Servers

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Domain name service (DNS) is the service that resolves internet protocol (IP) addresses of fully qualified domain names (FQDNs). The DNS is implemented as a hierarchical distributed cache system that stores the IP addresses of the FQDNs for a certain amount of time which is specified in time to live (TTL) value. The TTL value is an arbitrary value set by the authoritative name servers, also known as service providers. However, calculation of the TTL value is not described in any literature, indicating a lack of knowledge regarding calculation of the TTL values of the DNS service.

This study proposes a generalized method to calculate the TTL value of the DNS record using network latency and the performance of web server (i.e., authoritative name server) where an actual web request has to wait until it is served. This research explains the proposed mathematical method for calculating the TTL values of DNS records and provides a detailed explanation of the used parameters with the reasons of selecting those parameters to calculate the TTL value.

$$(2) \rho = (K_c \times C) + (K_d \times D) + (K_m \times M) + (K_n \times N)$$

ρ (2) is the web server's performance, C is the central processing unit (CPU) utilization, M is the memory allocation, D is the hard disk drive (HDD), N is the network latency and K_c, K_d, K_m, K_n are the factors by which the CPU utilization, memory allocation, HDD and the network latency affects the factors respectively. When collecting data, two personal computers (PCs) were used, one as a server PC and the other as a client PC. The performance of the web server was measured manually by loading the server pc by stressing it. The network latency measured by sending ping commands to specific domains during peak times. While the server performance was fluctuating, data were gathered by capturing the time stamps using Wireshark. Satisfactory data sets were obtained by conducting the experiments more than 120 times. The average values of each and every data set was calculated to derive the parameters to the proposed method. The network latency data were gathered after doing over 40 experiments.

The objective of the proposed mathematical method is to calculate the dynamic TTL value for the DNS servers rather than configuring it as the current method. Throughout the study the obtained values were used to determine the ultimate value of TTL. The changes of the TTL value could be checked by running a shell script to modify the value in DNS configuration file. A private DNS server was implemented to prepare the modification to the TTL value.

The results of the proposed mathematical model proved that the performance of the web server may influence to fluctuate the TTL value of the DNS servers. HDD capacity was shown to affect the performance of the web server (> 77%) more than other factors to carry out modifications to the TTL value. The method for calculating TTL value presented in this study is more reliable than the existing method because the waiting times for the client to receive updated data when needed is less and at instances where novel data is not needed (the client do not have to update gradually).

Keywords: Domain, network latency, Wireshark, performance, peak times

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Scheduling Dynamic Electric Vehicle Charging Using Multi - Agent Technology

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During the past few years, the number of electric vehicles and charging stations have been developing rapidly with the advancement of technologies. As part of these technological advancements, renewable energy sources have been integrated into the charging station systems. This advancement creates new insight for dynamic scheduling where environmental conditions are rapidly changing. The charging price of a renewable energy unit varies from one charging station to another and also within the same station as well. Consequently, electric vehicle users are often faced with the problem of making the most appropriate decision regarding which charging station is to be chosen in order to charge their vehicle. Selecting a charging station can be a dynamic and complex task not only due to the fluctuations in price of an energy unit, but also other factors such as distance between the vehicle and the station, vehicle model and vehicle energy consumption. The aim of this study is to suggest the optimal station to the vehicle users based on users and charging station situations of such a highly coupled and distributed system. This study proposes new solutions for handling complexity arise in dynamic scheduling. The proposed solution addressed most of the problems where existing studies in this area have not been addressed effectively.

The proposed methodology is JAVA agent development (JADE) framework which is a software framework for interactive intelligent multi-agent systems to develop applications in accordance with Foundation for Intelligent Physical Agent (FIPA) specification. The solution to the problem was resolved using directory facilitator (DF) agents. Multi agent technology is rapidly becoming a powerful computing paradigm for dealing with the complexity of dynamic distributed systems, such as traffic control and management systems. The FIPA standardized work allows for greater interoperability between agent systems because, in addition to the agent communication language, FIPA also specifies the key agents that needed to manage an agent system. In this study, Multi-agent software engineering (MaSE) is used as the software development methodology. Proposed solution considers unit price of every charging station, distances from location of the vehicle to the stations, vehicle model and the energy consumption of the relevant vehicle model when suggesting the optimal charging station.

Keywords: Charging Stations, electric vehicles, energy consumption, traffic control, directory facilitator

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An ICT Based Framework to Leverage English Language Education in Sri Lankan Secondary Education.

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This study aims to develop an Information and Communication Technology (ICT) based English language teaching framework for the students of Sri Lankan secondary education sector to overcome the complications of English language learning in secondary education. The English language is the most widely used as an international language in the world and hence a proper education of English language is essential for the betterment of the students.

According to a survey previously conducted by us and studies in published literature, we observed that there are several issues in English language in relation to teaching and learning in secondary education. Such issues found in students also affect the teachers' ability to teach affectively. Our survey indicated that the majority of students prefer to use ICT as a tool to enhance their English language education.

This study proposes a novel notion of using ICT for effective English language education and thereby to improve the teaching and learning quality of English language in Sri Lankan secondary education. An ICT based framework to develop English language skills was developed using primary (structured questionnaire for grade 8 students and English teachers) and secondary sources (English language text and work books, the teacher's guide book, etc.). According to the responses received from both students and teachers, 89% of them showed inquisitiveness and willingness to use ICT for their English language education. The students also expressed that teachers are fully supportive of their learning. Moreover, the results of the study found more motives to use ICT to enhance learning and teaching English language in secondary education. Therefore, it can be concluded that the ICT tool based on the proposed framework can be used to enhance English language learning in secondary education of Sri Lanka.

Keywords: ICT, English Language, Secondary Education, Sri Lanka, E-Learning

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HEALTH PROMOTION

Effectiveness of a Health Promotion Intervention to Address Fathers' Alcohol Related Behaviours by Empowering Schooling Adolescents in a Rural Community.**Madubashini B. A. N.^{1*}, Fernando W. M. S.¹, De Silva J.² and Senarathna L.¹**¹*Department of Health Promotion, Faculty of Applied Sciences, Rajarata University of Sri Lanka*²*Consultant Psychiatrist (Board Certified), Colombo South Teaching Hospital³*

Spread of alcohol use in any community is mainly due to direct and indirect influences from alcohol industry. School children are the most vulnerable group to such influences. Apart from this, alcohol usage of parents (specially the father) plays an important role in initiation of alcohol use among children. Alcohol consumption of the father, the breadwinner of the family, has been identified as one of the major factors which effects the family income. This adversely effects the wellbeing of the family. School is an ideal setting to conduct interventions with adolescents to make them aware of adverse effects and to act on alcohol consumption of their fathers.

This study aimed to assess the level of knowledge, attitudes and practices of schooling adolescents aged 13-16 on alcohol, to identify the determinants that affect their father's alcohol consumption and related behaviours. The knowledge on the determinants was used to design and implement a health promotion intervention to empower an active group of adolescents to address the father's alcohol related behaviour at home. The intervention was evaluated for the effect on changing alcohol use and related behaviours of fathers of participating adolescents.

A quasi experimental design was conducted among schooling adolescents aged 13-16 in selected secondary schools in Anuradhapura District. The experimental school had 176 adolescents and the control school had 169 adolescents. The logical framework mainly consisted of a methodology to address determinants of alcohol consumption. Health Promotion principles were followed throughout the interventions. Interventions were mainly focused on addressing the previously identified determinants those contribute to the alcohol consumption of the father. Interactive discussions were conducted with the intervention group once a week for a period of four months. Discussions were supported with innovative tools and video presentations together with group activities.

Both descriptive and inferential statistical methods were used to analyse data using statistical package for social science (SPSS) as the tool and thematic analysis were used for qualitative data. According to findings of the study, 4% of fathers had stopped alcohol consumption in the intervention group, 11% had reduced the frequency of alcohol usage and 23% had changed the harmful alcoholic related behaviours. About 98% of the children in intervention group had changed their knowledge, attitude and practices (KAP) on alcohol usage. Adolescents used various tools and strategies to address identified determinants of fathers' alcohol consumption. Qualitative analysis showed that community actions had been carried out among students to challenge the practice of masking the real harm of alcohol within communities. Similar group actions had been useful for adolescents to understand the real harm of alcohol and avoiding the use of it.

The adolescents acted as change agents of this study. Health promotion approach is effective in empowering the students towards taking actions for reducing alcohol usage and related behaviour of the father.

Keywords: Alcohol prevention, quasi experimental design, determinants, health promotion interventions

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Effectiveness of a Health Promotion Intervention for Improving the Protective Environment Among Children Aged 10 – 18 Years in a Selected MOH Area in Jaffna District

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Child abuse is an important public health problem. Globally, one in five women and one in 13 men have been sexually abused as a child. Sri Lanka's National Child Protection Authority reports an increasing trend, with 10,732 complaints in 2015 and 9,014 child abuse cases during 2017. This study focused on the effect of empowering children and their mothers in improving the child protective environment in a rural village in Sri Lanka.

A quasi-experimental study was carried out over a period of six months in Chavakachcheri Medical Officer of Health (MOH) area. Two randomly selected villages were identified as the intervention and control settings, from which 42 and 43 children aged 10-18 years were recruited, respectively. Their mothers were also recruited for the study. The intervention was the improvement of the protective environment of the child, by adopting a community-based health promotion approach. In the interventional setting, the initiation, maintenance, monitoring and modification of the health promotional process was facilitated step by step by one investigator among the children and mother groups. Pre and post-data were collected from both settings using an interviewer-administered questionnaire, observation check list and focus group discussion. Quantitative data were analysed using statistical tests, and qualitative data through thematic analysis.

A total of 28 determinants underlying for child unsafe environment were identified by the children's and mothers' groups under the guidance of facilitator. Based on criteria such as high prevalence, importance and ease of addressing, five determinants were prioritized to address child protection. These were unsafe physical environment, lack of cordial relationship between children, verbal and physical punishment at home, addiction to television and mobile phones, and poor household income. To address these, seven activities were designed by children and mothers. There was a significant reduction of verbal and physical punishment of children, among mothers in the intervention group (mean reduction = 5.84; $p < 0.001$) and there is no significant reduction in the control group (mean reduction = 0.09; $p = .80$). Also, there was a 64.2% reduction of watching television during 5.00–7.00 pm among children in the intervention group and there is no reduction in the control setting. Children's group gave 8.4 (out of 10 marks) for their village child protection level prior to the intervention; 3.2 during the process; and 7.1 six months following the intervention.

Children and mothers can be empowered successfully to improve the child protective environment in rural settings. Health promotion approach is effective in identifying and addressing the determinants at community level.

Keywords: community based interventions, child abuse, child protective environment, rural villages

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Health Promotion Intervention to Address Determinants of Neglect of Children Aged 5-18 Years in a Disadvantaged Community in Anuradhapura District

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Child neglect is identified as failure to provide children with basic needs. This a public health problem in Sri Lanka and throughout the world. Child neglect ranges from 22% - 32% in both sexes in East Asia and Pacific regions of the world. In Sri Lanka, NCPA (National Child Protection authority) has received 10,273 complaints regarding violence on children in 2013. Among those, 1263 complaints were on educational neglect and 1101 complaints were related to other forms of neglect. The aim of the study was to improve knowledge, attitudes and practices of mothers related to child neglect using health promotional approach.

The study population was 'Ihalaulpathwewa' community in Mihintale Medical Officer of Health (MOH) area in Anuradhapura district. This is a disadvantaged, migrated community where majority of people (88%) belong to the ethnic group 'Thelingu'. All the mothers (n=42) in the community having at least one child within the age of 5-18 years were selected as the sample. One child from each mother (elder child in the age group 5-18 years) was selected to be the agents of change (n = 42). Control group was Bediwewa- Kudagama community in Thambuttegama MOH area which has similar socio-demographic characteristics ($p > 0.05$) to experimental group. Study was for a period of one year and the intervention took an average of six months. First, the determinants for child neglect were identified with mothers and children using focus group discussions. Children delivered the interventions to mothers and they monitored the process. Through interviewer administered questionnaires for mothers and children, effectiveness of the intervention was assessed.

The prioritized determinants of child neglect were, poor practices of mothers that contribute to child neglect, poor mother-child relationship and poor social support. After the health promotional intervention, experimental group mothers had significantly improved ($p < 0.05$) their knowledge regarding child neglect. The improvement of knowledge in experimental group was significant compared with control ($p < 0.01$). In post-intervention phase, there were significant differences in attitudes of mothers in experimental group when compared to the control group ($p < 0.05$). Following the intervention, mothers in experimental group have significantly improved ($p < 0.05$) their practices related to safety, education and nutrition of children, relationships with the child and social support for child caring except the practices related to hygiene of children ($p = 0.062 > 0.05$). The improvement of practices of mothers in experimental group was significant compared with control ($p < 0.05$).

Children who are the victims of neglect could act as agents of changing the process. The implemented health promotional intervention was effective in improving knowledge, attitudes and practices of mothers related to child neglect. Health promotional model could be used and more effective interventions to address child neglect can be designed.

Keywords: Child neglect, disadvantaged communities, community based interventions, change agents

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Effectiveness of a Health Promotion Intervention in Addressing Determinants of Tobacco Use Among School Children Between 13-16 Years of Age in a Selected School in Batticaloa District

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Globally, tobacco kills more than 7 million people per year and 80% from it from low and middle income countries. Use of this poisonous substance either as smoke or in other forms is largely promoted as a fashionable act. Marketing campaigns of tobacco industry target adolescents and young adults of school age. Hence, the risk of early initiation of tobacco use is high among this group. Children who initiate smoking at an early age elicit difficulties in quitting which leads to serious tobacco related health issues. Developing interventions to prevent or discourage tobacco consumption among adolescents is vital for any tobacco control and prevention program. The aim of the study was to empower school children in selected schools in identifying and addressing the determinants of tobacco usage.

A quasi-experimental study was conducted among school children aged 13 to 16 years in selected secondary schools (type 1C) in the district of Batticaloa. An intervention developed using health promotion principles was delivered to the intervention group and no intervention was given to the control group. There were 88 and 82 students in intervention and control groups respectively. During the intervention, student groups were facilitated to identify the determinants that promote usage and initiation of tobacco products among children. These activities were prioritized by the students and then activities were introduced to address the determinants. This process continued for a period of six months. A self-administered questionnaire, peer group discussions and observations were used to collect information from students. Quantitative data analysis was carried out using descriptive and inferential methods with the help of SPSS 21.0 version and qualitative data was analysed thematically.

Six determinants related to tobacco use were identified and prioritized to quit, low family functioning and industry strategies. These determinants are media influences, image attached to use and users, privileges attached to use and user and not being encouraged. Activities such as observatory book (a book which includes industrial strategies that are maintained by students), “Arivai alavidum peddi” (a tool used to measure the media influence on tobacco usage) and “enkal kudumpaththudan tool” (a tool used to monitor the relationship among family members) were designed to counteract those determinants. Following the intervention, the proportion of students who considered tobacco usage as attractive was significantly reduced ($p < 0.05$). Students improved their knowledge on chemicals in tobacco products ($p < 0.05$), tobacco promotion strategies of the industry ($p < 0.05$). Overall, the proportion of students who identified tobacco as dangerous and futile increased ($p < 0.05$) and these changes were not significant within the control group.

Health promotion approach is effective in empowering students towards identifying and addressing determinants of tobacco consumption such as industrial strategies, media influence and family bond that influenced the demand for tobacco usage and early initiation of smoking.

Keywords: Tobacco control, positive image, school-based interventions, media influence

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MATHEMATICS

Testing for Long Memory in the South Asian Foreign Exchange Rates

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Exchange rate movements have a great impact on the political and economic stability of a country. Understanding the dynamic behaviour of exchange rates is extremely important for decision makers such as legislators, investors and market participants in foreign exchange markets. The efficiency of the foreign exchange market is related to the long memory property of the exchange rate dynamics. The question of whether exchange rate markets are efficient or not, is directly related to the long memory in the exchange rate changes. Therefore, detecting long memory in exchange rate dynamics is important to understand whether exchange rate markets of an economy are efficient or not. Long memory suggests very strong market inefficiency.

However, South Asian exchange rates have not received much attention on long memory in the finance literature. This study intends to fill this gap in the finance literature by examining the long memory properties of the South Asian foreign exchange rates of eight South Asian currencies against U.S. dollar. The South Asian foreign currencies examined in this study are, Sri Lankan Rupee (LKR/USD), Indian Rupee (INR/USD), Pakistan Rupee (PKR/USD), Bangladesh Taka (BDT/USD), Bhutanese Ngultrum (BTN/USD), Nepalese Rupee (NPR/USD), Maldivian Rufiyaa (MVR/USD) and the Afghan Afghani (AFN/USD). The study covers the period from January 1, 2007 to December 31, 2017 consisting of 2870 daily observations per country. The growth rates of daily exchange rates are measured by the return series defined as log difference of the exchange rate. The data were collected from the Central Bank of Sri Lanka. To examine the random walk nature (issue of unit roots) of empirical exchange rate behaviour, standard unit root tests; the Dickey & Fuller (ADF) test, the Phillips & Perron (PP) test, and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test were implemented on all exchange rate series. The ADF and PP tests are used to test the null hypothesis of the series that are non-stationary I against the alternative that they are stationary. The null hypothesis of KPSS test mentions that a series is stationary against a non-stationary series. To achieve the main objective of the study, a battery of non-parametric (rescaled range statistics (R/S)), semi-parametric (Geweke and Porter-Hudak (GPH) and local Whittle estimator (LWE)), parametric (fractionally integrated autoregressive moving average (ARFIMA)) tests are employed based on econophysics models.

Tests show that exchange rate return series has long memory except Maldivian Rufiyaa (MVR/USD), Bangladesh Taka (BDT/USD) and Afghan Afghani (AFN/USD) and they are fractionally integrated. The fractional difference parameters are significant at 5 % level. Findings showed that south Asian foreign exchange rates except Afghanistan, Bangladesh and Maldives possess long memory. The findings of the study have policy implications for traders and investors in implementing trading strategies. The results indicate that an exchange rate market which has long memory is not efficient.

Keywords: Exchange rate, Geweke and Porter-Hudak model, long memory, local Whittle estimator, Rescaled range statistics

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Estimation of the Gender Identity of Sri Lankan Population Using the Fragments of Femur Bone

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Estimating the gender identity from human skeletal remains is of crucial importance to forensic anthropologists and bioarchaeologists. The femur is the largest bone in the human skeleton and therefore it is more likely to have a forensic value. The main aim of this study is to develop a reliable and an accurate method to determine the sex of a contemporary Sri Lankan using measurements of the femur bone. A few classification methods are used for estimating the sex of the human skeleton and the classification methods are compared for their estimating accuracy.

A total of 22 measurements including the maximum length of right and left bone of the femur (FML), vertical diameter of the neck (VND), transverse diameter of the neck (TND), vertical diameter of the head (VHD), transverse diameter of the head (THD), subtrochanteric anteroposterior diameter (SAPD), subtrochanteric medial-lateral (transverse) diameter (SMLD), mid shaft anteroposterior diameter (MAPD), mid shaft medial-lateral diameter (MMLD), and epicondylar breadth (EpB) were used in this study.

Discriminant analysis and classification methods, namely, logistic regression, k-nearest neighbours (KNN), K-means clustering, hierarchical clustering, and decision trees algorithms were used to estimate the sex of the femur. Out of 22 measurements, only four measurements (FML, SAPD, SMLD, MAPD) of the femur bone were significant in detecting the sex of the bone. In addition, the analysis revealed that both left side and right side of the femur bone have similar variation and male femur bone is larger than that of the female bone. The accuracy of the sex identification of femur using discriminant analysis and classification methods were compared. 57.1%, 96.7%, 82.2%, and 88.4% accuracies were shown for the discriminant analysis, logistic regression, KNN algorithm, and decision trees respectively. Moreover, the results showed that classification methods perform better in estimating the sex of the femur bone than discriminant analysis. Hence, these classification methods can be used to estimate the sex of the femur of unknown, mutilated, and dismembered human skeletal remains with a higher accuracy.

Keywords: Femur bone, sex estimation, classification methods, logistic regression, KNN algorithm, K-means clustering, hierarchical clustering, decision trees.

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Social Media Network Participation and Academic Performance in Undergraduates in Rajarata University of Sri Lanka

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Technology has influenced the development of the modern society in numerous ways. One such negative development of technology is the addiction of people toward using social media such as Facebook, Twitter, LinkedIn, Viber, YouTube, etc. It is common understanding that the printed and electronic media as well as other social media have some impact on positive and negative attitudes of school and university students. The objective of this study is to explore the relationship between the addiction to social media and academic performance among undergraduate students of Rajarata University of Sri Lanka (RUSL). This could help students, lecturers and parents to understand the influence of social media on the academic performance of students. The data were collected from a survey conducted using 151 randomly selected undergraduate students of RUSL. The tabular and graphical data representation methods were used to descriptively analyse the data. Moreover, correlation tests, regression modelling, cross validation and mean absolute percentage error were used in advanced data analysis. Reliability test was used to measure the consistency of the questionnaire and Cronbach's alpha was 0.824 which indicated a high level of internal consistency. Analysis of descriptive statistics identified gender difference, the availability, level of usage, reasons and integration with social media as key factors of the study. The influence of these factors on the academic performance of students were analysed using Correlation and regression analysis techniques. Mean absolute deviation was used to test the average distance of all the elements in the data set. 10-fold cross validation was used to check the accuracy of the fitted model. SPSS (Statistical Package for Social Science) version 21.00 was used for statistical analysis.

Among the variables considered, level of usage of social media has a significant influence on the academic performance of students. However, only correlation and cross validation methods depicted that gender difference and reasons for using social media are significant. Multinomial regression methods showed that integration with social media is substantial. While the fitted regression model showed 0.168 accuracy, the cross validation fitted regression model showed 0.182 accuracy.

The results of the study showed that social media has a significant impact on academic performance of undergraduates. Moreover, the results also showed that social media, in particular YouTube, Facebook, Messenger, Viber and WhatsApp are most popular among undergraduates. Most of the students use social media for entertainment, to chat, to follow friends' posts, fashion and styles and kill spare time. Hence the study results concluded that social media negatively affect the academic performance of the students.

Keywords: Reliability analysis, Pearson's Correlation, 10-fold cross-validation, regression analysis, mean absolute deviation

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An Integer Programming Approach to Solve the Nurse Scheduling Problem

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Scheduling nurses is one of the most common problems in the field of operations research. Manually scheduling nurses to staff shifts is a challenging task and hence using a mathematical model to fulfil this task has drawn significant attraction in the field of hospital management. Since there is no known algorithm that is able to solve the nurse scheduling problem in polynomial time (i.e. time to find a solution to the problem grows exponentially with the size of the problem), it is considered as a non-deterministic polynomial-time (NP) hard problem. Hence it has become a demanding problem of all time. Although many studies have attempted to solve this problem, researchers are still unable to find a universally acceptable model or a method to solve the nurse scheduling problem.

The objective of this research is to formulate and solve a nurse scheduling problem in a hospital using an integer programming technique. The data was collected from the operating theatre of the General Hospital, Matara, Sri Lanka. Currently, the monthly nurse schedule of the operating theatre is manually prepared by the head-nurse. Manually preparing the nurse duty roster is an extremely difficult and a time-consuming task. The nurse schedule provides daily shift assignments to each nurse in order to balance their workload. The workload is calculated using key factors such as travel, distance, pregnancy, health issues, family issues, the requests made by the nurses in a favourable manner and satisfying specific requirements imposed by the hospital management in the best possible way. The constraints of the model are categorized into soft (e.g. night shift is assigned in every 8 consecutive days, etc.) and hard constraints (e.g. the minimum staff requirement must be satisfied, allows a nurse to work no more than a single shift per day, etc.) according to the nature of the constraint. Hard constraints should be indeed satisfied. Soft constraints are those that should be satisfied, however not at the expense of others.

The formulated integer programming model was solved using branch-and-bound algorithm with the help of LINGO optimization software.

The results showed that the optimal solution was able to completely satisfy the hard constraints. This is in fact a very positive and encouraging result given that the problem is NP hard. However, due to the structure of the model, the algorithm utilizes reasonably large computational time to solve the model. Hence, the proposed model needs to be restructured to reduce the computational time.

Keywords: Mathematical programming model, integer linear programming, nurse scheduling, branch and bound algorithm

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Applying Quadratic Assignment Problem for Modelling and Analysis of the Hospital Facility Layout

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Facility layout design arises both in the process of designing a new layout and redesigning an existing layout. Redesigning an existing layout was discussed in this study. This study focuses on giving a better service to the patients in a hospital and to increase the efficiency of its employees. The movement cost between entrance and the patient care rooms can be minimized by applying quadratic assignment problem to the hospital facility layout. We assume that the distance between the entrance and patient care rooms is directly proportional to a cost function which is defined based on the movement of the patients, doctors, medical staff and non-medical staff, known as entities, within the hospital. The research shows that the time spent by the entities in the hospital could be reduced significantly by minimizing their unnecessary movements.

The main purpose of this research is to develop a multi-floor facility layout for hospitals to minimize the total movement cost of entities. The movement cost is directly proportional to the travel frequency and distance between departments of the hospital. The travel frequency and the degree of travelling difficulty of the entities were measured by observing the movements. In addition, the distances between departments were obtained by using the existing hospital building layout plan. Finally, the cost factor was determined by assigning different weights for entities.

Multi-floor facility layout problem was formulated as a quadratic assignment model and it was solved using LINGO optimization solver. It was found that the solution to the model produces a better hospital layout plan compared to the existing layout. The solution clearly indicates that the travelling distance of entities is reduced significantly in the new layout. Finally, it can be concluded that the proposed model is capable of designing hospital layout plans which optimizes the total movements of entities.

Keywords: Facility layout, Quadratic assignment problem, LINGO Solver

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Estimating the Factors Affecting the Productivity of Large Onions in Hambantota District During the Off-Season

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Large Onions are a valuable crop since the early 1980s, and it has been popular among the farmers due to its high profitability. Large onions production in Sri Lanka is concentrated mainly within Matale and Anuradhapura districts, contributing nearly 90% to the national production in 2007. Currently, these onions are cultivated in Hambantota and Monaragala districts during the off-season. The main objective of this study is to identify the factors affecting the productivity of large onions in Hambantota district during the off-season. In addition, identifying the average productivity per acre in Hambantota district and comparing it with the other areas that cultivated large onions are among the other objectives. The main issues encountered and the critical contributing factors for the large onion cultivation in this area were also identified. Sample data of 201 farmers were collected from Hambantota district. Multiple regression model was used to identify the factors affecting the large onion productivity in Hambantota district during the off-season. Normality assumption of the regression was checked using Kolmogorov–Smirnov test and Shapiro Wilk normality test. Moreover, Pearson, Spearman’s Rank, and Partial correlation tests were used to check the correlations between the variables (factors). Variance inflation factor (VIF) values were used to check the multicollinearity between the variables. Mean Absolute Percentage Error (MAPE) and Symmetrical Mean Absolute Percentage Error (SMAPE) values were used to validate the fitted model. The results showed that the main factors affecting the productivity of big onion in the Hambantota area are seasonal months, monthly income, subsidies fertilizer, and cultivated quantity. Model accuracies were reported as 98.48% and 98.49% from MAPE and SMAPE respectively.

Keywords: Mean absolute percentage error, multiple regression, productivity, symmetrical mean absolute percentage error, variance inflation factor, large onions

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PHYSICS

Synthesis and Characterization of Mg Based Cd Alloy

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A material composed of at least two elements with one of those elements being a metal is commonly known as an alloy. In general, the physical and chemical properties of alloys are superior to those of the constituent elements and hence they are extensively used in numerous applications ranging from kitchen utensils to aerospace industry. Although, there are thousands of different types of alloys being used at present, still there is an infinite number of possibilities to make alloys theoretically.

The broad aim of this study was to synthesise an alloy with optimized properties using Mg as the based material and Cd as the alloying material owing to the fact that the Mg and Cd alloys have gained less attention in literature. These two metals were selected according to the Hume-Rothery rules for the formation of solid solutions. A series of samples were prepared varying the molar ratio of Mg to Cd from 50:50 to 90:10 with the intention of observing the Cd solubility in the Mg structure. The required amounts of Mg and Cd were cut into small pieces and were heated in an alumina crucible in ambient air at 700° C for 15 minutes using an electric furnace (Protherm PLF 110/15) and were kept under furnace cooling. The resulting samples were characterized using X ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) in order to see whether the resulting materials are composed of a single phase (solid solution) or a mixture of phases or an intermetallic compound.

The XRD analysis revealed that the samples were mainly composed of oxide phases of constituent materials and some other intermetallic phases. FTIR analysis also confirmed the presence of oxide phases indicating that the required solid solution phase (alloy) has not been formed satisfactorily. This would suggest that the expected alloy has not been formed when the samples were synthesized in ambient air indicating the need of an inert environment for the synthesis.

Keywords: Mg, Cd, alloy, solid solution

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Designing of Automated Tablet Dispenser and Liquid Measuring System for Medicines

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Proper management of medication is essential for a safe and effective healing process. Due to busy life style, majority of people completely forget to take medication or take it well after the recommended time of the day. It had been proved to be fatal in several occasions. Although there are different types of pharmaceutical tablet dispensers in the market, it is extremely difficult to find a reliable and affordable system. As a solution, an automated Arduino based pharmaceutical tablet dispenser was built to remind the relevant time and the dosage for the patient by sending a message via global system for mobile communications (GSM) module. The time is calculated using a real time clock (RTC) module and the relevant time is reminded to the patients to take medicines by ringing an alarm. The correct doses of tablets are automatically released to the patient. In addition, it sends a message to the patient or the caretaker to refill the tablets when the numbers of tablets are running low. The system is compatible with any type of mobile phone and does not require information and communication skills to utilize it.

In addition to the tablet dispenser, a liquid measuring system was designed and built especially for paracetamol, salbutamol, piriton and domperidone medicines. The proper dose of medication is released by the system once the caretaker enters the illness, age and the weight of the patient. The machine can measure the liquid up to 0.05 ml accuracy. This project can be further improved by connecting RTC module and a GSM module to remind the patient or caretaker to attend to taking medicines.

Keywords: Arduino, liquid measuring, global system for mobile communication module, real time clock module, tablet dispenser

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Design and Build a Set Up to Measure Magnetoresistance of Magnetic Thin Films**Jayampathi K. A. T. S.^{1*} and Jayathilaka K. G. P. B.**²

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The magnetoresistance (MR) of a material is defined as the dependence of electrical resistance of that material on an external magnetic field. While MR can be used for several industrial applications, it can also be used to characterize magnetic materials. Despite its importance, measuring MR in magnetic thin films remains a challenge due to the size and the shape of the samples. In this study a low-cost MR measuring system was designed and built to characterize magnetic thin films.

In this set up the sample was mounted between two pole pieces of an electromagnet on a wooden stage. The current was applied to the electromagnet using a bipolar power supply to generate a variable magnetic field. The resultant resistance change was measured using a 6½ digit multimeter. The magnetic field was measured by a LABQUEST² gauss meter. The interface software was developed using National Instrument LabVIEW and the data were simultaneously sent to a computer through a universal serial bus. LabVIEW program was used to record and to plot the resistance change as a function of magnetic field. The functionality of the set up was confirmed by measuring several magnetic thin films and magnetic sensors.

Keywords: Magnetoresistance, thin films, LabView

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The Effect of Uniform and Non-Uniform Electron Density Models for Determining Shock Speed of a Solar Radio Burst

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Solar flare is one of the solar activities bonded with the coronal mass ejections of the sun. It is a giant burst of x-rays, γ -rays, radio emissions and energy which travel at the speed of light in all directions. Emissions of radio waves create an important part of the solar radio burst. There are five types of radio bursts identified by the radio astronomers. Among the five types, type II radio burst, which is also called slow drift burst or shock waves have special features which are different from other radio burst types. The exact mechanism of type II burst is still a matter of debate. Therefore, the determination of properties of solar radio bursts enhances our knowledge of understanding this natural phenomenon. Shock speed or plasma velocity is one of the valuable parameters that gives much information about solar radio bursts.

In this study, shock speed of type II radio burst was estimated. The estimation was carried out by the use of uniform density model and the non-uniform density model for the sun. The spectroscopic data needed for the study was obtained by the e-CALLISTO data base. e-CALLISTO is a global network of radio spectrometers operating in 24 hours to detect solar radio bursts originating from the sun.

The results showed that there was a significant change in shock speed with the non-uniform electron density model. The rate of increase in shock speed with the altitude in non-uniform model is less than that of the uniform model. The shock speed is proportional to the electron density (N_e) and inversely proportional to the rate of change in electron density with altitude (dN_e/dr). The determined shock speed for the altitude of one solar radius is 2131 km/s for the uniform model and 766 km/s for the non-uniform model. The shock speed for uniform electron density model is quite higher than that of the non-uniform model. Hence, the shock speed calculated by the non-uniform density model which accounts for the actual electron destitution is needed to be used in further investigations of Type II solar bursts.

Keywords: Type II radio bursts, e-CALLISTO, uniform, non-uniform, electron density models

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Low Cost 3D Scanner**Thotawaththa T. C.^{1*} and Jayathilaka K. G. P. B.²**

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3D scanner is an object which analyses a real world object to collect data on its shape and appearance to construct a digital 3D model. Even though there are different types of 3D scanners available in the market, they are very expensive. Therefore, those types of 3D scanners have become unaffordable for most of the local research labs and small scale industries despite their importance. In this research a low cost 3D scanner is proposed using basic micro controllers and ultrasonic sensors. The ultrasonic sensor was fixed in a way that it could move in XY plane while Z axis is fixed. The data from ultrasonic sensor was simultaneously sent to a computer through universal serial bus (USB) while it is scanning the XY plane. The same procedure was repeated for all the surfaces of the object. The data were then uploaded to the Origin software and obtained the 3D models of the object using 3D plotting successfully under some conditions.

Keywords: micro controller, ultrasonic

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Synthesis of Zirconia from Zircon Sand

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The synthesis of zirconia (ZrO_2) from zircon ($ZrSiO_4$) sand obtained from Pulmoddai, north of the city of Trincomalee, in Sri Lanka is described in this work. Beach sand obtained from Pulmoddai consist of 65% ilmenite, 10% zircon, 10% rutile and the rest are nonheavy minerals. Zirconia is an oxide ceramic material which is used in industrial applications because of its excellent optical, chemical, electrical, thermal and mechanical properties. Biocompatibility is one of the most important properties of zirconia not resulting in inflammatory, allergic, mutagenic and carcinogenic reactions. Although, there are many mineral deposits around Sri Lanka, the country still does not have a mineral refining centre and therefore, mineral deposit resources haven't been exploited so far.

It was revealed that zirconia can be readily synthesized using zircon sand which can be separated directly from raw sand. After the preliminary preparation, the zircon sand was mixed with a 50% solution of aqueous caustic soda (NaOH) and heat treatment was carried out at 650 °C for 90 minutes. The effect of NaOH/ $ZrSiO_4$ ratio on the yield of zirconia was tested and the zirconia powder was obtained from crystallization of zirconium oxychloride. The resulting powder was analysed using X-Ray Diffraction (XRD) method. The XRD patterns of the raw sand and the resulting powder were compared with reference. It was confirmed that the raw sand was zircon and the resulting powder was zirconia.

Keywords: Zircon, Zirconia, Biocompatibility, X-Ray Diffraction

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