Ministry of Education
Research & Innovation Division
&
National Science Foundation

Symposium on Indo-Sri Lanka Collaborative Research Programme

2023

20th January 2023
SLIDA, Colombo 07

National Science Foundation
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MESSAGE FROM THE SECRETARY

It is with great pleasure that I extend my warmest greetings on the occasion of the second symposium on Indo-Sri Lanka Joint Research Programme organized by the Research and Innovation sector, Ministry of Education, Sri Lanka.

The bilateral relations between our two countries are built upon and shaped through a number of key agreements among which, the Programme of Cooperation between Sri Lanka and India for collaborative research is accorded a prime and a prominent role. This programme has provided much needed impetus for bolstering research ties and knowledge sharing between our countries.

The benefits gained by our country from this programme are immense. The research strength of India has been instrumental and played a pivotal role in the scientific advancements that we have witnessed as a country. The invaluable support which we received from the Government of India has resulted in considerable investment and development being made in different sectors such as agriculture, healthcare, space research, and nuclear power through scientific research in India. It is understood that India is gradually becoming self-reliant in nuclear technology.

The collaborations started and connections made during the course of these projects would not stop here. They will become stronger and expand further building friendships and alliances and going further afield building multinational networks and creating an enabling environment for sustained engagement in mutually beneficial areas. Together we can become strong, excelling in research and innovation, and work towards finding solutions to national and global problems.

This is a formal platform where these researchers can share their research findings with a broader community who can use these final outcomes of these researches to provide the highest benefit to the society. I hope that this event will be most illuminating and rewarding for all and wish this symposium every success.

Mr M N Ranasinghe
Secretary
Ministry of Education

January 2023

MESSAGE FROM THE ADDITIONAL SECRETARY

I wish to place on record my warmest felicitations on the day of the second Symposium of the Indo – Sri Lanka Joint Research Programme.

We entered into and became part of this agreement in 2008, and the ensuing years saw us progressing to the point where we have completed three calls of proposals along with the finalization of the list of projects to be supported in the 4th round. Although 6 areas of importance have been highlighted in the Programme of Cooperation, the two countries have made sure that nationally important areas for each country are focused on and are accorded due priority. Sri Lanka's long history of plant based medicine boasts immense potential in satisfying the rising global demand for the wellness of mind and body. Recognition by the World Health Organization of Sri Lanka's holistic and natural healthcare system also strengthens its authenticity and competitive advantage in the region. The Indo-Sri Lanka cooperation has taken advantage of this and some of the projects have been supported in this area.

Our scientists and researchers have benefitted from these developments, sharing the knowledge and research experience with the Indian counterpart. The exchange programmes built into the programme, have exposed our young scientists not only to new technologies but also to the research culture in India, learning good practices and effective methods and procedures. I hope Sri Lankan scientists also would contribute equally in enhancing the research culture in Sri Lanka. In 2017 alone, there were many exchanges between the two countries.

The 2017 batch of projects, resulted in 28 journal publications 211 conference papers, and 21 abstracts published by the research teams. As we all are aware, research publications in turn help elevate the research and innovation status of the country. All these activities which I have highlighted above, lead towards increasing both of our countries' knowledge and technology outputs and in turn affects the status of our countries in the Global Innovation Index.

Finally, I wish to thank the organizing committee for their part in the successful conduct of this event and the researchers for their contribution towards knowledge sharing while uplifting the collaborative spirit between the two countries.

Mrs Nadeeka Wataliyadda
Additional Secretary (Development & Innovation)
Research and Innovation Sector
Ministry of Education

January 2023

MESSAGE FROM THE CHAIRMAN

I am pleased to send a message to commemorate the Symposium on the Indo-Sri Lanka Collaborative Research Programme -2023.

India and Sri Lanka have a long history of scientific and cultural cooperation in a mutually rewarding and reinforcing manner, and the Government of the Republic of India and the Government of the Democratic Socialist Republic of Sri Lanka entered into an agreement in 2008 to promote scientific cooperation between the two countries. This agreement provided a platform for collaborative research, technology transfer and exchange of scientists. Under the Programme of Cooperation (PoC) signed in 2017, seventeen research projects were successfully completed and about thirty scientific organizations, including Universities and R&D institutions in both countries, have benefited a great deal. It is heartening to learn that findings emanating from research investigations carried out will be presented at the symposium.

On behalf of the Ministry of Education, the National Science Foundation, an apex scientific institution mandated to promote S&T for national development, is happy to organize this historic event. While thanking the NSF staff for organizing this important event, I wish the symposium all the success.

We look forward to furthering scientific cooperation between the two countries to advance the cause of S&T for the benefit of humanity!

Professor Emeritus Ranjith Senaratne
Chairman
National Science Foundation
Colombo 07

January 2023

MESSAGE FROM THE DIRECTOR GENERAL

As the Director General of the National Science Foundation (NSF), I am privileged to send this massage on this special occasion, which is a joint effort of NSF and the Ministry of Education.

Through its vision and mission, the National Science Foundation prioritizes Science, Technology and Innovation (STI) for socio-economic prosperity of the nation, mandated by the Science and Technology Development Act No.11 of 1994 of Sri Lanka. NSF being one of the responsible and leading institute in the Science and Technology sector of the country, is committed to generate, disseminate and transfer scientific knowledge and more to ensure the effective utilization of scientific knowledge for the greater benefit of the people, as its prime objective.

In this backdrop, considering the request received from the Ministry of Education, NSF organized the Symposium on Indo- Sri Lanka Collaborative Research Programme. This was entrusted to NSF by the Ministry of Education considering the research excellence of NSF.

The symposium will provide a platform for the scientists to disseminate knowledge generated through collaborative research projects, to share the experiences of collaborative research efforts with fellow scientists and to discuss the way forward of the completed projects with experts and stakeholders.

I thank Head and staff of Research Division for their unstinted efforts and cooperation to make this event a success.

I wish the symposium a great success!!

Dr Sepalika Sudasinghe
Director General
National Science Foundation
Colombo 07

January 2023

INTRODUCTION

The Government of the Republic of India and the Government of Democratic Socialist Republic of Sri Lanka entered into an agreement in 2008 to encourage the scientific cooperation between India and Sri Lanka.

The first Programme of Cooperation (PoC) between the two countries was signed on 22nd September 2011 which was renewed time to time for a period of three years unless terminated. According to the PoC both parties agreed to execute scientific and technological projects and workshops within the proposed budget. Four PoC's were signed up to now from 2011.

Under the PoC signed in 2017, two parties were to cooperate with the following nationally important research areas;

- Food Technology
- Plant-based Medicine
- Metrology
- Space Research and Applications
- Robotics and Automation
- Industrial Electronics
- Waste Management
- Renewable Energy
- Information Technology

In the 2017 research cycle, 17 projects were successfully completed. So far 28 journal publications, 211 conference papers and 21 abstracts have been published based on the outputs of the research projects.

Indo-Sri Lanka cooperation has been an advantage to strengthen research of many projects. Our scientists and researchers have benefitted from these developments, which enabled sharing knowledge and research experience with the Indian counterpart. The exchange programmes built into the programme have exposed our young scientists not only to new technologies but also to the research culture in India. During the 2017 research cycle, there were many exchange visits between the two countries.

Benefits harnessed from the collaboration between India and Sri Lanka

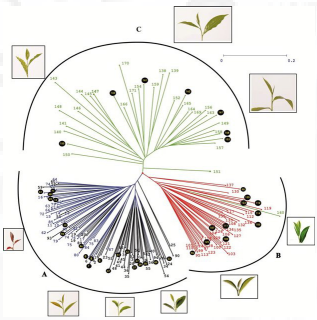
- Share intellectual properties
- Exchange information and cost
- Exchange of collaboration experts taking part in projects
- Capacity building
- Encourage the scientific cooperation between Indian and Sri Lankan Universities, research institutes, and other science and technology institutions

Research Highlights

Project Title : High throughput genotyping to expedite the genetic characterization and dissection of important genomic traits of tea

Project No. : MSTR/TRD/AGR/03/02/04

The investigation was undertaken to expedite the genetic characterization and identification of important agronomic traits of Sri Lankan tea germplasm using high throughput genotyping with comparing to the Indian germplasm. Also, metabolite diversity was assessed by quantifying green leaf catechins, caffeine and gallic acid by HPLC method and considerable variations were observed. Results revealed that based on molecular diversity, Sri Lankan genotypes could be separated from Indian genotypes indicating the diverse origins and ancestry of accessions. Promising cultivars were identified for specialty tea production such as purple tea, yellow tea and low caffeinated tea. Two core subsets to represent the diversity of Sri Lankan and Indian tea germplasm have been identified. Accessions with high catechins, high anthocyanin and low caffeine have been identified. Capacity building of Sri Lankan scientists was done. Selected diverse accessions will be used for the tea breeding programme in 2023. Commercial exploitation of potential cultivars for producing specialty tea such as purple, yellow, and low caffeine tea with enhanced quality and medicinal properties.



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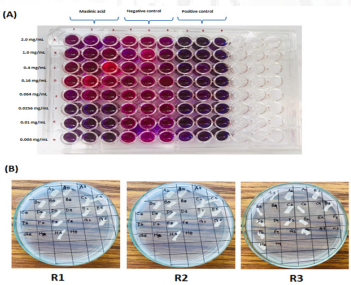
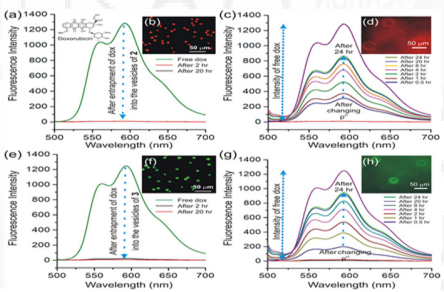
Project Title : Renewable chemicals from the plants of Indian subcontinent: isolation, self-assembly and utilizations in drug delivery, medicine and catalysis

Project No. : MTR/TRD/AGR/03/02/06

Terpenoids are one of the important classes of plant secondary metabolites with vast array of biological activities. Owing to the nanometric lengths, lipophilic backbone and the presence of several hydroxyl and/or carboxyl groups, terpenoids could be considered as an attractive choice for the study of their self-assembly properties. The present study was conducted to evaluate the biological activities of some commonly available plant species in India and Sri Lanka and to isolate bioactive secondary metabolites, particularly terpenoids for the assessment of their self-assembly properties in different liquids. Our investigations led to determination of critical vesicular concentrations (CVC) of arjunolic acid and oleanolic acid. A decrease in CVC values were observed with increase in the percentage of water in the binary liquid mixture in both these terpenoids. Furthermore, the vesicular self-assemblies of sodium and potassium salts of maslinic acid were capable of encapsulating the anticancer drug doxorubicin in aqueous medium could be harnessed for targeted drug delivery applications. Interestingly, a paradoxical antimicrobial behavior was observed with some of the isolated terpenoid compounds and to the best of our knowledge this is the first time that such a phenomenon was detected in plant secondary metabolites.





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Project Title : Bioprospecting endolichenic fungi from mangroves in Negombo lagoon in Sri Lanka and gulf of Khambat, gulf of Kutch from Gujarat India: an untapped treasure trove for discovery of special structures and bioactive compounds

Project No. : MSTR/TRD/AGR/03/02/07

Endolichenic fungi (ELF) is considered as a novel source of natural products with prominent bioactivities. Study conducted in Negombo lagoon on 65 ELFs, isolated from 31 lichens, revealed significant bioactivities and metabolite profiles with many non-dereplicable masses in LCMS dereplication. Following bioassay-guided fractionation, the ELF *Phanerochaete sordida* yielded a compound with antioxidant, anti-inflammatory and anti-cancer activity and *Phanerochaete chrysosporium* has revealed three compounds and structure elucidation and bioactivity analyses are being conducted. From an ongoing project, two ELF from the Puttalam lagoon, *Neurospora ugadawe* and *Talaromyces pinophilus*, yielded two novel and three known bioactive compounds respectively. These establish how important ELF are as a source to fulfil demands in the pharmaceutical industry. As a subproject, ELF's ability in Low Density Polyethylene (LDPE) deterioration was studied. *Phanerochaete chrysosporium* showed the highest activity and a spore suspension of the same is being developed as an enhancer of LDPE biodeterioration to help solve a crucial environmental issue.

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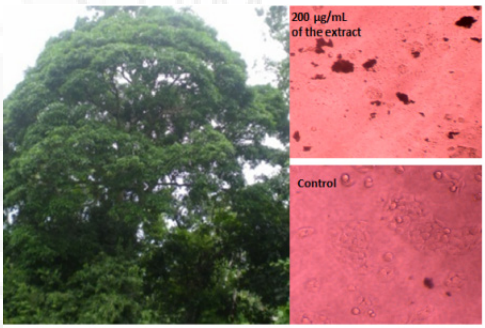
Project Title : ***In vitro*** **and** ***in vivo*** **epigenetic investigations on anti cancer and radio-priming effects of different parts of** ***Mangifera Indica*** **(India) and** ***Mangifera zeylanica*** **(Sri Lanka) and impact of green silver nanocomposites**

Project No. : MSTR/TRD/AGR/03/02/08

Lung cancer is a significant health problem with a high mortality. Available chemotherapy and radiotherapy methods are associated with serious adverse effects. Hence novel therapeutics are needed for its treatment. The research team had previously shown endemic mango (*Mangifera zeylanica*) to possess compounds effective against breast and ovarian cancers. Various groups had demonstrated anticancer effects of common mango (*Mangifera indica*). In the present study both Sri Lankan endemic mango and common mango were investigated for their ability to specifically kill lung cancer cells. Certain solvent extracts of leaves of both mango varieties were effective in killing lung cancer cells by regulating selected anti-cancer signaling pathways in the laboratory setting. Research work was enabled identification of active fractions of *Mangifera zeylanica* and *Mangifera indica* leaves effective in killing lung cancer cells, elucidation of mechanisms of action of active fractions.



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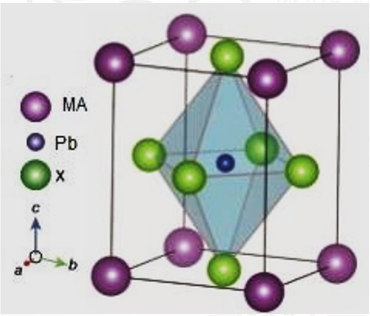
Project Title : Electronic and photovoltaic properties of two-dimensional hybrid organic and inorganic perovskites

Project No. : MTR/TRD/AGR/03/02/15

This research project, developed more stable perovskites with better properties, such as rapid rise in energy conversion efficiency, low degradation, and higher moisture stability for optoelectronic and photonic devices. The research team numerically modeled several perovskites based thin-film solar cells with better efficiency under different light conditions. The project results contributes to the general understanding of low dimensional hybrid organic -inorganic perovskite compounds, and provide necessary understanding of electronic band structure, band gap and optical properties of such materials. The numerically developed thin-film solar cell architectures give significant guidance on how to increase energy conversion efficiency and build low dimensional hybrid organic - inorganic perovskite thin-film multijunction solar cells. The computational approaches and results described in the project are dedicated to assist experimentalists in extracting the maximum information and understanding from their experiments. The results of this project can be extremely helpful in identifying technologically significant strategies to improve the performance of existing 2D hybrid organic-inorganic perovskite-based materials in solar cells and search for new relevant 2D halide organic-inorganic perovskites.



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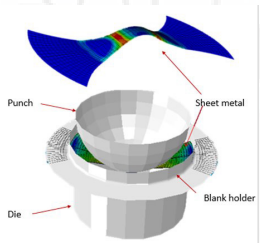
Project Title : Enhancing the formability of automotive materials at elevated temperature and selection of lubricants for sustainable manufacturing

Project No. : MSTR/TRD/AGR/03/02/16

AA2014-T6 is an Aluminum alloy series that is popular in the aircraft industry because of its strength and lightweight. However, there are constraints in using these in the automotive body panel manufacturing industry because of difficulties in forming. Therefore, in this study, the formability of AA2014-T6 alloy was investigated with varying forming parameters:forming temperature, lubricant type, lubricant thickness, sheet thickness etc. In the first phase of this study, the formability of AA2014-T6 was tested at three elevated temperatures with three types of hot forging lubricants. Phase two of the experiment was planned to do further investigation on parameters: sheet thickness, lubricant thickness and also to investigate the use of green lubricants: Canola oil with boric acid powder mixture, and Saopnut for metal forming at 300^0C temperature. A Finite Element simulation model was developed in ABAQUS/CAE to predict the formability of AA2014-T6 aluminum alloy, and thereafter, the model was validated using experimental findings. Furthermore, model was generalized for different levels of parameters that were affecting the formability of lightweight metals. Friction behavior at the forming surface was not considered because of the complexity of studying the friction coefficient in forming surface.



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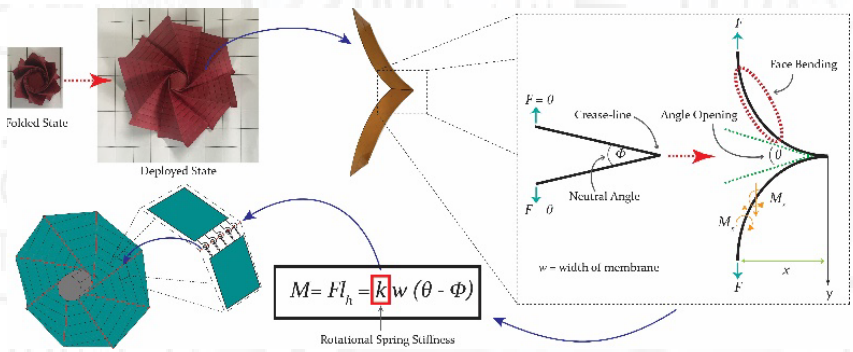
Indian Institute of Technology, Guwahati

Project Title : Dynamic analysis and shape control of inflatable structures for space applications

Project No. : MTR/TRD/AGR/03/02/09

Limited stowage volume of launch vehicles demands compact packaging of large membrane structures that is essential for future space explorations. The employment of origami-based folding techniques allows engineers to fold these large structures into highly compact configurations. The accuracy of simulating folding and deployment behaviour of ultra-thin membrane structures was improved through this study. These improved prediction techniques play a significant role in design optimization of inflatable/deployable space structures. Research team is now working on enhancing the simulations by including the time-dependent behaviour of material and combining the effects of creasing and wrinkling into a single simulation. This project delivered four Science Citation Index Expanded publications in Q1 ranked journals (Scimago ranking) and produced three MSc degrees at University of Moratuwa. In addition to active collaboration with IIT-Roorkee, numerical simulation facilities at University of Moratuwa were enhanced with the addition of a high-performance workstation and LS-Dyna finite element package.



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INDIA

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Project Title : Wireless sensor in-network distributed detection mechanisms for structural health monitoring in civil structures

Project No. : MSTR/TRD/AGR/03/02/10

Wireless sensor network (WSN) based structural health monitoring (SHM) systems have shown significant improvement as compared to traditional wired-SHM systems in terms of cost, accuracy and reliability of monitoring. However, due to the resource-constrained nature of the sensor nodes, it is a challenge to process a large amount of sensed vibration data in real-time. Existing mechanisms of data processing are centralized and use cloud or remote servers to analyze the data to characterize the state of the structures, i.e., healthy, or damaged. These methods are feasible for wired-SHM systems. However, transmitting huge data sets in WSNs has been found to be arduous. In this context, two major areas were in concern during this study. That is removal of outliers in measured vibration data using gravitational outlier detection algorithm (GOD), and the introduction of a mechanism named as “in-network damage detection on edge (INDDE)” which extracts the statistical features from raw acceleration measurements corresponding to the healthy condition of the bridge and use them to train a probabilistic model, i.e., estimating the probability density function (PDF) of multivariate Gaussian distribution for damage detection. A mechanism for damage detection, “in-network damage detection on edge (INDDE)” was introduced.

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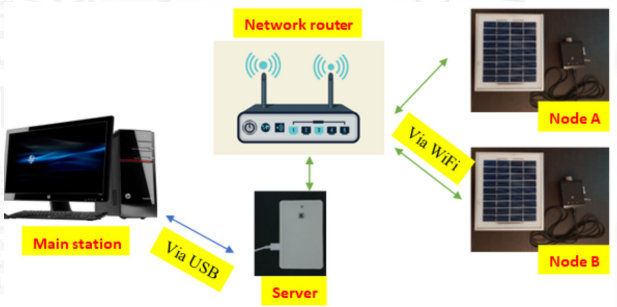
Project Title : Design and development of detection and extinguishing systems for forest fire using sensor networks, aerial and ground robots

Project No. : MTR/TRD/AGR/03/02/12

Forests are an important component in the ecosystem. Due to natural and human interventions, these forests can get destroyed. Forest fires are such cause where unimaginable damage to the eco system, and property is inflicted. Therefore, early detection and extinguishing such fires would be a benefit. This report presents such a detection and extinguishing system that uses wireless sensor network to predict and detect forest fires and an automated robot system to extinguish such fires. Wireless sensor nodes with temperature sensors, humidity sensors, pressure sensors, CO_2 sensors and LoRa module are distributed in a 2m×2m size grid and data obtained by that system is used to train an artificial neural network to classify if a fire is present in that particular grid or not. Construction and the operation of this sensor network is explained in this report. Furthermore, the design and the evaluation of the ground robot used for extinguishing the forest fire is presented and an experiment conducted to validate the system is introduced. The sensor network can classify a fire starting in one of its grids with about 65% accuracy and the automated robot has the ability to extinguish such a fire.



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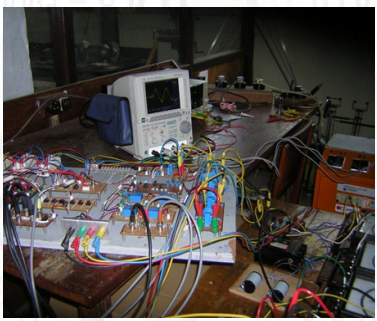
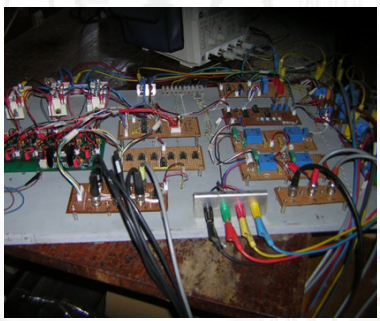
Project Title : Design and development of hybrid wind solar power generation system using multilevel inverter for grid connected application

Project No. : MTR/TRD/AGR/03/02/14

Due to the depletion of the fossil fuel resources and the increased concern on the environmental pollution, electricity generation from renewable energy sources such as wind and solar has become popular. However, due to the intermittent nature of the renewable energy source, it has created technical challenges to harness them at their full capacity. Energy management among different renewable sources has become critical in order to harness the optimum capacities from the renewable sources. Hence, the main objective of the research project was to design and develop a wind solar hybrid power generation system for effective energy management. It was intended to use a multilevel inverter for the grid integration of the wind solar hybrid system due to the increased power quality of the multilevel inverters. Space vector pulse width modulation technique was utilized to operate and control the grid interfaced multilevel inverter. The entire system and the proposed control algorithms were modelled and simulated using MATLAB/Simulink software. A real time control prototyping of the above system was implemented using DSPACE DS1104 controller board for the experimental verification of the proposed system and the control algorithms. Both numerical simulation and the experimental setup verified the successful operation of the proposed system.





Research Team

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INDIA

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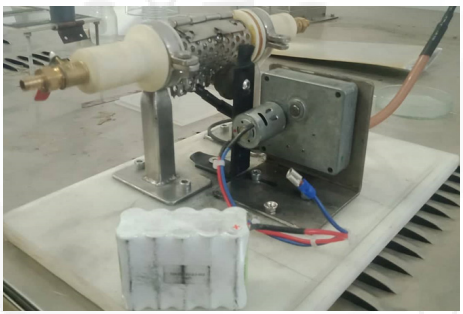
Project Title : Studies in surface sterilization of spices using non-thermal processes

Project No. : MSTR/TRD/AGR/03/02/03

India and Sri Lanka are major producers and exporters of spices. Project undertook establishing a method of decontamination of microorganisms in spices by using cold plasma with advanced UV sterilization technology for the first time in Sri Lanka and to determine its effect towards the microbial inactivation and physico-chemical characterization of the selected spices in Sri Lanka and India. Higher priority given to the cold plasma technology. Cold plasma and UV have the ability to kill the microbes present in selected Sri Lankan spices and morphological and genetic level identification of specific microbes in selected Sri Lankan spices were also carried out. Design development for sterilization of spices by Atmospheric Pressure Cold Plasma Gliding Arc Discharge (APCPGAD) and Atmospheric Pressure Rotary DBD Plasma were established. Developed UV rotary drum and UV canopy type sterilizers are cable to reduce microbial contamination to the level of 55%-60%. Dialogues and measures are being taking to incorporate the findings into the Sri Lankas spice industry to improve the quality of spices via dissemination of the technological findings and actions are being taking to work under common umbrella between Sri Lanka and India and partnership development.



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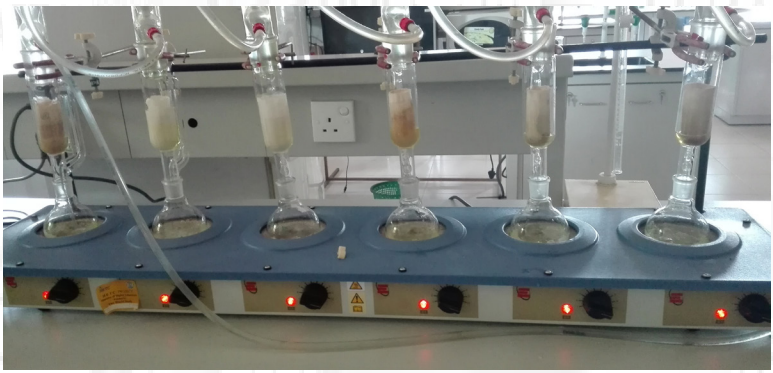
Project Title : Biopolymers/biosurfactants basedmicro-/nano-vehicles for safe delivery of food bioactives and nutraceuticals

Project No. : MTR/TRD/AGR/03/02/05

The major goal of the project was to fabricate a novel, green, sustainable and stable system employing biopolymers and biosurfactants for improving the stability of vitamins/nutrients towards environmental factors (such as heat and light) and for substantially improving the bio accessibility and absorption of vitamins/nutrients in the gut along with preservation of functionality. The bioactive compounds selected were curcumin, folic acid and hydroxycitric acid and the biopolymers selected were alginate, chickpea protein and soy protein. Fabricated nano and submicron particles of curcumin, folic acid, and hydroxycitric acid in alginate, chickpea protein and soy protein matrices. Successful encapsulation and slow release were observed. The stability to heat and light were improved on encapsulation. The bio accessability of the encapsulated compounds showed an increase on intestinal digestion in comparison to free compounds meaning that absorption may favourably improve. This study demonstrates that encapsulation may enhance absorption of bioactive agents in the gut thereby increasing the bioactive potential, via increased stability and slow release of the entrapped bioactive agent.



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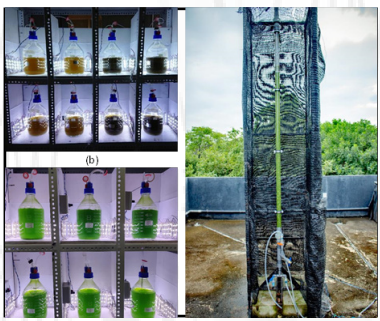
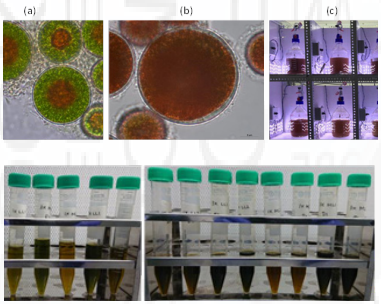
Project Title : Process development and assessment/evaluation of microalgae-based biofuels and value-added products

Project No. : MSTR/TRD/AGR/03/02/18

The project objectives included development microalgae cultivation systems, synthesis/extraction/purification of microalgae based high-value products and biofuels, and assessment of biorefinery routes. Collaboration by the two institutes resulted in the build-up of state-of-the-art research facilities and establishment of a vigorous scientific background for future research on microalgae bioprocessing. The Sri Lankan team developed new processes for synthesis and extraction of high-value microalgal bioproducts such as astaxanthin, fucoxanthin and docosahexaenoic acid. Knowledge on microalgal bioprocesses was disseminated via interactive webinars and workshops, jointly organized by the Sri Lankan and Indian teams.The bioprocesses thus developed could be applied in large-scale production of high-value compounds, targeting export-oriented industries in Sri Lanka and India.





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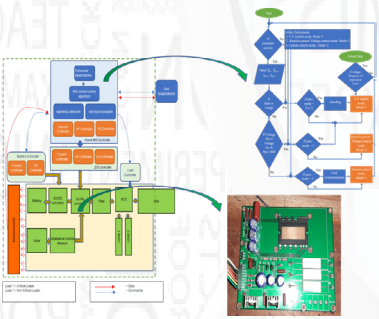
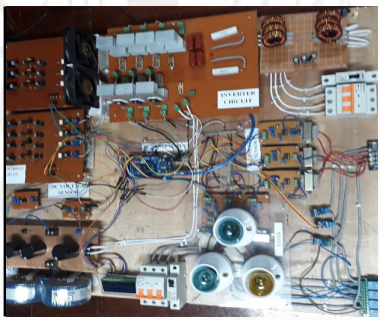
Project Title : Reconfigurable architecture for solar photovoltaic microgrid systems

Project No. : STR/TRD/AGR/03/02/13

This research project was focused on rearchitect the solar PV connection configuration to overcome existing limitation of solar PV penetration into distribution feeders. Accordingly, a conceptual reconfigurable architecture is designed for ZSI based Solar PV microgrid (MG) and functional performances are evaluated through MATLAB/Simulink interface. Further, a prototype of ZSI was successfully implemented. Outcomes of this project shall be beneficial for all prosumers as well as utilities. Accordingly, the proposed MG architecture shall reconfigure itself from current(P) control mode into another configuration whenever unexpected grid failure or voltage dips and rises happened through Voltage(V)-Frequency(F) control mode or Reactive power(Q) control mode. ZSI improves the power quality and reliability of MG while reconfigurability increase fault-tolerances and controllability to existing SPV system during non-production hours. In future, an optimization algorithm and adaptive protection should be integrated for economical dispatch of solar PV - battery systems and for enhancing MG protection.





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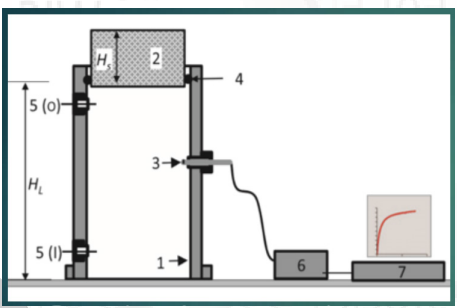
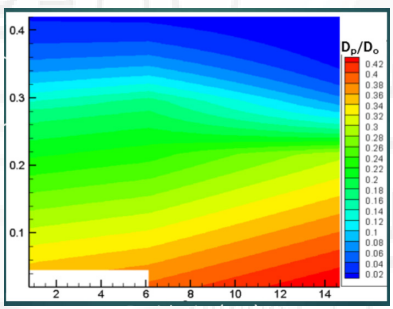
Project Title : Characterizing landfill gas emissions: experimental and numerical investigation

Project No. : MSTR/TRD/AGR/03/02/17

The Overarching objective of the CLEAN research project is to carry out a detailed experimental and numerical characterization of landfill materials and gas emissions in order to evaluate the effects of controlling subsurface characteristics (e.g. soil moisture, density, heterogeneity) and atmospheric controls (e.g. wind and temperature) on landfill gas emissions. The project also evaluated the potential of differently-sized landfill materials on facilitating gas migration. The results provide useful implications on methane migration in old dumps where hierarchical development of "soil-like" matter in aged solid waste may result in higher gas emissions and large variability with saturation. In addition, pronounced effects of wind and, to a lesser degree, of temperature on soil-landfill gas migration was also observed in the laboratory experiment. Atmospheric CH_4 migration originated from the landfill surface based on wind, leakage rate (inflow rate) and leakage direction highlighted the distinct effect of gas leakage direction on diffusion-controlled lateral gas migration. Furthermore, low wind and high leakage rate showed a tremendous impact on exposure to methane in indoor/outdoor environments, thus providing useful implications on occupational health of the community residing in the neighborhood of dumpsites. While the results provided a valuable insight to understand the gas transport behavior in aged landfill materials, further research is need to account more complex landfill variables to obtain more realistic outcomes.





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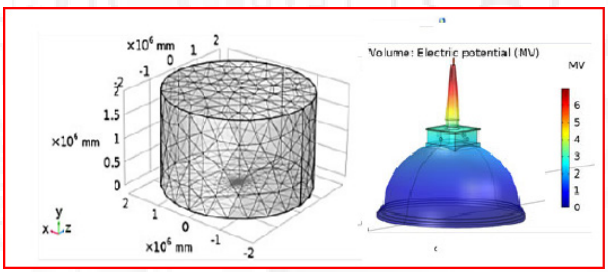
Project Title : Protection of heritage monuments and landmarks of national and international importance in India and Sri Lanka due to direct lightning strikes – traditional and scientific methods

Project No. : MSTR/TRD/AGR/03/02/19

Lightning is one of the inevitable disastrous phenomena damaging tall structures, and also harmful to humans due to lightning-human interactions. This research focuses on investigations of lightning risks on Indo Lanka heritage monuments and suggesting possible remedial measures to mitigate such risks. Different heritage monuments were selected from India and Sri Lanka including giant stupas namely Jethawanaramaya, Abayagiriya, Ruwanweliseya, Mirisavetiya, Rankothvehera, and Kirivehera, two Lord Buddha statues namely Avukana and Maligavila statues, and two hindu temples namely Brihadishvara temple and Gangaikonda Cholapuram from India. Their possible lightning risks were investigated based on geometrical model (by Protective Angle Method), electro-geometrical model (Rolling Sphere Method and its modification) and considering leader propagation and ground effectiveness (by FEM based analyses in COMSOL Multi-physics®). In parallel, the lightning human interaction was studied under the five lightning mechanisms. It was found that the tested monuments are prone to lightning, but the tested methods give different risk levels for lightning.



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Project Title : Probing the provenance and distribution of heavy mineral placer deposits in coastal areas of Southern India and Sri Lanka: a new multi-mineral proxy approach to understand source-to-sink link

Project No. : MTR/TRD/AGR/03/02/20

This project investigated the source of placer mineral deposits and their distribution in southern India and Sri Lanka. This is the first comprehensive study in similar capacity including modal, rare earth element and geochronological data of coastal mineral sands. Heavy placer minerals such as garnet, zircon, monazite, rutile and opaques are well sorted, occurring in grain sizes 297µm - 105µm indicating similar depositional conditions in the southwestern coastal region. Especially garnet is indicative of the changes in protolith (source rock) from alumino-silicate rich bedrocks around Hambantota to ferromagnesium rich bedrocks towards Kalutara. The geochemical characteristics and the radiometric ages of placer deposits indicate genetic relations to various lithologies in the respective hinterlands. In bulk sediments, rare earth elements (REE) and other trace elements such as Y, Zr, Hf and Th were found enriched and more associated with the heavy minerals. U-Pb geochronology of detrital zircon from the beach sands of southwest Sri Lanka attained ages range from 650 – 1600 Ma and few grains with >2300 Ma (Ma: million annum). Identification of new heavy mineral deposits and their significance for new exploration possibilities and rare earth element mining in the future will enhance the economic development of the two countries.

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