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SASTRA was established in 1984 as Shanmugha College of Engineering and conferred with University status by the Ministry of Human Resource Development (MHRD) in 2001. SASTRA offers various undergraduate, postgraduate & doctoral programmes in Engineering, Science, Management, Law and Arts. It is recognized as a Scientific & Industrial Research Organization (SIRO) by the Government of India and is actively undertaking research for various agencies like Department of Science & Technology, Department of Biotechnology, Department of AYUSH, Defense Research & Development Organization, Indian Space Research Organization, Board for Research in Nuclear Sciences, etc. SASTRA is re-accredited (III cycle) by the National Assessment & Accreditation Council (NAAC) with ‘A+’ grade (CGPA:3.54/4.00).

SASTRA has acquired major national and international recognitions this year. First, SASTRA has been placed under Category 1 by the University Grants Commission through the Categorization of Universities for Grant of Graded Autonomy Regulations, 2018. SASTRA becomes one of the 33 Universities in the country and one of the three universities in Tamil Nadu to be accorded this status.

SASTRA is one of the Institutions to be featured in Times Higher Education – World University Ranking 2018, QS Asia Ranking 2018, Times Higher Education Asia Ranking 2017 and also in the QS BRICS Ranking. In the National Institutional Ranking Framework of the MHRD, Government of India, SASTRA has been ranked 54th in Overall, 36th in University and 33rd in Engineering categories. Amongst the private Institutions,
SASTRA has been ranked 8th in Overall and University and 5th in Engineering categories. These multiple National and International recognitions, I believe, has positioned SASTRA at a higher plane.

SASTRA has been recognized for its excellence in academic, infrastructure facilities, faculty and students. In all programmes, students are admitted to SASTRA through a merit-based transparent system and the Institution is known for its merit-based admission, which is transparently done without collecting even a single rupee as capitation fee or donation.

The Government of India has established the Centre for Relevance & Excellence (CORE) in Advanced Computing & Information Processing, Centre for Advanced Research in Indian Systems of Medicine (CARISM), Centre for Nanotechnology & Advanced Biomaterials (CeNTAB), National Facility in Mechatronics and National Facility for the Scientific Preparation of Ayurvedic drugs. The Department of AYUSH has also recognized CARISM as a Centre for Excellence. The Drug Licensing Authority, Government of Tamil Nadu, has certified CARISM as a Drug Testing Lab for Ayurveda and Siddha Drugs. CeNTAB is engaged in research in the frontier areas in Nanotechnology.

The National Science & Technology Entrepreneurship Development Board (NSTEDB), under the aegis of Department of Science & Technology, Government of India has established a Technology Business Incubator (TBI) in the areas of 3–D Printing and Internet of Things (IoT). This TBI has been housed in ASK II with state-of-the-art equipment for 3D printing and IoT.

I thank all the prestigious funding agencies – DST, DBT, DRDO, CSIR, AYUSH, ISRO, ICMR, IGCAR, etc. and other industry partners for their sincere and continued support in all our endeavours.

The annual research report for the year 2017–18 presented to you, gives a glimpse of the wide range of research activities at SASTRA. Our diverse activities highlight the University’s place as a dominant research institution, which is committed to a social cause in the global system.

We invite you to visit our campus. I hope you will find this brochure an inspiring introduction to the research activities at SASTRA.

Prof. R. Sethuraman
Vice-Chancellor
RESEARCH ACTIVITIES
Being acutely aware of the importance of interdisciplinary research to tackle scientific and technical challenges in a global scenario, this Institution has established the SASTRA’s Hub for Research & Innovation (SHRI) in its premises. SHRI is a multi–disciplinary centre that has been a focal point of the University to translate laboratory innovations to product / technology development. Phase I has been established in an area of about 1,00,000 square feet at a cost of Rs 20 crore, exclusively funded by the Management of the University.

The need for universities to be comprehensive in its overall pursuit has been a key input in SASTRA’s endeavours to engage in research, teaching, consultancy, training & community outreach activities. SASTRA demonstrates a fine mix of all of these and has also managed to contribute to the research ecosystem and deliver high quality research output placing it amongst the premier universities in the country. In its constant pursuit to uncover knowledge and share it with a wider cross–section, SASTRA has engaged in meaningful research through its various centres which are undertaking research activities to enhance the quality of life & society. The University’s research ethos and its basic belief that good researchers are equipped to be good teachers have made it a truly integrated Institution.

The following niche areas of research have been identified in various disciplines and active research is being carried out with both extramural and internal funding:

School of Chemical & Biotechnology
- 3–D Printing
- Biosensors
- Chromatin epigenetics
- Electrophysiology
- Green chemistry
- Indian systems of medicine
- Natural products
- Plant & animal toxins
- Quorum sensing
- Smart delivery systems
- Structural biology
- Bioremediation
- Cancer genomics
- Computational drug design
- Fuel cells
- Immunology
- Nanotoxicology
- Optoelectronic materials
- Process intensification
- Smart & functional materials
- Stem cells & regenerative medicine
- Synthetic organic chemistry

School of Civil Engineering
- Concrete technology
- Geology
- Remote sensing & GIS
- Transportation engineering
- Environmental engineering
- Hydraulics
- Structural engineering
- Water resources engineering
School of Computing
• Algorithms
• Big data
• Cyber Security
• Embedded & VLSI system
• Machine vision & pattern recognition
• Simulation & modelling

• Artificial Intellignece
• Cloud computing
• Data mining
• Image processing
• Network security

School of Electrical & Electronics Engineering
• Antenna & radar design
• Device modelling
• High voltage engineering
• Nanophotonics
• Nanosensors & devices
• Power electronics & drives
• Thin films & coatings

• Control systems
• Electric vehicles
• Information security
• Nanocomposites
• Non-linear science
• Sensor fusion
• Wireless communications

School of Management
• Development management
• Rural sustainable livelihood

• Financial services
• Learning & Development

School of Mechanical Engineering
• Additive manufacturing
• Robotics & automation
• Powder metallurgy

• Advanced manufacturing
• Nanofluids & heat transfer
• Welding metallurgy

School of Humanities & Sciences
• Algebra
• Cryptology
• Fuzzy topology

• Bitopological spaces
• Functional analysis
• Number theory

Later sections of the book captures some of the cutting edge research carried out by our faculty in the above areas.
RESEARCH CENTRES

The following Centres have been established at SASTRA to foster multi-disciplinary research and are actively functioning:
1. TIFAC–CORE on Advanced Computing & Information Processing
2. National Mechatronics Facility in collaboration with M/s Brakes India Ltd.
3. Centre for Advanced Research in Indian Systems of Medicine (CARIISM)
4. Centre for Nanotechnology & Advanced Biomaterials (CeNTAB)
5. Model Production Centre
7. Centre for Excellence in Scientific Preparation of Ayurvedic & Siddha Rasa Aushadies and Bhasmas
8. Central Animal Facility for Preclinical Studies
9. Centre for Advanced Research in Environment (CARE)
10. Central Instrumentation Facility
11. Centre for Rural Development Studies (CFRDS)
12. Centre for Computational Chemistry & Materials Science
13. Centre for Nonlinear Science & Engineering (CeNSE)
14. Centre for Information Superhighway (CISH)
15. Centre for Research in Infectious Diseases (CRID)
16. Technology Business Incubator in 3-D Printing & Internet of Things (IoT)
Centre for Information Super Highway
The Centre for Information Super Highway is a part of the Centre of Relevance and Excellence (CORE) in Advanced Computing & Information Processing established by the Technology, Information, Forecasting & Assessment Council (TIFAC), Department of Science & Technology, Government of India. The TIFAC-CORE was established in 2000 with an initial investment of Rs 8 crores with a HP- RP8400 Supercomputer, VLSI & Embedded System Lab, Sun Lab, Digital Online Library and Image Processing Laboratory for R&D work in Data mining, Information Security, 3-D imaging and visualization projects of industrial applications.

The facility has been constantly upgraded to meet the academic and research needs of the entire campus. M/s Tata communications Lab for Cyber Security, Microsoft Technical Services Lab for Cloud and recognitions like Nvidia - CUDA Centre of Excellence makes this facility a world class infrastructure paving way for students and faculty members of SASTRA Deemed University to excel in their respective domains.

With continuous upgrade in the central computing facility, the TIFAC-CORE houses a powerful 22 Teraflop High performance Computing Cluster, Private clouds built on VMWare and Openstack with Xen Virtualization, Web, Mail, Academy web, toolkit and other academic servers. The strong Gigabit LAN with fibre connectivity connects all the buildings of the Campus to carry data and video traffic (165 Surveillance cameras) facilitating the students and faculty members to remote access of the IT resources at TIFAC-CORE from their location. Connected to the NKN backbone at 1 Gbps, this central computing facility also provides uninterrupted internet access to the classrooms, labs, administrative block and hostels with 540 access points deployed across the campus.

The Centre for Information Super Highway (CISH), a research lab established in 2009 at the TIFAC-CORE primarily focuses on research relating to Network Security, Cloud Computing, Machine & Deep Learning and Brain-Computer Interface. CISH is funded by various National and International funding agencies like ICPS-DST, MHRD, MeitY, TataPower, TCS, IBMSUR, etc., to a tune of about Rs 1.5 crore, which has also resulted in quality publications in top-tiered SCI journals. Some of the most significant research works carried out in CISH, TIFAC are captured below.

**Machine Learning based Intrusion Detection Framework for Computer Networks & SCADA Systems**
Intrusion Detection Systems (IDSs), a second line of defense-in-depth provides a solution to safeguard the network infrastructure from cyber-attacks with its signature and anomaly based detection models. Combining the functionalities of signature and anomaly-based
“The TIFAC-CORE in Advanced Computing & Information Processing at SASTRA University is a success story.”

Dr. R. Chidambaram
Principal Scientific Advisor
Govt. of India
IDS results in a hybrid intrusion detection system which aims to achieve high detection rate and minimal false alarm rate. Further, the operation and design principles of ICS and Information and Communication Technology (ICT) with conflicting order of priorities emphasize the need for domain-specific cyber security mechanisms to safeguard the critical infrastructure from the adverse impacts of cyber-attacks. Therefore, we at the CISH employ a set of hypergraph properties, wavelet functions, statistical and optimization techniques to improve the performance of machine learning-based hybrid IDS (for both Computer Networks and SCADA Networks) with high detection rate, minimal false alarm rate, and reduced complexity. A prototype of the proposed approaches will be integrated with real time, online, open source IDS tools like Snort, Bro, Suricata, Selks 4.0 and Security Onion.

**Cloud Service Selection Model**

The immense popularity of cloud computing due to its “as-a-service” principle, “on-demand” service and “Pay-As-You-Use” model has led to the emergence of several cloud service providers with a wide range of service offerings. The existence of functionally-similar service offerings to satisfy the diverse set of users’ Quality of Service (QoS) requirements makes the identification of appropriate and trustworthy cloud service providers, a difficult task. Further, the emergence of new cloud services and the unavailability of sufficient assessment data poses a significant challenge in the cloud service selection process. One plausible solution for the above challenge is to express the intrinsic relation among the QoS attributes (subjective and objective) which reflects the performance of the cloud service providers throughout its life cycle. The Team- CISH employs hypergraph based techniques, privacy preservation techniques and Multi Criteria Decision Making (MCDM) approaches to design efficient trust and privacy-aware cloud service selection models. Further, we also use statistical techniques to address the privacy, uncertainty, and credibility issues in the cloud service selection problem.

**Epilepsy Seizure Prediction**

The recent advancements in the field of Bioinformatics paved the way for the direct communication between the brain and electronic devices, which is known as Brain-Computer Interface (BCI). BCI offers a real-time support for the people who are affected by neurological disorders. Epilepsy, a chronic neurological disorder, occurs due to the unusual neuronal activity of the brain that results in uncontrolled seizures. Early diagnosis and prognosis of epileptic seizures remains a complex task. Electroencephalogram (EEG), one of the BCI, has been the predominant choice of researchers for diagnosing Epilepsy. In recent years, several machine learning-based computational algorithms have been developed to differentiate the EEG signals as ictal, preictal, and interictal for reliable seizure detection. To overcome the challenges like noise, transient nature, non–stationarity of EEG signals, we at CISH lab develop Deep Neural Networks hybridized with Bio-inspired Metaheuristic Optimization algorithms by employing the wavelet properties for the early prediction of epilepsy.
Centre for Advanced Research in Indian Systems of Medicine  
**Bridging Traditional and Modern Science for Redefining Healthcare**  
The Centre for Advanced Research in Indian Systems of Medicine (CARISM), an autonomous research Centre, was established in 2004 for carrying out multi-disciplinary research to unravel the scientific basis involved in the preparation as well as the molecular mechanism of Ayurvedic and Siddha formulations. The research at CARISM is centred around the following objectives:

- To standardize and validate the safety and efficacy profiles of classical Ayurveda and Siddha formulations including herbo-mineral and metallic preparations following WHO guidelines
- To recognize, identify and characterize the raw materials, intermediates and the products with both therapeutical and nutraceutical values
- To isolate and identify biologically active compounds from medicinal plants used in traditional medicine
- To carry out biochemical evaluation studies and understand the mechanism of action of traditional drugs
- To promote and cultivate important medicinal plants by adopting good agricultural practices
- To train Ayurveda and Siddha practitioners and traditional medicine manufacturers on quality control aspects

The Centre is equipped with state-of-the-art characterization facilities that includes advanced chromatography, spectroscopy, microscopy units, and elemental analyzers for accurate separation, identification and quantification of the components in the traditional medicinal preparations. The Centre has been funded by Department of Science and Technology, Department of AYUSH, DRDO, ICMR, CSIR, National Institute of Siddha, apart from industries like M/s Kaleesuwari Refineries Pvt. Ltd., Chennai. The Centre is also recognized as a Drug Testing Laboratory by the Drug Controller of Tamilnadu wherein the drug samples from different traditional medicine manufacturers has been analyzed at the sophisticated instrumentation facility housed in the Centre. The Centre has also received NABL certification since 2016 for biochemical, pathological and chemical analysis. The Centre has been recognized as a National Facility for the Scientific Preparation of herbometallic preparations and also as a Centre of Excellence for the Scientific Preparation of Rasa Aushadies and Bhasmas. The Centre is currently preparing a compendium of microscopic features typical for different plant ingredients for easy and error-free identification of plant ingredients. The Centre has also standardized protocols for fingerprinting of major plant biomarkers using high performance thin layer chromatography for identification. Further, analysis of pesticide residues and essential oil content from plants are also routinely performed in the gas chromatography-mass spectrometry facility.
using the standard protocols developed at the Centre. The research work carried out at the Centre has resulted in interesting findings that highlight the scientific rationale involved in the different ingredients and processes described in the classical texts for the preparation of Ayurvedic and Siddha medicines. For instance, adherence to the classical protocols for the preparation of Rasa sindura results in the formation of alpha form of mercuric sulphide with hexagonal lattice. Similarly, the use of milk during the purification of sulphur was found to prevent the reconversion of the amorphous sulphur in to the more stable orthorhombic form, which facilitates further reactions.

Along similar lines, during the preparation of the lead-based Naga bhasma, the elemental lead is converted to an intermediate PbO that reacts readily with arsenic sulphide to form PbS, provided the temperature profiles and number of cycles are maintained as prescribed in the classical texts. The use of rice gruel, cow’s urine, horse gram decoction, gingelly oil and butter milk during the purification processes for metals has been found to play an important role in size and shape control of the resultant product.

The safety as well as therapeutic effects of these preparations on one time administration and repeated administration at different concentrations have also been conducted in rodent models at the GLP-compliant central animal facility at the University. Further, in vitro and mechanistic studies carried out at the Centre have revealed several interesting leads on the mode of action of some of these preparations. Chandraprabhavati, a polyherbal Ayurvedic formulation, was found to regulate the expression of pregnane X receptor (PXR) that in turn mediates PPAR-γ and GLUT4 signaling which contributes to its anti-diabetic effects. Investigations on Brahmi Nei, a Siddha formulation, has been found to enhance working memory in rodents. The microarray analysis of the hippocampal regions of the animals treated with Brahmi Nei has revealed the modulation of several targets implicated in Alzheimer’s disease, thus suggesting its potential as an anti-Alzheimer’s medication. It has also been found that the neurite outgrowth is promoted in neurons by Brahmi Nei after a chemical insult indicating its neuro-restorative properties. Identification of novel molecules with therapeutic potential is another active area of research at the Centre. A pyridine-based derivative isolated for the first time from Jatropa tanjorensis at the Centre was found to exhibit anti-cancer activity in Ehrlich ascites tumour models. On similar lines, search for an ideal anti-tuberculosis and anti-cancer drugs is ongoing at the Centre from local flora.

In an effort to promote awareness and maintain precious flora used in traditional medicines, CARISM is nurturing a theme-based herbal garden, at Thachankurichi village, located in the Thanjavur-Pudukkottai border. The garden spread over 25 acres comprises of 150 medicinal plant species depicting various themes such as Navagraha (nine planetary bodies),
Rasi (moon sign), Nakshatra (birth star) and Kayakalpa (immunomodulatory plants). In addition, periodic training sessions and workshops are conducted to train traditional medicine practitioners and manufacturers with an emphasis on quality control and appropriate quality control techniques to be employed for different traditional medicine preparations. Till date, 4 workshops and 5 conferences have been conducted by CARISM since 2010 that has benefitted over 800 participants. Trainings and workshops are also conducted periodically for creating awareness among self help groups in the cultivation of medicinal plants and preparation of simple herbal medicines. CARISM also engages in societal service by conducting medical camps jointly with SASTRA NSS team and Shanmugha Polytechnic College at Vaidyanatha Arogyasala, the campus hospital as well as in and around Thanjavur, where Ayurveda and Siddha doctors associated with the Centre offer free consultation to the villagers.

The Centre has over 340 publications and has seven patents and 17 Ph.D. students have graduated in the field of traditional medicine. The Centre strives to leverage on its infrastructural and intellectual capital to demonstrate the molecular mechanisms and therapeutic significance of traditional Indian medicine for global acceptance and visibility.
Centre for Nanotechnology & Advanced Biomaterials

Started in 2005, the Centre for Nanotechnology & Advanced Biomaterials (CeNTAB) is a multidisciplinary Centre working at the forefront of science and technology. The objective of the Centre is to develop products for energy and health care through the applications of nanoscience and nanotechnology. The Centre has faculty from diverse research groups in Nanomaterials, Cell & Tissue Engineering, Smart Delivery Systems and Nanosensors & Devices.

The Nanomaterials division is involved in development of novel nanostructured multifunctional materials and technologies for energy and health care applications. The Tissue Engineering & Additive Manufacturing (TEAM) group is engaged in developing engineered scaffolds and materials for nerve regeneration, cardiovascular grafts, myocardial patch, liver, cartilage, skin tissue, bone and oesophagus. In addition, chromatin signalling during disease progression & development and cellular apoptotic mechanisms are explored using high-throughput and live cell microscopy.

The Smart Delivery System group develops and evaluates various surface engineered multifunctional nanoparticles for imaging and targeted delivery of therapeutic molecules (drugs, proteins, enzymes, peptides, oligonucleotides, etc.) against cancer, AIDS, cardiovascular & neurodegenerative disorders, etc. Research is carried out in the development of stimuli - responsive materials for ‘on-demand’ drug release and up-converting nanoparticles for effective photo dynamic therapy. The Nanosensors & Devices group is currently working on the development of e–nose and e–tongue for food quality assessment, pollution monitoring and clinical diagnostics. Further, nanostructured surface coatings for orthopaedic implants and stents are also being developed at the Centre.

The Centre houses laboratories for tissue engineering, drug delivery, nanomaterial characterization, nanosensor development, nanofluids, materials electrochemistry, electrophysiology, biomolecular simulations, chromatin epigenetics and specialized instrumentation facilities. Live animal imaging, micro-CT, field emission scanning electron microscope, laser confocal scanning microscope, atomic force microscope, high throughput fluorescence microscope, scanning electrochemical microscope, electrochemical analyzers, vibration sample magnetometer, flow cytometer with sorter, extracellular flux analyzer, x–ray diffractometer, particle size analyzer, robotic pipetting engine, energy dispersive x–ray spectrometer, high performance liquid chromatograph, real time RT–PCR, high–end server for molecular simulations, Fourier transform infrared spectrometer, differential scanning calorimeter, UV–visible spectrophotometer, multi-mode reader, uni–axial mechanical testing machine, mercury porosimeter, thin film coating units and a variety of support tools provide the infrastructural support to the Centre.
There are currently 22 faculty members from various Schools of the Institution with 48 full-time Ph.D. students. Currently 32 research projects have been funded by various funding agencies such as Department of Science & Technology, Department of Biotechnology, Indian Council for Medical Research, Defence Research & Development Organization and private agencies like M/s Tata Consultancy Services, M/s Brakes India, M/s Bruker, M/s Orchid Pharmaceuticals, etc.

Recently, the Centre has been competitively selected by the Nano Mission of the Department of Science & Technology to set up a Thematic Unit of Excellence (TUE) on Tissue-on-dish and Lab-on-Chip. The Nano Mission of the Department of Science & Technology has recognized CeNTAB for conducting postgraduate programmes in Medical Nanotechnology in 2008 and DST supported the first phase till 2014. Considering the success of the programme, Nano Mission Council has decided to continue this programme at SASTRA for another 6 years.

The Centre has developed various technologies and products ranging from development of scaffolds for tissue regeneration, smart functional drug delivery vehicles for various cancers, sensors with high sensitivity to detect biomarkers and toxic gases and nanofluids with excellent heat transfer cooefficient.

The Centre has established collaborations both at the National as well as International levels with premier research and academic institutions as well as hospitals. These include University of Connecticut, USA, University of Bordeaux, France, Osaka Prefecture University, Japan, University of Alabama, USA, Sankara Nethralaya, Chennai, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry, Sri Venkateswara Institute of Medical Sciences, Tirupathi, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, IISc., Bangalore, Indian Institute of Technology, Kanpur, CSIR-Institute of Genomics and Integrative Biology, New Delhi, All India Institute of Medical Sciences, New Delhi, etc. The Centre continues to innovate and integrate the multi-disciplinary team working in nanotechnology to realize the ‘Make in India’ and ‘Swath Bharath’ vision into reality.
Centre for Nonlinear Science and Engineering

Centre for Nonlinear Science and Engineering (CeNSE) at SASTRA was formally inaugurated by Prof. M. Lakshmanan in 2014. The objectives of the Centre are to address the various nonlinear phenomena considering the interdisciplinary nature of emerging fields across basic science and engineering. Though the Centre is relatively young, it nurtures diversified research interests from nonlinear science to engineering applications including complex networks, magnetic switching, quasi phase matching devices and nonlinear fiber sensors using theoretical modeling and experiments. Faculty and researchers in CeNSE are working together and collaborating with the renowned scientists both in India and abroad. With the expertise in the Centre, it is progressing towards developing a world class computational as well as experimental facility to enhance the research in the areas of nonlinear science and engineering.

At present, CeNSE has seven faculty members and thirteen full time research scholars. The faculty members have received research funds over Rs 1.7 crores from various funding agencies such as DST, CSIR, INSA etc. The faculty members of the Centre have published more than 90 research articles in reputed international journals like Nature Communications, Physical Review A, Physical Review E, Journal of Applied Physics, Journal of Optical Society of America B, Journal of Optics and various IEEE Journals, since its inception in the year 2014. A brief abstract of the Centre’s major achievements in various research areas is provided in the following sections.

Complex Networks

Complex networks are quite common in nature and are around us in various forms like the social networks, the internet, ecological systems, and also within us in the form of different biological networks. The collective behaviour in complex networks plays a crucial role in accomplishing purposeful outcomes. Hence an understanding of complex networks and the occurrence of collective behaviour in them becomes necessary to gain better knowledge about the systems around us and to manipulate and/or control them for the beneficial outcome. In this direction, the Centre has proposed the mechanism behind symmetry breaking phenomena in complex networks, that helps to understand the formation of the Turing pattern in organisms and complex pattern in brain dynamics. We have also identified the mechanism involved in the existence of chimera states in coupled oscillator network, since the chimera and chimera-like states are identified in the brain during epileptic seizures and the unihemispheric sleep in mammals.

The occurrence of sudden, rare and recurrent high amplitude oscillations are inevitable in natural and human-made systems which are known as extreme events. The generation of rogue waves in optical systems, stock market crashes, large-scale power blackouts,
jamming in computer and transportation networks, development of epileptic seizures in human brain are few examples of such events. In order to understand the dynamics and the occurrence of such events and their controlling mechanism, we studied the generation of extreme events in mathematical models and provided a numerical evidence that self time-delay feedback can control the occurrence of such events.

The interaction among oscillating systems in many cases leads to quenching of oscillation. Such quenching of oscillations often leads to dreadful situations such as cardiac arrest, burst suppression in EEG patterns or inactivation of the brain. Thus, it is of great interest to find out a reliable mechanism that can overcome these oscillation quenching. Recently, we have found out that the feedback mechanism may offer a solution to this problem and can resurrect oscillations from various oscillation quenched states.

**Nonlinear Optics**

The Centre has developed the Quasi-Phase-Matching (QPM) device fabrication facility, which is the second such facility in India and the first in an academic institution in India. We have optimized the in-house fabricated room temperature electric field poling setup and the UV aligner for wastage/breakage free QPM device fabrication. Further, a linear far-field diffraction setup was also developed to evaluate the quality of the fabricated QPM devices. This lab is now capable of fabricating various domain engineered QPM devices.

**Nonlinear Fiber Optics**

At the Centre, we are investigating the nonlinear optical phenomena with ultra-broadband radiation and ultrashort pulses in photonic crystal fiber (PCF) using numerical modeling. For the description of these processes, two widely used techniques namely pulse compression and soliton induced supercontinuum generation (SCG) is implemented. Hence, the goal has been divided into two topics namely pulse compression and SCG which are connected to each other by the investigation of ultrashort pulses and broadband spectrum in PCF.
particular, we have established temperature as a control parameter to tune the bandwidth of broadband spectrum in different spectral regions. It is found that a water core PCF that exhibits the re-orientational type of nonlinearity can be used to tune the bandwidth of the generated spectrum over 100 nm in the visible region and tunability of over 300 nm is achieved in IR region by employing a CS2 core PCF (CSPCF). Also, novel PCF design for generating high quality ultrashort pulses through supercontinuum induced pulse compression process has been modelled. Through designing PCF with cascaded fiber technique, ultra-short femtosecond pulses with pulse width of 6.98 fs from 140 fs has been achieved in a single nonlinear device by pumping with an IR source. This promises a compact, stable, coherent and cheap setup that can revolutionize the accessibility of ultrashort pulses, and the reduced pedestal of the compressed pulses means that they can also be used for more sensitive applications such as medical surgery, OCT, spectroscopy, airborne countermeasures and frequency metrology.

**PT Symmetry Systems**

Recently, a class of non-Hermitian systems with parity-time (PT) symmetry have been shown to possess novel features. One of the interesting applications of PT symmetric systems is in the unidirectional light transport which enables the construction of on-chip unidirectional optical devices such as optical diodes and optical isolators. In this context, two problems have been cited in literature. One among them is the necessity to balance loss and gain in PT symmetric systems which is non-trivial from the experimental point of view. Consequently, we explored the possibility to use unidirectional light transport in loss-gain free systems and found an interesting class of PT symmetrically coupled nonlinear systems. The other problem is the blow-up responses that arise due to the non-Hermitian nature of these PT symmetric systems. To resolve this problem, a useful nonlinear coupling to stimulate Raman scattering that can control blow-up responses in a PT symmetric system with nonlinear and linear loss and gain has been proposed.

**Spintronics**

Spin torque / transfer nano-oscillator (STNO) is essentially a nonlinear oscillator capable of generating microwaves over an ultra-wide range of frequencies due to its varied oscillatory properties as a function of injected spin current and applied magnetic fields. Although the low output power (nW) of single STNO makes the device unsuitable for practical purposes, a synchronized oscillation of an array of STNOs can enhance the power by square of the number of oscillators. It was found that the applied external magnetic field can act as a medium to induce synchronization of STNOs for with and without coupling through spin current, thereby leading to the exciting possibility of enhancement of microwave power.
The fast magnetization switching can be achieved by making the free layer and a spacer layer of the nanopillar device, with minimal thicknesses in the presence of orange peel coupling (48 ps). In continuation with the nanopillar device, we modelled a theoretically devised homogeneous Tilted Polarizer-STNO (TP-STNO). The maximum operating frequency of TP-STNO is 124.5 GHz and the corresponding power is 1.478 μW/GHz/mA² obtained for β = 60° and τ = 90°. The results open up a new route for the implementation of nanoscale microwave sources for future generation integrated electronics.

**Integrable Systems**
To identify and explore the dynamics of the integrable systems, several novel and ingenious methods have been introduced in the nonlinear dynamics literature. Among these, some are reinventions of the integration techniques which were developed in the earlier centuries by distinguished mathematicians, whereas a few others were introduced to overcome the demerits in some of the earlier ones. Even though the methods are different, they all essentially seek either one or more of the following aspects, namely symmetries / integrating factors / integrals / solutions. Therefore, attempts have also been made to interconnect these methods. Interconnection among all the methods in a single platform has been established at the Centre. Synthesizing these methods bring out the interplay between Lie point symmetries, λ-symmetries, adjoint symmetries, null-forms, Darboux polynomials, integrating factors and Jacobi last multiplier in identifying the integrable systems described by nonlinear ODEs.

**Magnonics**
We have proposed a new method of solving Landau-Lifshitz (LL) equation of one dimensional bicomponent magnonic crystal through which the propagation of solitons in magnonic crystals and their velocity are controlled by spin current. Further, magnonic spin filters which help to filter frequency in the microwave regime has been modelled at the Centre.

Based on the findings, Centre members have received Young Scientist Award and the research scholars have received many best paper awards in various National / International conferences. The Centre aims to employ novel strategies to emerge in the forefront among peers in the field of non linear science and engineering.
Centre for Research in Infectious Diseases

Centre for Research on Infectious Diseases (CRID) is part of the School of Chemical and Biotechnology (SCBT), SASTRA Deemed to be University. CRID was inaugurated by Prof. K. Vijayaraghavan, Secretary Department of Biotechnology, Ministry of Science and Technology, New Delhi on 25th July 2015. CRID envisions generating new foci and approaches to tackle antibiotic-resistant microbes and neglected infectious diseases with special emphasis on interdisciplinary and translational research on molecular pathogenesis, host-pathogen interactions, and drug development.

CRID currently comprises 12 faculty members of SCBT, with research expertise on diverse areas ranging from biofilm biology, quorum sensing, immunomodulation, efflux inhibition, phage therapy, anti-biofilm agents, viral genomics, leishmaniasis, HIV pathogenesis, anti-snake venom production, all of which primarily focus on drug development or development of resistance modulatory agents to address antimicrobial resistance (AMR) among nosocomial pathogens and neglected tropical diseases.

As on date, CRID members have 8 completed extramurally funded research projects to the tune of Rs 2.22 crores and 10 currently ongoing research projects with a value of Rs 3.05 crores, supported by various funding agencies like Department of Science and Technology, Department of Biotechnology, Indian Council for Medical Research, etc. Major research areas which attracted funding include device innovative strategies to combat biofilm lifestyle of pathogens, tackling AMR by targeting efflux proteins, quorum sensing targeted drug development, immunomodulatory therapeutics, anti-biofilm agents, immunogenetics of HPV, bioprospecting of marine drugs, electronic nose (e-nose) for detecting biofilm volatiles, development of diagnostic tools based on QS markers and chicken egg yolk sourced antibody production.

The diverse expertise is one of our greatest strengths, which has facilitated to obtain two industrially funded projects from Foundation for Neglected Disease Research (FNDR), Bengaluru and M/s. Indus Biotech Pvt Ltd, Pune for Rs 63.65 lakh and Rs 9.0 lakh respectively. In progress towards translational research, CRID has secured DBT-BIRAC project on preparation and validation of chicken egg-yolk sourced anti-snake venom for Rs 50 lakh.

For the past four years, CRID members have published 93 peer-reviewed SCI indexed research publications in reputed journals like Nature Scientific Reports, ACS Applied Materials and Interfaces, Frontiers in Microbiology, Applied Microbiology, and Biotechnology, European Journal of Medicinal Chemistry, Microbial Pathogenesis, Meta Gene etc., The major research highlight of CRID involves identification and in vivo validation of naturally derived, semi-synthetic and synthetic organic hit compounds that are
effective against drug-resistant ESKAPE pathogens in both planktonic and biofilm mode of growth. In addition work from CRID has identified a potent synergistic combination of plant metabolites/its derivatives with the anti-leishmanial drug in curtailing the parasite \textit{in vivo}. Study on genetic diversity of HPV-16 from 70 women with cervical cancer showed that the frequency of HPV-16 was 12\% in normal women and 86\% in cancer patients. HLA DRB1*11 and DRB1*08 were positively and HLA DRB1*13 and DRB1*14 were negatively associated with HPV+ status. As an indicator of translational potential, CRID has filed two Indian patents for two lead compounds that serve as anti-infectives.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Pathogen</th>
<th>Relevant Disease</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furanone derivative</td>
<td>\textit{Cryptococcus neoformans}</td>
<td>Meningitis</td>
<td>Anti-fungal Immunomodulant</td>
</tr>
<tr>
<td>Quinolone derivative</td>
<td>MDR \textit{Klebsiella pneumoniae}</td>
<td>Urinary tract infection</td>
<td>Immunomodulant Anti-biofilm</td>
</tr>
<tr>
<td>Thiolactone peptide mimics</td>
<td>\textit{Staphylococcus aureus}</td>
<td>Skin related infections</td>
<td>Anti-virulence</td>
</tr>
<tr>
<td>4-[(2,4-difluorobenzyl) amino cyclohexanol SarABI</td>
<td>\textit{Staphylococcus sps.}</td>
<td>Vascular Graft Associated Infections</td>
<td>Anti-biofilm</td>
</tr>
<tr>
<td>4-[(benzylamino) cyclohexyl 2-hydroxycinnamate] UTI\textsuperscript{28}</td>
<td>\textit{Staphylococcus sps.}</td>
<td>Urinary Tract Infections</td>
<td>Anti-biofilm</td>
</tr>
<tr>
<td>2-[(methylamino) methyl] phenol</td>
<td>\textit{Staphylococcus sps.}</td>
<td>Soft-skin infections</td>
<td>Anti-biofilm</td>
</tr>
<tr>
<td>Aromatic 1,3-di-m-tolylurea</td>
<td>\textit{Streptococcus sps.}</td>
<td>Dental caries</td>
<td>Anti-biofilm</td>
</tr>
<tr>
<td>Acyclic amines and Diamines</td>
<td>\textit{Staphylococcus sps.}</td>
<td>Catheter related infections</td>
<td>Anti-biofilm</td>
</tr>
<tr>
<td>Pyrazine Dicarboxylic Acid Derivative PDCApy</td>
<td>\textit{Vibrio sps.}</td>
<td>Cholera</td>
<td>Anti-virulence</td>
</tr>
<tr>
<td>Fructose furoic Acid Ester</td>
<td>Uropathogenic \textit{E. coli}</td>
<td>Urinary Tract infection</td>
<td>Anti-biofilm</td>
</tr>
<tr>
<td>Benzochromene derivatives</td>
<td>MDR \textit{Staphylococcus aureus}</td>
<td>Wound</td>
<td>Efflux pump inhibitor</td>
</tr>
<tr>
<td>Marine-derived Dnase</td>
<td>MDR \textit{Psuedomonas spp}</td>
<td>Wound</td>
<td>Biofilm inhibition</td>
</tr>
<tr>
<td>Surfactant derived from Cardanol</td>
<td>Uropathogenic E.coli</td>
<td>Device-based infection</td>
<td>Anti-biofilm</td>
</tr>
<tr>
<td>Eugenol derivate</td>
<td>\textit{Leishmania donovani}</td>
<td>Visceral Leishmaniasis</td>
<td>Anti-leishmania</td>
</tr>
</tbody>
</table>
Model Production Centre
Shanmugha Precision Forging (A manufacturing unit attached to SASTRA), is a model production centre, established in 1984. This world class manufacturing facility at an outlay of Rs 15 crores primarily trains the students in the following activities:

- Providing industrial exposure in the manufacturing practices to all branches of engineering student in their first year
- Providing hands-on training to B.Tech. Mechanical, Mechatronics, & M.Tech. Advanced Manufacturing Engineering students and students of Diploma in Mechanical Engineering of Shanmugha Polytechnic College in the areas of Manufacturing Systems engineering
- Free training to school drop-outs belonging to the economically challenged section of the society from rural areas with stipend for enhancing their skill levels and ensuring their placements after the training
- Engaging in various types of applied research in the areas of metal cutting, metal joining, metal forming, industrial engineering, etc.

Students are trained in the manufacture of precise and quality parts to meet the Industrial requirements across various continents which includes Asia, North America & Europe and catering to customers like M/s Emerson, M/s Circor, M/s Schneider, M/s Mersen, M/s ABB, M/s Alstom, M/s Aluminium Industries, etc., in the power and valve industry.

The training module which is at par with world class standards, comprises of design, manufacturing, quality, metrology, logistics and system implementation. The following facilities are available at Shanmugha Precision Forging (SPF):

1. Forge Shop

<table>
<thead>
<tr>
<th>Friction Screw Presses (400 T, 200 T &amp; 100 T capacities)</th>
<th>Trimming Presses (50 T &amp; 100 T capacities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Bar Cutting Machines</td>
<td>Induction, Oil &amp; Electrical Furnace</td>
</tr>
<tr>
<td>Effluent Treatment Plant</td>
<td>Mechanised Pickling Shop</td>
</tr>
<tr>
<td>Scrap and Oil Separator Machine</td>
<td>Plating Shop for Zinc plating</td>
</tr>
</tbody>
</table>

2. Design Software & Tool Room Facilities

<table>
<thead>
<tr>
<th>Electrical Discharge Machine</th>
<th>Shaping Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Speed Vertical Milling Machine</td>
<td>Drilling Machine</td>
</tr>
<tr>
<td>Surface Grinder</td>
<td>Pro-E &amp; CAD</td>
</tr>
</tbody>
</table>
3. CNC & Conventional Machine Shop

| Twin Spindle Seven Axes 32 Tools Tsugami make CNC Precision Automatic Lathe | CNC Turning Centres with and without bar feeders |
| Vertical Machining Centres Pneumatic Tapping Machine | High Speed Universal Milling machines Capstan Lathe |
| Drilling Machines of various capacities | Vertical Milling Machines |
| Grinding Machines | E-shopx – Customized software |

4. Standards Room

| Universal Length Measurement for calibration of Gauges, Verniers, Micrometers and Scales | Surface Finish Measurement for measuring surface finish to all applicable international standards |
| Slip & Dial Gauge Calibrator for calibration | Alloy analyser to detect elements in raw material |
| Caliper Checker for calibrating Vernier | Conductivity Measuring Instruments |
| Coordinate Measuring Machine (CMM) for 3 Dimensional Measurements | Calipers, Micrometers & Optical Microscope |
| Profile Projector | Trimos Height Gauge for 2 Dimensional Measurements |

Research Activities

Research and training activities at SPF has resulted in the following:

- Development of aircraft landing wheels for CVRDE (Combat Vehicles Research and Development Establishment) and critical parts for ISRO with SoME faculty members are underway.
- Research work on additive manufacturing, lean & six sigma, alternate materials for automobile parts are being carried out in collaboration with M/s TVS Motors, M/s Brakes India, M/s Sundaram Clayton, etc.
- Four research scholars from the School of Mechanical Engineering completed their Ph.D. using the facilities.
- Currently, many research scholars and faculty members are pursuing their research work by utilizing the facilities of standards room, forge shop & CNC Turning & Machining centre.
- Research works carried out in different areas have resulted in over 60 publications in various peer reviewed SCI & Scopus indexed journals.
• Faculty members, research scholars and students have presented their papers in various National & International conferences
• Shanmugha Precision Forging (SPF) organizes industrial visits to Machine Tool Exhibitions to witness world class manufacturing practices in the Industries and to relate with their area of study
• Faculty members from SASTRA Deemed University are encouraged to participate along with the SPF team in International exhibitions which are being organized by Engineering Export Promotion Council, Confederation of Indian Industries in various countries like Germany, South Africa, Singapore and USA.
• Other premier institutions like NIT-Trichy and nearby Engineering Colleges are also utilizing the facilities of SPF for their research
• Students from other departments and Management Studies from SASTRA Deemed University & other colleges utilize the facilities of SPF for their internships and projects
Foundation for Innovation & Research at SASTRA-TBI (FIRST)
FIRST is a Technology Business Incubator (TBI) established in SASTRA Campus and supported by Dept of Science & Technology, Govt. of India. The focus area of FIRST is in the emerging technology domains of 3D Printing (3DP) & Internet of Things (IoT).

Objectives of FIRST
• To nurture the spirit of Entrepreneurship through a structured pathway comprising Ideation, Incubation & Initiation leading to establishment of successful entrepreneurial ventures in applications driven by 3D Printing and IoT
• To generate a knowledge-based & creative talent pool in the emerging areas of 3DP and IoT through teaching and training programmes leading to certification
• To leverage the infrastructure facilities by conducting research and consultancy to either create a new body of knowledge or extend existing knowledge to diverse applications beneficial for various stakeholders
• To emerge as one of the globally competitive TBIs offering end-to-end product and service solutions to varied end-users
• To directly or indirectly establish successful start-ups within the SASTRA Campus in line with global best practices
• To encourage young minds to willingly come forward and explore innovative ideas that celebrates the convergence of human desirability, technical feasibility and economic viability
RESEARCH FACILITIES
SASTRA recognizes that the quality research requires infrastructure, state-of-the-art-equipment, human resources who have the flair for research, e-resources, etc. All these have been constantly upgraded to keep in pace with the emerging areas of science and technology. Two exclusive research buildings have been constructed to nurture multi-disciplinary research in niche areas of science and technology. The multidisciplinary centre, which houses the Centre for Advanced Research in Indian Systems of Medicine (CARISM), Centre for Nanotechnology & Advanced Biomaterials (CeNTAB), Central Instrumentation Facility (CIF), the National Facility for Development of Herbometallic Preparations of Ayurveda, Siddha & Unani has 30 research laboratories. Each of the laboratories in this facility has been designed according to the requirements of the individual Principal Investigator. The Institution also houses a GLP–compliant Central Animal Facility to carry out pre–clinical studies. All facilities available on campus are made accessible to not only students and faculty of SASTRA but also to users from other institutions and industries.

The Management has been constantly supporting the creation of new facilities for research in the campus. New teaching, research and support facilities with a total investment of Rs 16.06 crore have been created during the year 2017–18. Some of the salient new initiatives are:
1. M/s Tata Communications has set up a Cyber Security lab at a cost of Rs 45 lakh
2. Biomechanics Laboratory has been newly established at the School of Chemical & Biotechnology at a cost of Rs 50 lakh. This was funded through the Research & Modernization Fund of the Institution. The Biomechanics Lab house the Force Plate, Optical Motion Trackers, Pressure Mat and Virtual 3D Gait Analysis Software
3. Network simulator, spectrum analyser, transmission line simulator, robotics lab, etc., have been set up in the School of Electrical & Electronics Engineering at a cost of Rs 77.60 lakh
4. Aerospace labs in the School of Mechanical Engineering have been set up at a cost of Rs 24.96 lakh
5. High performance cluster has been augmented to 22 teraflops and the current value of the HPC is Rs 1.70 crore
The following are the list of major facilities available for SASTRA students and faculty as well as for other users in the region:

**Microscopy Facility**

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Laser Scanning Confocal microscope</td>
<td>Scanning Electrochemical Microscope</td>
</tr>
<tr>
<td>High-Throughput Microscope</td>
<td>Atomic Force Microscope</td>
</tr>
<tr>
<td>Optical Microscopes</td>
<td>Olympus Polarized Research Microscope</td>
</tr>
<tr>
<td>Phase Contrast Microscope</td>
<td>Leica Reflection Research Microscope</td>
</tr>
</tbody>
</table>

**Characterization Facility**

<table>
<thead>
<tr>
<th>Vibrating Sample Magnetometer (VSM)</th>
<th>X-Ray Diffractometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Size Analyzer</td>
<td>Ultramicrotome</td>
</tr>
<tr>
<td>Zetasizer</td>
<td>Surface Area Analyzer</td>
</tr>
<tr>
<td>Multiwave Digestion System</td>
<td>Static Cone Penetration Apparatus</td>
</tr>
<tr>
<td>Freeze Dryers</td>
<td>Thermogravimetric Analyser</td>
</tr>
<tr>
<td>Differential Scanning Calorimeters</td>
<td>Uniaxial Mechanical Testing Machine</td>
</tr>
<tr>
<td>Microhardness Testers – 2 Isodynamic Magnetic Separator</td>
<td>Mercury Porosimeter</td>
</tr>
<tr>
<td>CHN Analyser with Microbalance</td>
<td>Goniometer Viscometers</td>
</tr>
<tr>
<td>Self Balancing Loading Frame with Data logger, load cells (1000 kN)</td>
<td>Computerized Compression Testing Machine (3000 kN &amp; 1000 kN)</td>
</tr>
<tr>
<td>Polarimeter</td>
<td>Electrospinning Units</td>
</tr>
<tr>
<td>Patch Clamp</td>
<td>Microelectrode Array</td>
</tr>
</tbody>
</table>

**Spectroscopy Facility**

<table>
<thead>
<tr>
<th>X-Ray Photoelectron Spectrometer</th>
<th>X-Ray Fluorescence Spectrometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Chromatograph Coupled with Tandem Mass Spectrometer</td>
<td>Inductively Coupled Plasma Mass Spectrometer with Laser Ablation</td>
</tr>
<tr>
<td>Gas Chromatograph Coupled with Mass Spectrometer</td>
<td>300 MHz Nuclear Magnetic Resonance Spectrometer</td>
</tr>
<tr>
<td>Spectrophotometers (Multi mode reader, FTIR, UV-vis NIR, spectrofluorimeter, Nanodrop)</td>
<td>Atomic Absorption Spectrometer with Graphite Furnace</td>
</tr>
<tr>
<td>Raman Spectrometer</td>
<td>Photoluminescence Spectrometer</td>
</tr>
</tbody>
</table>

**Chromatography Facility**

<table>
<thead>
<tr>
<th>High Performance Liquid Chromatograph</th>
<th>Affinity Chromatography</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Performance Thin Layer Chromatograph</td>
<td>Preparative High Performance Liquid Chromatograph</td>
</tr>
</tbody>
</table>
### Hardware & Software

<table>
<thead>
<tr>
<th>22 TF High Performance Computing Clusters</th>
<th>Image Processing Workstations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embedded Systems Tools</td>
<td>VLSI Design Laboratory</td>
</tr>
<tr>
<td>Atom Processors Innovation Facility</td>
<td>Labview and Multisim Software</td>
</tr>
<tr>
<td>25 Dedicated workstations and high end server with packages and compilers: ADAMS, ANSYS 12, NISA, CATIA, SolidCAM, EDGECAM, ALECOP, AutoCAD, Design CAD, Mechanical Desktop, Mathcad, Axum 6.0, Lahey Developer</td>
<td>EXTENDSIM (50 users license) and ADAMS multi-body dynamics software (50 users license)</td>
</tr>
<tr>
<td>MATLAB Software</td>
<td>ANSYS Software</td>
</tr>
<tr>
<td>Image Processing Work Station with CCD Camera</td>
<td>ASPEN Plus Steady–state Simulation Software</td>
</tr>
</tbody>
</table>

### Cell Culture Facilities

<table>
<thead>
<tr>
<th>Flow Cytometer with Cell Sorter</th>
<th>Micro Array analyzer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated Liquid Handling System</td>
<td>Liquid Scintillation with Gamma Counter</td>
</tr>
<tr>
<td>Real-time RT-PCR</td>
<td>Ultracentrifuge</td>
</tr>
<tr>
<td>Cell Homogenizer</td>
<td>2-D Electrophoresis</td>
</tr>
<tr>
<td>Refrigerated Centrifuges</td>
<td>Biosafety Cabinets</td>
</tr>
<tr>
<td>Western Blotting Units</td>
<td>ELISA Readers &amp; Washers</td>
</tr>
</tbody>
</table>

### Engineering Facilities

<table>
<thead>
<tr>
<th>Solar Panel</th>
<th>High Voltage Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Process Control Facility</td>
<td>Computer Controlled Electric Drives</td>
</tr>
<tr>
<td>Radar and Satellite Link Facility</td>
<td>Hall Measurement System</td>
</tr>
<tr>
<td>Mobile Robot with Laser Sensors</td>
<td>Wireless Sensor Nodes</td>
</tr>
<tr>
<td>Gas Testing Facility</td>
<td>Physical Vapour Deposition Units</td>
</tr>
<tr>
<td>Electrochemical Workstations</td>
<td>Photolithography setup with Mask aligner, Spin coater, Plasma cleaner, etc.</td>
</tr>
<tr>
<td>Screen Printing facility</td>
<td>Automobile Lab Facilities</td>
</tr>
<tr>
<td>Computer Assisted Exhaust Gas Analyzer Variable Compression Ratio Engine Test</td>
<td>Rig and Fuel Injection Pump Calibration Facility</td>
</tr>
<tr>
<td>Computerised Engine Test Rig</td>
<td></td>
</tr>
</tbody>
</table>
ONLINE RESOURCES
The Central Library has a total collection of 2,56,821 books. 3210 books have been added during the academic year 2017–18 at a cost of Rs 98.97 lakh. As on date, Springer, IEEE and eBrary provide access to over 1,38,799 e-books worth Rs 2.87 crore. The total investment on books (print format) as on date is Rs 10.04 crore.

SASTRA subscribes to more than 40 reputed Online Databases like SCIENCE DIRECT, Springer Journals, ASME, ACM, IEEE, ASTM standards, ACS, IOP, AIP, Bentham Science Journals, Nature.com - Complete, ABI / INFORM, EBSCO, Lexis India, Manupatra, Taxmann etc. In addition, Rs 4.69 lakh was spent as subscription to 271 print periodicals of which 219 are national and 52 are international. The annual expenditure for subscription of online databases is over Rs 2.77 crore. The overall annual expenditure of our Central Library during this academic year is Rs 3.81 crores.

The online resources are supported through Wi–Fi and wired internet. The classrooms, corridors of various academic and administrative buildings have been enabled with Wi–Fi for the convenience of faculty, students and researchers and also for students staying in all the 12 hostels on campus. This 1 Gbps (NKN) and 20 Mbps (Reliance) free internet connection and Wi–Fi environment, which enables 6000 registered users is fully used for various academic and research pursuits.
Highlights of Research Activities
OBJECTIVES

- Quorum sensing targeted drug development against bacterial infections
- Host – pathogen relationships

RESEARCH HIGHLIGHTS

Biomodal regulation and reciprocal cooperation of industry compounds (Phytomolecules) and antibiotics for quorum quenching activity against various multidrug resistant pathogens. The research focuses on the bimodal regulation mechanism as a solution to tackle the current scenario of antibiotic resistance. It incorporates the use of plant polyphenols: Type A Procyanidin Pentamer (cinnamon extract) and Rosmarinic acid (spearmint) which are polyphenolic compounds that are widely distributed in higher plants. These secondary metabolites have shown to exhibit defence against plant pathogens. In the present work the bimodal regulator, Type A Procyanidin Pentamer is studied to target the recurrence of resistance by two mechanisms: reducing the dependence on antibiotics by a synergistic effect in combination with the antibiotics and through immune modulation by enhancing the production of LL-37. Thus, addressing both the mechanisms offers the potential to boost the elements of immune responses as an anti-infective strategy reducing the selective pressure and chance of resistance to antibiotics.
Discovery of a multi-targeted alkaloid-metal complex from an Indian traditional Siddha Formulation for Burn Wound Infections: A Reverse Pharmacological approach

A Siddha formulation, Mathan Tailam, a proven effective treatment for chronic burn wound infections. The chemistry and the biological activity is yet to be uncovered for this miracle formulation. The presence of alkaloids that can form a metal complex with copper and improve the wound healing activity, which leads to the hypothesis of the study. This study aims to unravel the mechanism of action of the Siddha formulation, Mathan Tailam, with the hypothesis that the Alkaloid – Copper complex acts on quorum sensing pathways for curtailing the pathogenesis of Pseudomonas aeruginosa.

Bioprospecting RMA for anti-infectives to combat Vibrio cholerae pathogenesis

Rare Marine Bacteria (RMA) have greatly been established as decomposers of organic and inorganic matter, these bacteria co-exist with other microorganism in every ecosystem and found to be producing inhibitory substance other than antibiotics to prevent the formation of biofilms. In this study, we aim to screen Quorum sensing (QS)-activating molecules from RMA to reverse engineer the QS-circuit from Low cell density (LCD) to High Cell Density (HCD) state in Vibrio cholera.

Investigating the therapeutic potential of urinary catheter functionalized with composite drug molecules to resist bacterial biofilm

The healthcare settings have been improving dramatically with the advent of the latest medical devices. The major downside in the associated infections and 70-80% of the infection are CA-UTIs. The potential repercussion is the adherence of MRSA on the urinary catheter surface. Management strategies include the frequent change of catheters to render them inhospitable to short-term MRSA colonization and biofilms in long-term dwelling catheters which requires amendment. Previously,
our research group have developed a hybrid molecule, (4-(Benzy lamino) cyclohexyl2-hydroxycinnamate) (termed as BCHC Quorum Quencher, BCHCQQ) against MRSA biofilm which has fuelled this comprehensive project proposal. The aim of this project is to develop novel synergistic combination of BCHCQQ and antibiotics anti-adherence based catheter coating that could prevent MRSA biofilms.

**Major Publications**


2. Gurmeet Kaur., P. Balamurugan and S. Adline Princy. Inhibition of the quorum sensing system (ComDE pathway by aromatic 1,3 di-m-tolylurea (DMTU) cariostatic effect with fluoride in wistar rats. Frontiers in Cellular & Infection Microbiology, 2017; 7: 313. (IF: 3.520)


OBJECTIVES

- To build an in vitro model of the Neuromuscular Junction to study aging and drug effects
- To build 3D Cardiac scaffolds

RESEARCH HIGHLIGHTS

Our lab works on the *in vitro* modelling of the Neuromuscular Junction (NMJ). The microfluidic chip is being designed and moulds are currently being made. Cell culture is currently being optimized with cell lines and then the primary cultures will be started. Neuronal and Cardiac cell lines are currently being cultured on microelectrode arrays to study their electrical network properties and further culture these cells on scaffolds.

Pictures: Microfluidic chip design using PDMS moulds
S. Anuradha  
anuradha@bioengg.sastra.edu  

Research Areas  
Regenerative Engineering, Biomaterials, Theranostics and 3D Bio-Printing

OBJECTIVES  
- Explore regenerative potentials of biopolymers for various tissue injuries  
- Explore additive manufacturing technology for biomedical applications  
- Develop Multimodal and multifunctional theranostics for circulating tumor cells using computational approaches

RESEARCH HIGHLIGHTS  
Joint Centre on Orthopaedic Regeneration  
Open porous biodegradable orthopaedic screws were developed using FDM 3D printers. Orthopaedic screws with varying head and thread designs were designed using solid work and fabricated with high accuracy and precision using this rapid prototyping technology. The biodegradability, biocompatibility, mechanical and porous characteristics of the fabricated screws were evaluated. Further the neovascularization potential of these screws were validated using in vivo subcutaneous rat model.

Stimuli Responsive Theranostics Magnetic Nanomicelles for Treatment of Breast Cancer  
Development of multifunctional stimuli responsive nanotheranostic against circulating breast tumor clusters is the prime focus of this study. Superparamagnetic iron oxide nanoparticles with high magnetism have been synthesized as MRI contrast agents. Circulating tumor clusters mimicking model have been developed using metastatic breast cancer cell line for evaluating the efficacy of fabricated multifunctional nanotheranostics.
Direct-3D wet writing

A perfusable living construct has been developed by facile template-free process. This 3D wet writing approach overcome the shortcomings of the existing template assisted technology such as poor lumen integrity due to removal of templates and time consuming process. These tubes have been tested for hemodynamics of the arteries using flow loop simulated set-up. These tubes withstand arterial hemodynamics of both physiologic and pathologic conditions.

3D printing and development of Tissue-On-Dish and Lab-on-Chip

The major objective of this study is to develop tissue-on-dish and lab-on-chip. Our part is to develop the cardiac tissue on a dish. We have designed the laser based 3D printer and the suitable bioinks were tested using the fabricated 3D printer. These printers could deposit the single cell and the motorised stage helps to precisely position the cells.

Major Publications

OBJECTIVES

- To produce cogeneration of biofuel and biopolymer from agricultural waste feed stock through biological process
- To produce biodiesel from renewable, non-edible vegetable feedstock through enzymatic transesterification

RESEARCH HIGHLIGHTS

One pot production of Biohydrogen and polyhydroxyalkanoate using Calophyllum inophyllum oil cake under alternative dark and light fermentation in 100L closed loop tubular bioreactor

We investigate the feasibility of coupled biohydrogen and PHA production by Enterobacter aerogenes and Rhodobacter sphaeroides using Calophyllum inophyllum oil cake. The dried powder of Calophyllum inophyllum oil cake obtained after oil extraction will be used as the carbohydrate source for fermentation. A fermentative facultatively anaerobic bacterium, E. aerogenes and R. sphaeroides will be used for fermentation process. Under optimized fermentation conditions, biohydrogen and low molecular weight PHA will be produced using lab scale fermenter (2L). The biohydrogen produced during the fermentation process will be collected in a gas collector. From the fermented solution, low molecular weight or short chain length PHA will be obtained. The economic analysis of production of biohydrogen and PHA from C. inophyllum oil cake by E. aerogenes and R. sphaeroides will be studied. The fermentation of C. inophyllum oil cake will be simulated with Aspen plus (V 8.6, Aspen Tech., Inc.).

Pilot plant studies on enzymatic transesterification of Calophyllum inophyllum oil by lipase immobilized on SBA-15 synthesized from low-cost precursor

Identification and development of economically viable alternate fuels is the need of the hour as the fossil fuel resources are fast depleting. Biodiesel appears to be one of the promising alternate fuels in the recent years. Biodiesel can be produced from nearly all vegetable oils. However, the economic prospect of such fuel mainly depends on the cost, composition and availability of the vegetable oil feedstock and cost of processing. Recently it has been reported by the researchers that the characteristics of the methyl esters derived
from Calophyllum inophyllum oil meet the requirement of diesel engine. In our lab we have successfully produced biodiesel from Calophyllum inophyllum through enzymatic transesterification process. The biodiesel so produced had properties very similar to/better than that of petroleum diesel. Calophyllum inophyllum is an abundant species and its oil is non-edible oil. It is now widely cultivated in nearly all tropical regions. Since it is tolerant to different soil conditions it is easily propagated to inland regions as well. Attraction of this plant is that yield of oil per hectare is the second highest worldwide. It is reported that average yield of biodiesel feedstock from Calophyllum inophyllum is 5000 litres/ha. Thus, C. inophyllum has been chosen as a feedstock for the present research. Towards reducing the production cost, an enzymatic trans-esterification process using immobilized lipase enzyme on SBA – 15 established in our laboratory, will be employed.

**Major Publications**

5. A. Arumugam & V. Ponnusami, Ethanol Production from Cashew Apple Juice Using Immobilized Saccharomyces cerevisiae Cells on Silica Gel Matrix Synthesized from Sugarcane Leaf Ash, Chemical Engineering Communications, 2015; 202: 709-717. (IF: 1.280)
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Research Areas
Computational Biophysics, Molecular Structure & Sequence Analysis

OBJECTIVES
- To understand the sequence structure relationships in proteins
- To perform statistical modelling of significant patterns in macromolecular sequences based on their biophysical descriptors
- To develop algorithms and tools for pattern recognition at a genome scale

RESEARCH HIGHLIGHTS

Protein Contact Prediction

This Project aims to identify the protein residue – residue contacts from the sequence information alone. The conventional structure prediction methods like homology modelling and threading approaches fail to work when a given sequence have very poor known sequence homolog. Development of computational tools that can predict residue-residue contacts in such cases can help us interpret the overall fold. Statistical models and classification tools based on the biophysical characteristics of the amino acids are being developed and tested on several subsets of proteins. For example, we have developed a Bayesian network classifier which can predict the fold of proteins, with sequence similarity as low as 20% with other known protein homologs. The same principle is also applied to develop computational tools that can scan a given genome/proteome for the presence of any given protein fold.

Major Publications
OBJECTIVES
• To characterize human genetic variation in infectious and non-infectious diseases
• To perform genomic characterization of human pathogens
• To decipher the genetic structure of Indian population

RESEARCH HIGHLIGHTS
Correlates of Human Papillomavirus genomic diversity and Immunogenetic variation of the host
The work aims to identify the genetic diversity of HPV-16 isolated from the cervix of cervical cancer patients and normal individuals. The whole genome of the virus will be sequenced. The HLA-A, B, C, DRB and DQB alleles of the cases and controls will be determined. So far 700 cervical swabs from healthy women and 70 cervical cancer tissue specimens have been collected and HPV testing has been performed. HPV-16 was found to be at a frequency of 12% in cervix of normal women and 86% in Cervical cancer cases.

Development of Bacteriophage Cocktail to Curtail Pathogens of Bacterial Sepsis
• Bacteriophages will be isolated from the environment (water bodies and sewage)
• Characterization of the bacteriophages will be performed using whole genome sequencing and electron microscopy
• Efficacy of the phages to curtail common sepsis causing pathogens will be evaluated

Major Publications
3. Smriti Anand, Amudha Govindaraju, Vinithra Vairavan, Suresh Kumar Narayanan, Rashmi Rajagopal, Anirudh Chellappa, Ashok Ayyappa, Kumanan Thiagarajan,


OBJECTIVES

• To isolate and identify the potent microorganisms from different sources and to check the applicability of the isolated strains for dye degradation studies, oxidoreductive enzyme production, biosynthesis of nanoparticles and also for probiotics studies
• Develop a mutant strain through random mutagenesis for over-production of enzymes and to develop a bacterial-fungal consortium for effective decolorization and degradation of azo dyes

RESEARCH HIGHLIGHTS

Bioremediation is a cost-effective, eco-friendly and alternate approach for treating wastewater containing dye from the textile industries. The synthesis of dyes and pigments used in textiles and other industries generate hazardous wastes. Discharge of dye-containing wastewater from the textile industries causes serious environmental problems worldwide. Conventional physicochemical methods had failed to achieve satisfactory results for dye removal as these methods are found to be inefficient, expensive, have less applicability and produce wastes in the form of sludge, which again needs to be disposed off. Hence, there is an urgent need for all the researchers to develop an alternate technology for complete mineralization of azo dyes. Selection of the indigenous adaptive microbial strain and strain development for exploitation of their enzymes with different substrate specificity are considered as one of the prime factors for complete mineralization of mixed dyes. The main aim of the present study is to develop a novel microbial consortium for hyper-production of oxidoreductive enzymes for effective decolorization and degradation of different structural stable azo dyes.
**Major Publications**

1. Arunkumar M., Sheik Abdulla, S.H. Improved bacterial-fungal consortium is an alternative approach for enhanced decolorization and degradation of azo dyes: A review. Nature Environment & Pollution Technology, 2018 (Accepted). (IF -0.6)


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Research Areas
Secondary Metabolites Chemistry, Food Science, Bionanotechnology

OBJECTIVES
• Process optimization for recovery of nutraceuticals from sustainable plant sources
• Chemistry of unravelled food plants and their application in food bionanotechnology
• Phytochemical Investigations of select Ayurvedic and Siddha plants and process

RESEARCH HIGHLIGHTS

Major Publications

4. Subramaniam, S., Sivasubramanian, A. An alternative green separation process for the pure isolation of commercially important bioactive molecules from plants. Green Processing and Synthesis, 2017; 6 (2): 235-244. (IF: 0.736)


10. Subramaniam, S., Sivasubramanian, A. Microwave assisted adsorption based elution: A benign green process optimized by Box-Beihken modeling yields pure vasicine from Adhatoda vasica Green Processing and Synthesis, 2016; 5 (3): 253-267. (IF: 0.736)
OBJECTIVES

- Multi-omics systems modelling of disease conditions esp. Cancer
- Algorithmic and computational solutions to biological problems
- Machine learning approaches for Bioinformatics Big data

RESEARCH HIGHLIGHTS

Cancer Systems Biology

We are developing computational approaches to the stage-specific detection of biomarkers in various types of cancers, since the success of cancer treatment depends crucially on early diagnosis. We are combining multiple OMICS modalities in the search for the ‘needle in the haystack’.
Promoter Strength Prediction
We are developing machine learning approaches for the predictive modelling of promoter strength given the – 35 and – 10 hexamer sequences in the regulonDB. The position weight matrices capture a generative model of the hexamers and a non-linear regression of the strength on the scores is yielding significance. A web server for the same has been implemented (https://promoterpredict.com).

Fourier spectrum analysis of conservation profiles of transmembrane proteins
Conservation profiles in regular secondary structures signify functional protein interfaces, and Palaniappan and Jakobsson have developed a method for the analysis of such conservation profiles. We are extending the Fourier spectrum analysis technique for the analysis of G-protein coupled receptor proteins and other ion channels.

P-glycoprotein in Drug Resistance
P-glycoprotein is an ubiquitous efflux pump, working to protect the organism from xenobiotics. Our aim is the in silico study of medically important P-glycoproteins. These include bacterial, fungal, and human PGPs, which play roles in infections, neglected tropical diseases and cancer drug resistance, among other conditions.
Major Publications


OBJECTIVES

- Conventional pharmacological approach to address bacterial quorum sensing control
- Drug repurposing for infectious diseases
- Reverse pharmacological approach to address pathogenic infections using Ayurvedic formulations

RESEARCH HIGHLIGHTS

Inhibition of agr mediated quorum sensing in multidrug resistant Staphylococcus aureus from skin and soft tissue infections

Among the various S. aureus infections, 90% of them are skin and soft tissue infections (SSTIs). The rapid emergence of multidrug resistance in bacteria has emphasized the need for alternative strategies to target bacterial infections. Quorum sensing control is an alternative therapeutic approach where in, bacterial biofilm and virulence factors are targeted, instead of killing the pathogenic bacteria. This eliminates the selective growth pressure for attaining drug resistance. This study aims at identifying quorum sensing inhibitors (QSIs) for S. aureus agr quorum sensing system. As a result, promising QSIs were identified that had significantly inhibited the bacterial community establishment and with down-regulation of virulence genes that are responsible for the pathogenesis. The QSIs had also exhibited significant inhibition of skin infection in a dermonecrosis animal model.

Confocal microscope images showing the effect of quorum sensing inhibitor, (QSI-1) at 80 μM in preventing the establishment of a bacterial community on the selected strains of S. aureus (ATTC, mutant and clinical) and S. epidermidis (MTCC)
Down-regulation of virulence genes in *S. aureus* clinical isolate AB459 and *S. aureus* agr mutant (ALC355) when treated with quorum sensing inhibitors, QSI-1 at (80 μM) and QSI-2 at (0.1 μM) expressed as relative fold change.

Efficacy of QSI-1 and QSI-2 showing the ulcer development in an *in vivo* dermonecrosis model infected with *S. aureus* AB459 clinical isolate.

**Major Publications**


OBJECTIVES
To establish the mechanistic concepts of epithelial-mesenchymal transition and neurodegeneration using CRISPR/Cas9 technology and employ it as an advanced gene therapy both individual or in combination therapy for various disorders.

RESEARCH HIGHLIGHTS
Mechanistic investigation of EMT in SNAIL CRISPR/Cas9 knockout model

Targeting the marker signaling molecules in TGF-β signaling seems to be effective therapeutic hits that favor the lung cancer management. In this context, Snail, a zinc-finger transcription factor, which specifically targets E-box sequence (CAGGTG) of E-cadherin promoter region, serves as an important transcriptional inhibitory protein in lung cancer progression and metastasis. Snail expression has been observed in many malignant tumors and is related with severe invasion and metastatic potential of the tumors. Therefore, negative mutation of SNAIL will play an essential role in the implication of reversion of metastatic phenotype characteristics of lung cancer. This can be achieved using CRISPR/Cas9 therapeutics, which involves development of transformative gene-based medicines for patients with serious diseases. Our therapeutic approach is to manage diseases at the molecular level using the breakthrough genomic engineering technology called CRISPR/Cas9.
Major Publications

1. Banudevi S, Maheswari KU, Vignesh R. Amelioration of oxidative stress in differentiated neuronal cells by rutin regulated by a concentration switch. Biomedicine and Pharmacotherapy, 2018 in press. (IF: 3.4)


4. Banudevi S. Current perspectives on printing technology for biomedical applications. Biochemistry and Physiology, 2016, 5:3. (IF: 0.8)


OBJECTIVES
• Toxin-Antitoxin systems in bacterial persistence
• Horizontal gene transfer in bacterial genome evolution
• Mechanisms of antibiotic resistance evolution and dissemination

RESEARCH HIGHLIGHTS

Significance of Type II Toxin-Antitoxin Systems to Bacteria
Toxin-Antitoxin systems (TAs) are encoded by diverse bacterial chromosomes, often in multiple numbers, and hence were predicted to contribute to the propagative potential of the bacteria. Consequently, TAs are implicated in a multitude of physiological phenomena by various groups. Type II TAs are implicated in programmed cell death, bacterial persistence, anti-addiction, biofilm formation, etc. We have shown that the endoribonuclease encoding chromosomal TAs are most likely selfish DNA. TAs are likely used by various replicons as ‘genetic arms’ that can allow the maintenance of themselves and the associated genetic elements. TAs seem to be the ‘selfish arms’ that made the best of the ‘arms race’ between bacterial genomes and plasmids. However, TAs have the potential to reduce the metabolic rate and hence there is a possibility for TAs to induce dormancy and consequently stress tolerance.
Horizontal Gene Transfer in Bacterial Genome Evolution and Ecology

Bacterial genomes are highly plastic to generate variation by the acquisition of genetic information and optimisation by the loss of frivolous genetic information at the population level. The dynamic niche with varying degrees of selection pressures allows for genome diversification of a species resulting in genetic heterogeneity of the population. Bacteriophages, plasmids, and transposons enhance large scale variations thereby expediting the genome diversification in bacteria. We use bioinformatic tools to determine various elements that propagate through HGT and genetic elements that promote HGT such as plasmids and phages. Our goal is to understand the properties of the genetic elements that confer the potential for HGT. In pursuit of HGT, we are especially interested in ‘selfish DNA’ which seems to propagate across and along with cellular entities despite not contributing to the propagative potential per se.

Generalized model representing the route in which prophages enhance the rate of bacterial genome diversification and evolution.
Mechanisms of Antibiotic Resistance Evolution and Dissemination

The use of antibiotics, apart from treating infectious diseases, causes the evolution of antibiotic resistant strains. This is referred to as “antibiotic paradox”. Spontaneous evolution of multidrug tolerant bacterial pathogens and the rapid spread of the resistance genes have become a leading problem for clinicians. Using microbiological, molecular and bioinformatic techniques we explore the mechanisms of resistance. We also explore the mechanisms of plasmid mediated dissemination of antibiotic resistance genes. We are studying the contribution of Toxin-Antitoxin systems in the bacterial persistence as well as in plasmid maintenance.

Major Publications

OBJECTIVES

- To enhance therapeutic metabolites and their pathways in medicinal plants using novel genetic engineering-based approaches
- To understand the molecular mechanism regulating secondary metabolites in model plants, Catharanthus roseus and Nicotiana benthamiana

RESEARCH HIGHLIGHTS

Understanding the gene-based regulation of precursors towards improving therapeutic secondary metabolites production in *N. benthamiana*

- Plant secondary metabolites are being abundantly used in disease therapy, and there is an increasing demand for low-volume-high-value plant therapeutic metabolites
- Our aim is to understand the transcriptional regulation of sucrose metabolism genes that serve as precursors and intermediates for the biosynthesis of secondary metabolites in *N. benthamiana* plant
- The work involves gene isolation, characterization and transgenic studies to unravel the regulatory network connecting primary and secondary metabolism in *N. benthamiana*
- Our orks indicate that different concentration of animal neurotransmitters could positively influence the precursor and secondary metabolism pathway, leading to an up-regulation of therapeutic metabolites in planta
- This strategy could be further applied to other well-known commercially used medicinal plants, thereby improving its productivity and therapeutic potential

Developing novel elicitor treatment strategies to enhance the levels of Terpenoid Indole Alkaloid (TIAs) in the medicinal plant, *Catharanthus roseus*

- Highly potent indole alkaloids (like Vincristine, Vinblastine and Vindoline produced via TIA pathway in *C. roseus*) are most in demand due to their activity against various forms of cancer (lymphomas, lung and brain cancers)
- Due to the extremely low levels of these therapeutic compounds, various genetic engineering approaches are being developed to increase their levels in planta
- Our lab is involved in enhancing the levels of these compounds in *C. roseus* through various novel elicitor treatments and DNA based engineering methods
- The mechanistic gene regulation studies in the same plant allowed the identification of
significant transcription factors (proteins) that seems to play a role in the improvement of TIA-based anticancer drugs

- Our future work would involve transforming these transcription factor genes into *C. roseus* and generating transgenic plants producing higher amount of the high quality anticancer drugs in planta

**Major Publications**


OBJECTIVES

- To standardize and validate the safety and efficacy profiles of classical Ayurveda and Siddha formulations
- To recognize, identify and characterize the raw materials and the products of both Pharmaceuticals and Nutraceutical value

RESEARCH HIGHLIGHTS

Centre for Excellence and National facility for the Scientific validation and Standardization of Ayurveda and Siddha – Rasa Ausbadies and Bhasmas

Fifteen Ayurvedic and Five Siddha herbo-metallic preparations were selected and standards determined as per WHO protocols. Chemical markers were also identified such as Piperine, Gallic acid, Chebulinic acid, 6-Gingerol, Embelin, Andrographolide and Ferulic acid for the selected formulations which included Kalyanaka kshara, Chandraprabha vati, Karpuradi curna and Lasunadi vati.

Pharmacognistic studies were carried out to detect adulterants used in place of Piper nigrum (Black pepper) and Zingiber officinale (Ginger) in the selected formulations like Chandraprabha vati and Tribhuvanakirti Rasa. Improper ingredients if used may have undesirable effects and may influence the therapeutic potency of the selected formulation. Another study was also carried out to understand the impact of purification process of the ingredients like Acorus calamus and Zingiber officinale using milk.

Toxicity Studies on Thirithoda Mathirai

This is a collaborative research project with the National Institute of Siddha where standardization and toxicity profiles of Thirithoda Mathirai were determined for 4 different stages involved in the purification process of Veeram (Mercury) a main ingredient in the formulation. Acute toxicity and standardization studies have already been completed and sub-acute toxicity studies are in progress.
Pharmacognostic evaluation and *in vivo* anti-cancer efficacy studies on *Dillenia pentagyna* (Kanagal) extract

Transverse section of leaves were taken and stained with toluidine blue and Phloroglucinol to study the general micromorphological characters such as structure of epidermis, lamina, vascular bundles, sclerenchyma, stones cells and parenchymata cells. Attempts were also made to study starch grains, raphids, druses and calcium oxalate crystals. Powder microscopic studies were carried out to identify the types and structures of xylem vessel elements, tracheids, fibers, xylem parenchyma, trichomes, acicular, druses and prismatic calcium oxalate crystals, starch grains and to localise the presence of mucilage, oil globules and tannins. Histochemical localisation studies confirmed the presence of starch, lipids, terpenoids, and flavonoids. The *in vivo* study on the anti-cancer potential of aqueous extract of *D. Pentagyna* in rat liver cancer model is in progress.

Major Publications


OBJECTIVES

- To measure the contractile/relaxant effect of Bioactive molecules on different smooth muscles
- To optimize different animal models for screening bioactive test substances on experimental animals

RESEARCH HIGHLIGHTS

Role of Potassium channel in the regulation of vasorelaxation of unexplored Siddha medicinal plant Plectranthus vettiveroides in isolated descending aorta of rat

The root of Plectranthus vettiveroides (Lamiaceae) is aromatic and is reported to reduce elevated blood pressure (kuruthiyalal) in Siddha literature. The major chemical compounds of root essential oil (EO) are (+)-3-carene-10-acetylmethyl, β-costol and (E)-isovalencenol. The vasorelaxant (ex vivo) property of EO nanoemulsion was evaluated in rat’s descending aorta using 16 channel polygraph. The effect of EO against the adrenergic receptor, potassium channels and calcium ion along with their antagonist was evaluated. From the ex vivo experiments, it was found that root essential oil of P. vettiveroides showed vasodilatory effect mediated by ATP-sensitive potassium channel. Based on the results of ex vivo studies, in vivo studies on the anti-hypertensive potential of the above mentioned EO are being carried out using animal models.
Major Publications


OBJECTIVES

• To develop new electroactive materials for energy storage that are cost-effective, scalable and industrially practical for commercial applications
• To convert hazardous industrial waste into value added products
• To harness energy from industrial and domestic wastes

RESEARCH HIGHLIGHTS

High energy supercapacitors

Generally adopted strategies to improve energy density of the electrode materials involve tuning various properties of the electrode material or increasing the cell voltage. While tuning the properties of the electrode material is tedious, increasing the cell voltage is restricted by the stability of the electrolyte. We developed a facile approach to improve the energy density of MnCO$_3$ by the influence of SiO$_x$ nanofluid in the electrolyte. The presence of small amount of SiO$_x$ nanofluid in the electrolyte provides higher diffusivity and more conductive percolation paths for ions and thus decreases internal resistance and increases ionic conductivity of the electrolyte. As a result, 60% enhancement in the capacitance is witnessed for MnCO$_3$. Further, the nanofluid containing electrolyte was found to be stable over a month.
Electrically rechargeable Zinc-air batteries

Zn-air batteries have several advantages such as low cost, high abundant resources, environmental benignity, a flat discharge voltage, long shelf-life, high theoretical energy density (1084 Wh/kg) and use of non-noble metal catalysts for oxygen reduction reaction. However, electrically rechargeable Zn-air battery has critical issues such as low power density, low practical energy density and poor cycle-life. Our group focuses on developing electrically rechargeable zinc-air batteries by mitigating the above mentioned issues via enhancing the kinetics of oxygen reduction and evolution reactions, optimizing three phase (catalyst-electrolyte-gas) interface by strategic distribution of catalysts on a graded carbon structure and by increasing hydrogen evolution reaction.

Mesoporous g-C₃N₄ for high energy supercapacitors

Synthesis of mesoporous graphitic carbon nitride (MGCN) by soft template method is still challenging and its application as an electrode material for supercapacitor remains unexplored. Our group unveiled MGCN as a promising electrode material for supercapacitors. MGCN synthesized by facile direct carbonization of methylolated surfactant-polymer composite displayed excellent capacitance properties in 1 M H₂SO₄ electrolyte with a specific capacitance as high as 279 F g⁻¹ at a current density of 0.25 A g⁻¹. It also exhibits good rate capability and outstanding cycling stability with excellent coulombic efficiency of 100% over 5000 cycles. This superior capacitive storage performance is attributed to the high surface area, easily accessible mesopores and high pyridinic nitrogen content.
Major Publications


OBJECTIVES

- Epigenetic alterations and cell signaling events involved in Radiation-induced toxicity
- Isolation of phytochemicals from plant extract, synthesis of nano particles and study of their effects on radiation-induced toxicity

RESEARCH HIGHLIGHTS

Mechanistic investigation on histone modifications during radiation-induced alveolar epithelial-mesenchymal transition (EMT): in vitro and in vivo approaches

Radiotherapy is a major therapeutic modality for cancer treatment; but has often resulted in normal tissue complications including pneumonitis and fibrosis. Epithelial mesenchymal transition (EMT) has emerged as a critical phenomenon in fibrosis. Although significant progress has been made in understanding the molecular regulation of EMT, a little is known about chromatin modification in EMT. Chromatin modifications through histone acetylation and methylation determine the precise control of gene expression. To the best of our knowledge, no studies have prospectively examined histone modifications during radiation-induced alveolar EMT. Hence, the project unravels the role of histone acetylation and methylation in transcriptional regulation of EMT markers during radiation-induced toxicity in vitro and in vivo. HDAC inhibition decreased radiation induced toxicity (A) and HDAC inhibitor (TSA) binds with Snail protein (B).
In vitro and in vivo epigenetic investigations on anticancer and radio-priming effects of different parts of Mangifera indica (India) and Mangifera zeylanica (Sri Lanka) and impact of green silver nanocomposites

Green synthesis of silver nanoparticles from the extracts of these plant species might enhance the bioavailability and targeted delivery of the active principles for the treatment of cancer. Hence, we focus on the investigation of in vitro and in vivo anticancer potential and radio-modifying activity of Mangifera indica and M. zeylanica collected from India and Sri Lanka, respectively and their nanocomposites. We aim to determine the epigenetic modification through evaluation of following parameters:

- Epithelial mesenchymal transition, fibrosis and cancer markers including NFκB, MEF2C, TGFBR2, nestin, FOXA1, E-cadherin, Snail, Slug, Vimentin, CTGF, MMPs, TIMPS, p53, p21, PTEN
- Global histone acetylation/methylation and DNA methylation status, histone modifying enzymes (HME) and DNA methylation enzymes.
- Signalling pathways including Akt/phosphoAkt (PI3K pathway), elf4E / phospho-elf4E and P70S6K/phosphor-P70S6K (mTOR pathway), MAPKinase pathway, TGF β1/ SMAD2/3

Major Publications
5. Subramanian U, Nagarajan D. All-Trans Retinoic Acid supplementation prevents cardiac fibrosis and cytokines induced by Methylglyoxal. Glycoconj J. 2017; 34: 255-265. (IF: 2.2)
**OBJECTIVES**

- Exploring various cellular signalling cascades associated with evasive strategies of cancer
- Investigating the crucial role of mitotic spindle in facilitating proliferation of cancer cells
- Prospecting diverse novel compounds for their efficacies against cancer

**RESEARCH HIGHLIGHTS**

**Deciphering the Role of Chromosomal Instability - Associated Signalling Cascades in Breast Cancer**

Cancer cells are extremely intelligent as they can evade major cellular checkpoints despite harbouring various types of aberrations. One such aberration is chromosomal instability, which in fact, is a hallmark of cancer. Presence of such aberrant features normally triggers diverse cellular checkpoints which in turn drive the cell(s) to death. Interestingly, cancer cells have devised several strategies to circumvent this problem. The researchers at Cardiac Dyshomeostasis Laboratory (CDHL) are interested in deciphering the variegated cellular and molecular mechanisms that confer this evasive attribute to breast cancer cells, thereby ensuring their sustained growth and proliferation.

**Mitigation of Cancer Chemotherapy - Induced Thromboembolism**

Chemotherapy is one of the most popular intervention strategies against cancer. While the repertoire of various chemotherapeutic agents has been steadily widening over the years, emergence of myriad side-effects characterize it as a ‘necessary evil’. Occurrence of cardiovascular disease is one such complexity that is closely associated with the
administration of cancer chemotherapeutics. Thus, the formation of embolic thrombus often makes administration of chemotherapeutics a challenging option. The CDHL group is interested in comprehending diverse molecular players that might be closely associated with chemotherapy-thromboembolism nexus thereby generating plausible road maps to overcome the same.

**Major Publications**

OBJECTIVES

- Preparation of polyclonal antibodies for prophylactic, therapeutic & diagnostic applications
- Investigating alternative methods to combat with multi-drug resistance
- Evidence based medicine–validating animal studies by systematic review & meta-analysis

RESEARCH HIGHLIGHTS

Preparation and Validation of Chicken Egg-Yolk sourced Anti-snake-Venom

Snake envenomation is a common life-threatening medical emergency in the tropics, particularly in rural areas. It has been listed as “Neglected Tropical Disease” by WHO in 2009. India has the highest snakebite mortality in the world WHO estimates the number of bites to be 83,000 per annum with 11,000 deaths. Presently, equine and ovine-derived Antia-snake-venom ASV is the only effective and medically accepted remedy. Nonetheless, the high cost of generating antibodies in horses and the side-effects are the bonafide problems with mammalian sourced ASV therapy. In the recent past, chicken IgY has been explored as a promising alternative to mammalian antibodies due to its low cost and high yield. Hence, this study is aimed to generate chicken egg-yolk sourced ASV against venoms of Big four snakes Cobra, Krait, Russells viper and Saw Scaled Viper. The production of ASV using egg laying chicken would be a safer, cheaper, short-cycle and non-invasive technology.
OBJECTIVES

- Develop synergistic water purification and detection system using biogenic metallic/photocatalytic nanomaterials
- Develop novel plasticizer chemicals with industrial applications
- Synergistic production of high purity hydrogen and methanol from coal

RESEARCH HIGHLIGHTS

Develop novel plasticizer chemicals

In this work, novel plasticizer chemicals, propylene glycol monomethyl ether acetate (PMA) and propylene glycol benzoate (PGB) are being synthesized in both homogeneous and heterogeneous based processes. The scope of work includes laboratory synthesis of the chemicals, including understanding of the effect of process parameters on rate kinetics, scale-up of the process using chemical simulation methods and full scale development of the process in association with MPL. Experimental investigations conducted thus far has shown about 90% yield of PMA and 60% of PGB. Scale-up of the process is ongoing.

*Schematic diagram showing a Reactive Distillation process for Propylene Glycol Mono Methyl Ether Acetate production*

Development of Advanced Oxidation Based Wastewater Treatment System

The project involves the development of an Advanced Oxidation Process (AOP) based wastewater treatment system for the effluent generated at Wheel India Ltd., (WIL). Instead of using UV-based AOPs, permanganate was used for COD reduction, and it also enhanced coagulation and micropollutant removal. Compared to other oxidants, e.g., ozone, chlorine, chlorine dioxide, and potassium ferrate, permanganate was preferred due to its relatively low cost, ease of handling, effectiveness over a wide pH range, and comparative stability in aqueous solutions. The significant findings of the study were:
(1) Permanganate was an effective oxidant for COD removal from effluent wastewater, and highly effective in alkaline conditions: (2) Complete COD reduction was achieved within 8 hours using low dose, which resulted in significant cost savings; (3) The sludge formation was less than 1%, and significant reduction in TDS was observed.

Water Purification System using Biogenic Bimetallic Nanomaterials
This project involves the development of a facile synthesis method for preparing biogenic metallic and bimetallic nanoparticles using plant extracts. The as-synthesized biogenic Fe and NiFe nanomaterials showed higher adsorptive capacity for Cr (VI), and faster rate kinetics for methylene blue degradation in a catalyst – peroxygen assisted oxidation process, when compared to the chemogenic nanoparticles. In addition, the materials are now being used for Uranium removal from groundwater, and also for the development of Zn nanorods and gold nanoparticles for sensor applications.

Major Publications
**OBJECTIVES**

- Identification of disease mechanism
- Development of novel mitochondria based therapeutic strategies to improve cardiac function from ischemia reperfusion
- Understanding nucleo-mitochondria cross talk during ischemia revascularization and associated injury in distant organs

**RESEARCH HIGHLIGHTS**

The main aim of our research is to understand the contributory role of mitochondrial dysfunction to myocardial ischemia reperfusion (I/R) in normal and diseased rat heart and how to exploit this information in the management of I/R via developing drug from natural and synthetic route. Moreover, we investigate the impact of cardiac aging process in the outcome of I/R injury. We initiated the scientific analysis that explain the alterations in the nucleo-mitochondria communication during I/R. Our research also aims to determine the adverse effect of air pollutants of having different particle size in CVD especially I/R injury.

In addition, our group also studies the impact of cardiac revascularization in the cognitive decline in both CABG patients and rat undergoing carotid artery ligation and LAD ligation. Further, the hormonal imbalance and its contributory role in the outcome of I/R is the another study going on in our lab.
Major Publications
2. Ravindran S, Ramachandran K, Kurian GA. Sodium thiosulfate mediated cardioprotection against myocardial ischemia-reperfusion injury is defunct in rat heart with co-morbidity of vascular calcification. Biochimie. 2018; 147:80-88. (IF: 3.188)
5. Mahalakshmi A. Kurian GA. Streptozotocin-induced type II diabetic rat administered with non-obesogenic high-fat diet is highly susceptible to myocardial ischemia-reperfusion injury than fed normal diet – an insight into mitochondria. 2018 Journal of Cellular Physiology (In press) (IF: 4.08)
RESEARCH HIGHLIGHTS

Strain improvement of *Bacillus aerophilus* KGJ2 for enhanced production of xylanase and its application

The present research focuses on the isolation, molecular characterization and optimization of the process parameters for the production of xylanase enzymes in both submerged and solid state fermentation from the newly isolated *Bacillus aerophilus* KGJ2. To study the potential application of purified xylanase enzymes in the food industries, the xylan was extracted from corncob and process parameters optimized for enzymatic production of xylooligosaccharides (XOs). Further, the antioxidant potential of the extracted xylooligosaccharides has also investigated. In addition strain improvement of *Bacillus aerophilus* through physical and chemical mutagens followed by genome shuffling resulted in a strain that was reported for hyper produced xylanase.

OBJECTIVES

- Strain improvement of microorganism by genome shuffling to enhance the production of industrially important enzymes/metabolites through protoplastic fusion
Major Publications
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Research Areas  
Coordination and Organometallic chemistry, Homogeneous oxidation catalysis and Catalysis in ionic liquids

OBJECTIVES

• Synthesis of catalytically important coordination and organometallic complexes
• Performing a variety of catalytic reactions in ionic liquids and special conditions like low temperature, inert atmosphere and sensitive reagents

RESEARCH HIGHLIGHTS

Aerobic Oxidation Of Alcohols In Ionic Liquids Catalyzed By Transition Metal Complexes: A Green Catalytic System

New copper and palladium complexes containing triphenylphosphine and 2,4-dichloro-N-[di(alkyl/aryl) carbamothioyl]benzamide ligands have been developed as catalysts for the oxidation of various alcohols into carbonyl compounds in ionic liquids. In addition, antioxidant and cytotoxicity studies of 2,4-dichloro-N-[di(alkyl/aryl) carbamothioyl]benzamide derivatives have been reported.

Major Publications

**OBJECTIVES**

- Investigation of mitochondrial-extramitochondrial cross-talks in human cellular aging
- Study of the effects of mitochondrial stress on endothelial signalling
- Prospecting novel anticancer drugs against breast adenocarcinoma

**RESEARCH HIGHLIGHTS**

**Looking at mitochondrial-extramitochondrial cross-talks in cellular aging**

Mitochondria are known to determine the rate of aging in eukaryotic cells and tissues. The group at CDHL is investigating how the mitochondria interacts with the extramitochondrial facets in a cell to determine the rates of aging (structural & functional decline) of the cell. This study involves elucidating the variegated cellular proteins, which decide the longevity and fate of a cell, in coordination with mitochondrial modulations.

![Effect of mitochondrial modulations on myriad nuclear proteins](image1.jpg)

![A mutation map of the human mitochondrial genome](image2.jpg)

**Targeting Cancer Chemotherapy-Induced Thromboembolism**

In view of the fact that a number of cancer patients undergoing chemotherapy die of cardiovascular ailments, it is important to understand how several chemotherapeutics frequently end up causing such pathological conditions. Researchers at CDHL are looking at the role of endothelial mitochondria in chemotherapy-induced thromboembolism in rats. This study might provide a roadmap to mitigate cardiovascular complications arising from cancer intervention strategies.
Major Publications
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Research Area
NMR Spectroscopy

OBJECTIVES

• Method development for Two-dimensional NMR Spectroscopy
• Structural Characterization of Molecules by NMR Spectroscopy

RESEARCH HIGHLIGHTS

Structural Characterization
Structural characterization of molecules isolated from plants is being done by deploying two-dimensional NMR spectroscopy to map 1H, 13C, 15N, and 19F interactions. The experimental results are compared with the theoretically calculated results.

Data and Signal Processing Tools for Two-dimensional NMR Spectroscopy
The problems associated with data truncation and the time limitation are major bottlenecks in two-dimensional NMR spectroscopy. In order to overcome these problems, works in the areas of sparse sampling, iterative soft threshold, and CRAFT are being carried out. Non-Uniform Sampling (NUS) is being used as a tool to sample the FID in a selective manner and the resulting FID is subjected to processing tools such as CRAFT (Complete Reduction to Amplitude Frequency Table), which converts the raw FID data and extracts key parameters such as frequencies, amplitudes, decay rate constants and phases.

Major Publications
1. K. Krishnamurthy, N. Hari, Application of CRAFT (complete reduction to amplitude frequency table) in nonuniformly sampled (NUS) 2D NMR data processing, Magnetic Resonance in Chemistry 2018, 56, 535-545. Special Issue – Software Tools and Tutorials in Liquid State NMR (IF: 1.78)
OBJECTIVES

- Identification of microRNA modulators as therapeutic molecules against cancer
- Studying the role of non-coding RNA in metabolic reprogramming in cancer cells
- Identification of Nano-based drug delivery systems for targeting cancer

RESEARCH HIGHLIGHTS

Functional genomics approach to identify small molecule modulator CLL cancer

Deregulation of microRNAs such as miR-15a/16-1 cluster has a key role in pathogenesis of CLL, a clinically heterogenous disease with indolent and aggressive forms. MiR-15a/16-1-deletion accelerate the proliferation of both human and mouse B cells by modulating the expression of genes controlling cell-cycle progression (Klein et al., 2010; Cancer cell). miR-15a/b inhibits expression of cyclin E, cyclin D1 and plays a pivotal for the G1/S transition of cell-cycle progression (Ofir et al., 2011; CHENG-KUI CAI et al., 2012). Our goal in this project is to identify small molecules that modulate the miR expression and control cell-proliferation in CLL by down regulating anti-apoptotic proteins such as Bcl2 and Mcl-1.

Understanding role of the mTOR - A functional genomics and proteomics approach

Glioblastoma (GBM) is the most common and lethal form of brain cancer. Enhanced glucose metabolism (Warburg effect) is a hallmark tumor cells. mTOR pathway is documented in invasion and migration. The features associated with aggressive phenotype in human GBM. The activated mTORC2 pathway will activate a key component of mTORC2 complex rictor by acetylation. Persistent rictor acetylation in the presence of glucose renders GBM cells resistant to EGFR-, PI3K- and Akt-targeted therapies. Currently, we are attempting to identify the role of non-coding RNAs in cancer metabolism via mTOR pathway.
Major Publications


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Research Areas
Tackling drug antibiotic resistance and *C. neoformans* infections by Actinomycetes derived immunomodulants

**OBJECTIVES**
To explore diverse *Actinomycetes Spp* and their metabolites to tackle *C. neoformans* and MDR pathogens

**RESEARCH HIGHLIGHTS**
Integrated approach of Antibiofilm and Immunomodulation to combat catheter related *K. pneumoniae* blood stream infections

Central venous catheter related blood stream infections (CRBSI) caused by *K. pneumoniae* are significant infections associated with morbidity and mortality. In general, biofilm resists immune defences and antimicrobial actions. The current treatment strategies lead to further development of resistant phenotypes. Hence an antimicrobial agent promoting Antibiofilm and immunomodulation by skewing the macrophage cytokine response to a more proinflammatory one will enable a host friendly control of infection and further development of resistant bacteria. ASK2 compound from *Streptomyces rimosus* was identified as a potential anti-Klebsiella compound. Apart from its antagonistic effect, the added advantages of the compound includes enhanced phagocytosis, as well as skewing the macrophage cytokine response toward a more proinflammatory one and enhance phagocytic response of macrophages against MDR *K. pneumoniae*
Assessing the translational potential of compound-6 against cryptococcal meningitis
In the last 30 years, Echinocandins is the only new class of antifungal drugs that has been developed with no activity against *C. neoforman*. To the best of our knowledge, the furanone compound synthesised during the course of drug development has never been tested for its antifungal activity. Moreover, the ability of the compound to cross blood brain barrier advocates the potentiality of the compound for translational research. Compound-6 has many added therapeutic potential such as reduction of fungal burden in major organs like brain, lungs, kidney and liver. low molecular weight (174 Da), lipophilicity, ability to cross blood brain barrier, increased expression of protective Th1 type cytokines during host pathogen-interactions, enhanced phagocytosis and protective host response. Further study includes assessing the sub-chronic oral toxicity, efficacy, pharmacokinetics and biodistribution of the antifungal compound in higher animal model.
Major Publications


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**Research Areas**
Organic Synthesis & Medicinal Chemistry

### OBJECTIVES
- Asymmetric induction during carbon – carbon bond formation
- Development of active molecular scaffold against Mtb and Cataract
- Small therapeutic peptides

### RESEARCH HIGHLIGHTS

**Structure-activity relationship confined Isoxyl skeleton: Generation of new lead molecules against Mycobacterium tuberculosis (Mtb)**

We have prepared 1,3-oxazine-2-one based dual targeted molecules. Among the synthesized molecules, one was found to be equally active against both replicating and non-replicating form of Mtb (MIC 2.97 μg/mL and 2.15 μg/mL respectively). The activity against the replicating form is due to the inhibition of the mycolic acid biosynthesis which was found to get reduced by 4 and 40 folds for α’ and epoxy-mycolates respectively. Simultaneously, the capability of this molecule to inhibit the activity of MenG (IC50 = 10.15 μg/mL) is demonstrated as the primary reason for its success against the non-replicating form.

Crucial changes in the architecture of Isoxyl to develop better antibiotics against multi-drug Resistant (MDR) Mycobacterium tuberculosis (Mtb)

We have synthesized different diaryl urea derivatives targeting the inhibition of mycolic acid biosynthesis. Among the 46 synthesized molecules, compounds 46, 57, 58 and 86 showed MIC values ≤ 10 μg/mL against H37Rv and mc26030 strains. The best molecule with a methyl at ortho position of the first aromatic ring and prenyl group at the meta position of the second aromatic ring showed the MIC value of 5.2 μg/mL and 1 mg/mL against H37Rv and mc26030 respectively, with mammalian cytotoxicity of 163.4 μg/mL ring and prenyl group at the meta position of the second aromatic ring showed...
the MIC value of $5.2 \mu g/mL$ and $1 \mu g/mL$ against H37Rv and mc26030 respectively, with mammalian cytotoxicity of $163.4 \mu g/mL$.

**Major Publications**


OBJECTIVE
Bioprocess development of microbial metabolites that have potential applications in food, pharmaceutical and bioenergy sectors

RESEARCH HIGHLIGHTS

Screening of therapeutically important serine protease inhibitors
Proteases are ubiquitous in all living organisms, hydrolyze peptide bonds of proteins irreversibly, and any aberrations in protease activities may lead to many physiological disorders like cancer, neurodegenerative disorders, inflammatory and cardiovascular diseases. Protease inhibitors form a complex with their respective proteases and inhibit them partially or entirely to combat the disorders. Although serine protease inhibitors are ubiquitously present in all organisms, more class specific distinct inhibitors are found in microbes. Considering the therapeutic potential of the serine protease inhibitors and the lack of industrial strain for their production, our lab aimed to isolate a serine protease inhibitor producing bacterium from the unexploited marine environment. We also focus on the several bioprocess strategies for the enhanced production of microbial serine protease inhibitor. Further, to determine the inhibitor efficiency of the purified PI and role in the therapy, various kinetic studies and therapeutic applications (anticoagulant and anticancer) are underway.

Biohydrogen production by dark fermentation
Hydrogen is widely recognized as a clean and efficient energy resource of the future. It has the highest energy content per unit weight of any known fuel and is the only fuel that is not chemically bound to carbon. Biological production of hydrogen is selective, promising, ecofriendly and economical, provided a proper technology is developed. The dark fermentative route is a promising method of biohydrogen production due to its higher rate of H2 evolution in the absence of any light source as well as the versatility of the substrates used. Moreover, fermentative organisms have high growth rate and do not suffer much from inhibitory effects of oxygen in the system, as the anoxygenic. Bio-hydrogen production from the plant-derived biomass could serve the dual role of renewable energy production and waste reduction. In this study, various pre-treatment
methods (chemical, biological and combination of both) are being conducted for effective hydrolysis of lignocellulosic materials. In addition to this microbial community analysis will be conducted, to understand whether the hydrogen producers are dominating or non hydrogen producers are dominating. Further, optimization of bioreactor processes will certainly boost our endeavor in development of a biological route for hydrogen production in efficient, effective and ecofriendly manner.

**Major Publications**

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Research Areas  
Synthetic Organic Chemistry, Functional Organic Materials, Molecular Self-assembly, Low Molecular Weight Gelators

OBJECTIVES

• To design and synthesize amphiphilic molecules derived from renewable resources
• To investigate the self-assembly behaviour and stimuli-responsiveness of amphiphiles
• To identify the applications as drug carrier

RESEARCH HIGHLIGHTS

Synthesis of Sugar-based Stimuli-responsive Materials and their Applications

Interest towards the synthesis of multivalent glycoconjugates with rigid aromatic- and heteroaromatic-moiety has increased substantially as they impart the electronic properties, water solubility and hydrophobicity needed for the biological investigations. Moreover, the presence of a large number of functional groups in the periphery of the macromolecules favours the conjugation with biologically active molecules. Therefore, they can be potentially used in the field of medicine, molecular recognition, catalysis, sensing and light harvesting. Our group aims to design, synthesize and self-assemble the sugar-based gelator and utilize their stimuli-responsive behavior for diverse applications.
Major Publications


OBJECTIVES

• Supercritical fluid extraction of selected plants and investigation of their biomedical role in the treatment of cancer
• Development of plant secondary metabolite mediated nanoparticles and investigation of their biological activities

RESEARCH HIGHLIGHTS

Supercritical Fluid Extraction of Select Plants

The supercritical fluid state occurs when a fluid is above its critical temperature and critical pressure. This supercritical state allows CO$_2$ to take on the properties of a gas (high diffusivity, low surface tension), as well maintaining the solvent power of the liquid when it is between the typical gas and liquid states. Manipulating the temperature and pressure of CO$_2$ alters the solvent power and results in maximum yield of extract. Selected plants are being subjected to supercritical fluid extraction technology in our lab to obtain desired secondary metabolites which are being analysed/characterized using sophisticated instruments. Evaluation of their anticancer activity will be carried out using in vitro models and elucidation of mechanism of action using in vivo experiments through protein expression studies.

Major Publications


OBJECTIVES

- To identify the influence of xenobiotic and DNA repair gene polymorphisms on sporadic breast cancer development and progression
- To evaluate how interactions between xenobiotic and DNA repair gene polymorphisms promote sporadic breast cancer onset

RESEARCH HIGHLIGHTS

Influence of genetic polymorphisms in sporadic breast cancer predisposition

Our lab primarily focuses on the role of genetic polymorphisms that cause inter-individual variation in the human population. Hence, we ventured to analyze the role of genetic variations in key cancer susceptibility genes that may alter the susceptibility to sporadic breast cancer development in the Indian population. Analysis of 200 BC cases & 200 controls using MDR analysis of DNA repair genes revealed that individuals with mutant RAD51 genotype and wild type XRCC3 & XRCC1 have increased risk of BC development compared to control group. Our work also focuses on correlating such genetic changes with pathology and clinical presentation of breast cancer.
Platinum-based chemotherapy drugs remain the mainstay for solid tumours, but some individuals exhibit high toxicity to platinum-based chemotherapy. Hence, we are analyzing certain candidate genes’ genetic variations, which may pave way to inter-individual differences in the response rate of platinum drugs in metastatic breast cancer & ovarian cancer.

**Major Publications**

OBJECTIVES

• Develop computational models and experimental techniques to understand key flow features in multiphase contactors
• Use and promote free and open source mathematical tools and simulations software

RESEARCH HIGHLIGHTS

SASTRA FOSSEE CENTRE, A partner with FOSSEE, IIT-B

The SASTRA FOSSEE Centre promotes the use of free & open source tools such as Scilab, DWSIM, OpenModelica for education and also for research. Textbook companion projects, Process flowsheets are taken up under this initiative.

Process Simulation of Carbon Dioxide Liquefaction Plant

The process flowsheet for carbon dioxide liquefaction plant is developed using free and open source tool ‘DWSIM’. The objective of the project is to use simulation tool to understand key performance characteristics of process units employed in liquefaction plant and arrive at better operating window.

Major Publications

OBJECTIVES
- Studies focusing on Marine Microbial ecology
- Development of Anti-infectives from Marine biowaste and marine natural resources
- Cultivation and bioprospecting Rare Marine Actinobacteria

RESEARCH HIGHLIGHTS
Biofilm Disrupting Marine Microbial Enzymes
Biofilms are structurally complex microconsortia of surface adhering cells embedded within an extracellular matrix (ECM) composed of substances derived from cell lysis or produced and secreted by cells. Extracellular DNA (eDNA) is a matrix component of most biofilms. Bacteria require eDNA to maintain the structural integrity of aggregates and biofilms. The protective properties of the extracellular matrix are thought to be caused by the diminished transport of antibiotics through the matrix due to interaction with exopolysaccharides and proteins. The multifaceted role of eDNA makes it an attractive target for sensitizing biofilms to conventional antimicrobial treatment or for development of new strategies to combat biofilms. The therapeutic potential of biofilm dispersing enzymes particularly DNase has attracted considerable attention. Our research group explores marine bacterial DNAase for biofilm degradation and its synergistic effects with plant natural products like Essential Oils (EO).

Confocal Microscopy reveals the architecture of Pseudomonas aeruginosa matured biofilm dispersal by marine bacterial DNAase.
(A) Control;
(B) EO treated;
(C) DNaseI treated;
(D) MBD treated;
(E) EO + DNaseI;
(F) EO + MBD.
Bioprospecting Marine Biowaste for anti-infectives

Urinary tract infections (UTIs) are one of the most common infections which affect persons of all age groups. The use of indwelling medical devices like catheters is the prime cause of UTIs which is often called as Catheter Associated Urinary Tract Infection (CAUTI). Pathogens that colonize on the indwelling catheters form a thick assemblage of cells enclosed in an extracellular polymeric substance called as biofilms mediated by quorum sensing (QS). Owing to the emergence of drug resistant pathogenic biofilms, there is a need for novel antimicrobial agents to combat device-mediated biofilm infections. Our research group has shown that chitosan isolated from the crab shell (discarded as a waste) of an unexplored native crab species from the Gulf of Mannar inhibited biofilm formation and QS-mediated virulent traits of several drug resistant UTI-causing pathogens. Our group is further exploring the possibility of developing chitosan coated catheters in view of producing a biomaterial from marine biowaste.

Inhibition of slime production by Extracted Chitosan (EC) and Commercial Chitosan (CC) against Methicillin Resistant *Staphylococcus aureus* (MRSA)
Major Publications


OBJECTIVES
To measure the markers of endothelial dysfunction, angiogenesis and vascular permeability in umbilical cord, plasma and cord blood of normal and GDM mothers and to correlate the markers of endothelial dysfunction, angiogenesis and vascular permeability to GDM

RESEARCH HIGHLIGHTS
Impact of Gestational Diabetes Mellitus (GDM) on feto-placental vascular function
For this study, plasma samples were collected from normal glucose tolerant and GDM pregnancies Kovai Medical Center & Hospital, Coimbatore, India (Normal subjects = 50 & GDM subjects = 50).

Patient with a history of chronic illness including chronic kidney, liver or heart disease. Pregnancy complications such as hypertension, preeclampsia, pre-pregnancy diabetes, smoking were excluded while subjects were recruited according to IADPSG criteria. The study aimed at investigating the different angiogenic markers, namely VEGF and its isoforms, VEGF receptors and the mechanism behind in-utero perturbation in umbilical vein, plasma and cord blood of normal and GDM mothers. The study also tries to address the mechanism of vascular dysfunction in primary HUVEC isolated from both normal and GDM umbilical cords.

The study helps to unravel the mechanisms behind the feto-placental vascular dysfunction and thus aid in the development of novel therapeutic and management strategies for maternal and child health well being.
OBJECTIVES

- To investigate the role of nutrients in the regulation of lifespan in fruit flies *Drosophila melanogaster*
- To study the relationship between diets and life-history traits daily activity of flies

RESEARCH HIGHLIGHTS

Understanding the mechanisms of diet-driven lifespan extension and cost of reproduction in fruit flies *Drosophila melanogaster*

Diet Restrictions are nutritional approaches reduction of 1 or more components of diet is carried without causing malnutrition. To understand the effects of nutritional components especially protein manipulations (a type of Diet Restriction) on life-history traits and daily activity in fruit flies *Drosophila melanogaster*, a series of diets with varying yeast content was imposed on the pre-adult and adult stage of fruit flies. Results from our study suggests that Diet restriction (DR) mediated lifespan extension can be achieved in flies by subjecting diet with nutrients lower than that in ad-libitum (AL-Control) food by reducing the protein (yeast) concentration alone (Fig. 1). Imposing DR to fruit flies at two different life stages (i) Pre-adult stage (Assay 1) and (ii) 8 days of adult flies (Assay 2) showed lifespan extension, while the extent of lifespan extension in pre-adult stage (Assay 1) is higher than that in adult stage (Assay 2; Fig. 1). Further, the activity levels of flies increased under imposed DR as compared with that of control AL food (Fig. 2).
Studying the relationship between nutrient levels, reproduction and lifespan in fruit flies *Drosophila melanogaster*

In order to understand the relationship between nutrition (especially protein restriction) and life-history traits in fruit flies *Drosophila melanogaster*, different diets with varying protein level was fed to study its effect on the pre-adult and adult stage of fruit flies. Our results suggest that pupation time, pigmentation time, the overall development time and pupation height of fruit flies *D. melanogaster* are influenced by the food quality (protein content/diet restriction), thereby suggesting that protein restriction might also have role to regulate the flies development time and pupation height. The flies developed with 30% and 50% of protein content in the media have the shorter development time as compared with that under AL in both males and females (Fig. 1).

![Graphs showing pupation time and pigmentation time](image)

**Major Publications**

OBJECTIVES

- Developing nanocatalysts for water splitting and environmental applications
- Smart fluorescent materials for data hiding/storage and sensor applications

RESEARCH HIGHLIGHTS

Stimuli Responsive Smart Fluorescent Materials

Optoelectronic propeller shaped triphenylamine has been utilized as core to generate solid state fluorescent materials and external stimuli responsive smart systems. Self-erasable/rewritable fluorescent platform has been achieved by attaching halochromic isoquinoline unit and temperature controlled fluorescence tuning by attaching meldrum’s acid acceptor.

Nanomaterials based electrocatalysts for water splitting process and environmental remediation

The ever increasing global energy demands, environmental concern and fast depletion of fossil fuels have triggered intense search for clean and renewable energy alternative source to fossil fuels. Highest mass energy density and clean combustion with air makes hydrogen as one of the most acceptable future clean fuels. Electrochemical water splitting is an important technique for hydrogen production. In our lab, we are focusing on earth abundant cost effective metal-oxide nanostructured material-based electrocatalysts for efficient water splitting (oxygen evolution reaction (OER) and hydrogen evolution reaction (HER) and environmental cleaning. Recently, we have reported enhanced bifunctional electrocatalytic activity using carbon encapsulated hybrid Cu-Cu$_2$O nanoparticles.
Major Publications


**RESEARCH HIGHLIGHTS**

**Production of microbial exopolysaccharides Xanthan and Curdlan through bioconversion of agricultural and forestry wastes**

Cassava bagasse (CB) is a solid waste generated from cassava starch industry. Owing to rich organic content and low ash content, CB has potential to serve as an excellent low cost alternate substrate for several microbial processes. Various value added products like organic acids, flavor compounds and aroma compounds can be produced through bioconversion of CB. Limited works on bioconversion of CB to n-butanol and xanthan gum have also been reported in the literature. In this work we have demonstrated use of cassava bagasse as a substrate for the production of commercially important microbial exopolysaccharides namely xanthan, curdlan and pullulan. Xanthan gum is an extracellular heteropolysaccharide. It is the second microbial polysaccharide to be commercialized next only to dextran. Xanthan has wide variety of applications in agriculture, petroleum production, toiletries, cosmetics, water-based paints and the food industry as a stabilizing, emulsifying, thickening and suspending agent. Curdlan is another commercially important microbial exopolysaccharide. Commercial xanthan and curdlan are relatively expensive as glucose or sucrose is used as sole carbon source for the production. Use of solid waste from agro industry can bring down the cost of production considerably and thereby can possibly improve the economy of the process. Other agricultural wastes like corncob, Asian palm kernel, jackfruit seed are also used as alternate substrates. Since, the composition of each waste is typically different from each other we recover sugar from these waste using suitable pre-treatment process prior to bioconversion. Products are obtained by subsequent fermentation of the sugars.
Solar active Ag/TiO$_2$ and Ag/ZnO nano-composites for environmental applications

Semiconductor photocatalysis is recently gaining importance in wastewater treatment applications as they are efficient in complete demineralization of organic contaminants. In photocatalysis, photo irradiation causes excitation of electrons from valance band to the conduction band. This results in the formation of electron-hole pairs which are responsible for degradation of the organic contaminants. In particular, TiO$_2$ and ZnO had been widely used in wastewater treatment because of their inert nature, stability and resistance to photo-corrosion. However, the major weakness of these semiconductor catalysts as a photocatalyst is that they require UV light source and they absorb only a small fraction of solar light. Several attempts had been made by scientists to make solar light responsive catalysts in the recent past. Surface modification of semiconductors, band gap modification by metal/non-metal doping, band gap modification by creation of oxygen vacancies in semiconductor had been found useful in developing visible light responsive catalysts. Plasmonic photocatalysis is a very recent development in this direction and it was first reported in the year 2008. Dispersion of noble metals like Ag or Au enhances the photo-reactivity of semiconductors through plasmonic photocatalysis. Significant characteristics of plasmonic photocatalysis are localized surface plasma resonance (SPR) and Schottky barrier. Noble metal nanoparticles deposited on semiconductor photocatalysts make the catalyst responsive to visible light through plasmonic resonance and increase probability of electron – hole pair formation. This also results in localised heating leading to increase in the rates of redox reaction and mass transfer. Meanwhile, Schottky junction forces the electrons and holes to move in different directions and suppresses the electron – hole recombination. Thus, incorporation of metal ions helps to overcome both the bottlenecks mentioned earlier and hence makes semi-conductor photocatalysts suitable for large-scale wastewater treatment. We are developing silver/TiO$_2$ and silver/ZnO composites using enzymes and biotemplates to decontaminate industrial and domestic effluents using solar light.

Biodiesel production from vegetable oils

To meet the ever growing energy needs of the human community, it is essential to switch over from fossil fuels to alternate renewable fuels. Utilizing renewable feedstock for the production of alternate fuels is, however, a challenging task. Alternate fuel must also be environmental friendly, cheap, technically acceptable and abundant. Mission Innovation countries have identified that second generation biodiesel is one of the important alternatives available to combat the energy requirements. Biodiesel, eco-friendly alternative liquid fuel, are fatty acid alkyl esters produced by chemical or lipase catalyzed transesterification of fats or oils. It has both economic and environmental benefits in addition to its renewable origin. Feedstocks such as animal fats and vegetable oils play a vital role in biodiesel production. In our lab we work on biodiesel obtained from various non-edible vegetable oils. Various technological options available for the conversion of $C.\ inophyllum$ oil into biodiesel, their
strengths and weaknesses are studied with an objective to develop a sustainable, cost effective and energy efficient fuels which can be blended with petroleum fuels and used in existing engines without modification. These fuels also helps to reduce green house emissions.

**Major Publications**


2. Arumugam A, Jegadeesan GB, Ponnusami V, Comparative studies on catalytic properties of immobilized lipase on low-cost support matrix for transesterification of pinnai oil. Biomass conversion and biorefinery, 2018; 8:69 – 77. (IF: 1.3)


OBJECTIVE
To develop new designs, materials and processes for intensification of heat and mass transport. Short-term objectives involve development of (i) nanoparticle enhanced solar salt-based latent heat thermal energy storage; (ii) hybrid nanofluids for solar energy collection and (iii) microfluidic systems for lab-on-a-chip and bioprocess optimization

RESEARCH HIGHLIGHTS
Heat Transfer Intensification in Latent Heat Thermal Energy Storage System
Latent heat thermal energy storage systems aid in bridging the gap in energy demand and supply during off-shine hours compactly. Solar salt, a eutectic mixture of sodium nitrate and potassium nitrate, can serve as constant temperature heat source for steam generation and for process heating. The lower thermal conductivity of solar salt can be overcome by incorporation of low-density nanomaterials such as magnesium oxide, graphene, carbon nanotubes, etc. These nanomaterials are being explored as additives at lower concentrations (< 2 wt. %) to achieve enhancement in thermal conductivity and specific heat, without comprising on the latent heat. Identification of appropriate method for incorporation of nanomaterials remains a challenge and a number of tools including high energy milling and ultrasonication are being utilized to formulate a shape stable nanoparticle-solar salt composite.
Hybrid Nanofluids for Solar Collectors
The performance of a liquid as a heat transfer fluid (HTF) depends on its thermo-physical properties viz. thermal conductivity, specific heat and viscosity. Thermal conductivity and specific heat of a heat transfer fluid can be simultaneously increased through dispersion of two nanomaterials with different characteristics, leading to hybrid nanofluids. The properties of hybrid nanofluids can be tailored through appropriate choice of nanomaterial with high thermal conductivity and chemical stability (metal oxide nanoparticles), phase change nanomaterial (organic) and their respective concentrations. Four different hybrid nanofluid formulations with propylene glycol-water mixture as base fluid have been developed. About 25% enhancement in heat transfer coefficient has been achieved with the hybrid nanofluid containing MgO nanoparticles and Mg-lined paraffin wax in natural convection (HNF1). Similarly, 15% enhancement was achieved with the use of hybrid nanofluid containing ZnO nanoparticles and nanoencapsulated paraffin wax (ZnO-PW-PG-W Hybrid nanofluid). These hybrid nanofluids may be used as heat transfer fluid in two-fluid loop solar thermal collector and work on evaluation of performance of hybrid nanofluids in commercial scale solar collectors is underway.
Major Publications
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Research Areas  
Dendrimer Chemistry and Organic synthesis

OBJECTIVES

• Synthesize novel dendrimers for efficient gene and drug delivery  
• Synthesize biologically important heterocyclic compounds  
• Develop new synthetic methodologies for organic transformations

RESEARCH HIGHLIGHTS

Amphiphilic Dendrimer based Multifunctional Nano-assemblies as si-RNA Delivery Systems for Cancer Therapy

Synthesis of biocompatible amphiphilic dendrimers that can self-assemble to form a nano-assembly with the capacity to simultaneously encapsulate negatively charged siRNA and hydrophobic small molecule (drug) to form a two in one complex, which can provide co-delivery of the combination of drug and siRNA for the inhibition of oncogene expression. The project also involves characterization and investigation of the efficacy of dendrimers in vitro in breast cancer cell lines for treatment of breast cancer.

Major Publications

**Objectives**

- Understanding the protein conformational changes due to the presence of glycosylation through in silico studies
- *De novo* design of therapeutic drugs for specific biomarkers

**Research Highlights**

**Role of N-glycan in the conformational changes of myelin oligodendrocyte glycoprotein**

Myelin oligodendrocyte glycoprotein (MOG) present in the outer layer of the myelin sheath plays a crucial role in the autoimmune disease. MOG acts as an auto-antigen and triggers T-cell as well as B-cell responses. Our research work aims to: 1. to understand the effect of glycosylation in the conformational dynamics of MOG both in a) free and b) complex with antibody, identify the MOG residues that plays an important role in the T-cell responses from mutation study and to design glycopeptide to target biomarker MOG instead of targeting auto-antibodies.

MD simulation studies were carried out for MOG both in the presence and absence of N-glycan (GlcNAc) in an explicit water environment using AMBER17 program. The main results inferred from the study were: 1) The flexibility of the protein decreases in the presence of glycan with the formation of additional secondary structural regions; 2) Glycosylation decreases the hydrogen bond interaction between protein and water molecules and 3) Glycan reduces the number of water molecules in the vicinity of the protein.

**Major Publications**

OBJECTIVES

• To evaluate biochemically the anticancer efficacy of medicinal plants.
• To identify probable anticancer molecules present in medicinal plants to develop a novel anticancer herbal drug.

RESEARCH HIGHLIGHTS

The researcher focuses on the anticancer activity of medicinal plants. Our group uses the techniques of GCMS, LCMS and other biochemical approaches to determine the anticancer property of medicinal plants. We decipher the possible mechanism of action of the active fractions of the medicinal plants through in vitro and in silico approaches. The research work involves pharmacognosy and identification of active principles. We have recently identified the presence of biochanin A-O-rhamnoside, eleutherol and cinnamic acid-o-hexoside, tricin, 4-ohxy-2,3,4,6-tetramethoxychalcone, pinocembrin and acacetin from the selected medicinal plants for the first time which were found to be effective against cancer. The long term goals of our work is to isolate, modified to determine their anticancer property for developing a novel anticancer herbal drug.

Major Publications

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Research Areas  
Bacterial efflux pump inhibition, Use of Bacteriophages to tackle MDR bacteria, Microbial mediated remediation

OBJECTIVES

- To screen and evaluate efflux pump inhibitors against ESKAPE pathogens *in vivo*
- Re-sensitize multi drug resistant (MDR) bacteria to antimicrobial agents
- Evaluate bacteriophages to curtail MDR bacterial pathogens

RESEARCH HIGHLIGHTS

Resensitizing MRSA using Efflux Pump Inhibitors

Methicillin Resistant *Staphylococcus aureus* is declared as a high priority multi drug resistant pathogen by WHO. Infection burden of MRSA in India across 15 tertiary care centres shows that MRSA is highly prevalent (41%) and 79% of MRSA strains are resistant to fluoroquinolones. The objective of current study is to employ modified norfloxacin salts of carboxylic acids, which were shown by us to be highly potent as an antibacterial and antibiofilm agent against ESKAPE pathogens including MRSA (Lowrence *et al.*, 2018; *J. Appl. Microbiol.* 2018, 124: 408-422) in conjunction with potent efflux pump inhibitors identified by our group viz., dithiazole thiones (Lowrence *et al.*, 2016), benzochromenes (Ganesan *et al.*, 2016) and Metal NPs (Lowrence *et al.*, 2015) to resensitize MDR MRSA to fluoroquinolones and thereby curtail MRSA infection *in vitro* and *in vivo* in a zebrafish infection model.

Bacteriophages from water bodies to tackle MDR pathogens *in vitro* and *in vivo*

Due to indiscriminate antibiotic use, its prevalence in environment and evolutionary selection pressures, bacteria has gained resistance to array of antibiotics by various mechanisms such as target mutation, drug degradation, drug modification, drug sequestration, restricting drug influx, drug efflux etc., and many MDR pathogens have multiple modes leading to resistance, which are at times difficult to mitigate using one compound as an adjuvant with antibiotics. Importantly, bacteriophages (viruses that target bacteria) are unaffected by drug resistant status of pathogens and hence phage cocktails can be employed against MDR pathogens. Thus the objective of this project is to isolate, purify, characterize and employ well characterized phage cocktails to curtail both planktonic and biofilm mode of growth of MDR bacteria both *in vitro* and *in vivo* in a zebrafish infection model.

Plaque morphology of *Klebsiella pneumoniae* Specific phages from Water bodies. Fluorescent imaging of biofilms treated with *Klebsiella* spp specific phages show that phage treatment causes a significant proportion of dead cells.

Infection of zebrafish with bacteria specific monophages cause a discernible decline in CFU relative to untreated fish.
Major Publications


**OBJECTIVES**
- To develop novel silicate based remote type phosphor for finger print and warm white light applications
- To design POSS based organic-inorganic hybrid fluorescent nanomaterials for dual drug delivery and theranostic applications
- To develop new class of upconverting nanomaterials for photodynamic therapy

**RESEARCH HIGHLIGHTS**

**Remote phosphor for warm white light emission applications**
Phosphor converted white light emitting diodes (pcWLEDs) are far-superior devices due to their promising features namely the low energy consumption in association with high efficacy and durability. But, the major challenges in forefront for the design of efficient pcWLEDs are the production of white light with low CCT (< 4000 K) and high CRI (>80) along with high luminous efficiency, high thermal stability and high quantum efficiency. The conventional phosphors that have been used so far in the pcWLED are inefficient in producing bright white light due to the absence of sufficient red spectral components. So, it results in a white light with high CCT and low CRI. The higher efficiency of pcWLEDs can be attained only by using the remote-type phosphor instead of powder type that utilizes the binding agent that gets affected due to long term thermal effect. Hence we focus on developing an efficient remote-type phosphor that illuminates smarter.
Major Publications
OBJECTIVES

• To study the biologically important drug molecules by X-ray crystallography
• To investigate the drug target enzyme/protein by X-ray and structural bioinformatics study

RESEARCH HIGHLIGHTS

X-ray crystal structure elucidation & characterization of Wolbachia surface protein (Wsp) from humanfilarial parasite Brugia malayi - a potential antifilarial drug target

Lymphatic filariasis caused by the nematode parasites, *Brugia malayi* and *Wuchereria bancroftii* is an important public health problem in India. Globally around 50 million people are estimated to be infected with filarial parasites. Current approach to control filariasis relies mainly on chemotherapy with prolonged treatment procedure. Existing drugs are effective only against microfilarial worms and not for adults. Thus other alternative effective drugs that reduce the treatment time and could control all the stages of parasites need to be developed. Filarial nematodes harbour intracellular bacterium, *Wolbachia* found in all developmental stages of the parasites. *Wolbachia* and filarial nematodes exhibit a mutualistic relationship of endosymbiosis activity and exchange their requirements through it (important for parasite survival). Interruption of this relationship will be a main goal to eradicate the filarial disease. Depletion of this bacteria or stoppage of the nutrients (FAD, Riboflavin, heme, etc) supply will be the powerful method for parasite nematode eradication. According to few studies, wolbachia surface protein (Wsp) is a channel type β-barrel transmembrane protein located in the bacterial cell wall surface and helps porin activity. Our goal is to find a new drug, which will block the channel of Wsp, so that porin activity might be curtailed. Due to the nutrient deficiency, parasites will die and newly designed drug is expected to have eradication activity of filarial worms. Given the importance of the *Wolbachia* in the filarial disease progression, our group has chosen Wsp from *B. malayi* as a potential drug target to design the antifilarial drugs. Our study includes cloning, expression, purification of target enzyme/protein that causes diseases and their structural studies by X-ray crystallographic method & structural bioinformatics tool analysis.
In addition, our group is focusing on the chemical crystallography to understand molecular characters.

**Major Publications**


OBJECTIVES
To examine the effect of natural products in experimental models of colon cancer by targeting cell proliferation, apoptosis and angiogenesis by evaluating the respective biomarkers

RESEARCH HIGHLIGHTS
NF-κB and Nrf2/Keap1-ARE signaling pathways as target for colon cancer chemoprevention by the plant phenolic compounds
This study aimed to develop potent pharmacological agents from natural sources targeting multiple pathways to prevent colon carcinogenesis. To achieve this objective two phytochemicals namely morin and esculetin were chosen. The colon cancer chemopreventive potential of these phytochemicals was evaluated by assessing histological and molecular biomarkers associated with colon carcinogenesis. Of the two phytochemicals tested morin was found to be the better tumor suppressing agent over esculetin as it showed a significant effect on all the biomarkers tested in the study. Further, the results obtained from the combined treatment of morin and esculetin were comparable to morin treatment alone and thus the combined phytochemical treatment failed to exert synergistic effects. Investigations to explore the effect of morin on NF-κB signaling in DMH induced carcinogenic events such as inflammation and apoptosis were analysed. Our findings revealed that molecular chemoprevention of morin operates by targeting NF-κB and morin also acts as a potent anti-inflammatory and pro-apoptotic agent for colon cancer prevention.

Fig.1. Gross observation of colon in experimental rats: Colon tumor burden in control and experimental groups. DMH alone administered rats showed the multiple adjacent tumors that are bigger in size (arrow) than the tumors that developed in the presence of phytochemicals morin and/or esculetin.
Impact of p-coumaric acid on GRP78 in colon cancer

This study hypothesis that Chemoprevention of colon cancer can be effectively achieved through oral administration of p-coumaric acid (p-CA) by modulating GRP78, a protein that greatly influences tumor microenvironment and major cancer hallmarks. GRP78 induction and UPR activation plays a key role in oncogenic progression. Therefore increased dependence of cancer cells on these UPR signalling pathways for survival can be exploited for anticancer research. Supplementation of p-CA to carcinogen administered rats reduced tumor burden, downregulated GRP78 and activated UPR mediated apoptosis both in in vitro and in vivo models of colon cancer. Further mechanistic studies revealed that p-CA inhibits GRP78 upregulation in cancer cells through PERK-eIF2α-CHOP pathway that culminates in apoptosis inducing effect of p-CA.
Fig 3. A) Silver staining of AgNOR (40x): The colonic tissue of DMH alone treated rats showed increased number of silver positive dots as compared to control rats. Colon of p-CA supplemented DMH administered rats showed reduced AgNOR dots. B) Immunostaining of PCNA (40x). The colonic tissue of DMH alone treated rats showed intense nuclear expression of PCNA as compared to control rats.

Fig 4. Downregulation of Grp78 and activation of UPR signaling pathway. Immunoblotting of proteins: (Lane 1: Control, Lane 2: p-CA, Lane 3: DMH + p-CA, Lane 4: DMH).

Major Publications


OBJECTIVES

- Development of oral long acting immunoprotective anti-leishmanial drug
- Synergic effect of drugs and immunomodulators to treat Visceral Leishmaniasis
- Identify macrophage polarizing bio-molecules to treat infectious disease and cancer

RESEARCH HIGHLIGHTS

Synergic potential of immunomodulators and drugs to treat visceral leishmaniasis
Combination therapy for the treatment of visceral leishmaniasis has been increasingly advocated as a way to increase treatment efficacy and tolerance. It has some other advantages unlike the conventional monotherapy, e.g., lowering the toxic effects, cost, and limit the emergence of drug resistance. The conventional drugs may exert its effect more efficiently in synergism with immunomodulator as expected to enhance host immune responses and parasite clearance. In this project, we have tested immunomodulator to improve the efficacy and therapeutic index of Miltefosine and Amphotericin B during treatment of VL in mouse (BALB/c) and human macrophages models.

Development of novel, long-acting, oral anti-leishmanial drugs
Visceral leishmaniasis (VL) is one of the neglected tropical infectious diseases caused by an intracellular parasite, Leishmania donovani. VL is fatal if left untreated. Since no vaccination is available, VL has been treated only. But the drugs of current therapies like pentavalent antimonials, pentamidine, amphotericin-B, miltefosine and so forth endure with low therapeutic index, severe side effects, acute cytotoxicity, high cost and emergence of their resistance strains. Hence, there is an urgent need for new treatments regimens against VL. In this project, a library of FNDR compounds will be evaluated for their antileishmanial activity, cytotoxicity to host cells and therapeutic index in vitro and in vivo model of VL. The best lead compounds will be tested for oral efficacy, bioavailability and PK study. Finally, mechanistic insights of the lead molecules will be explored, which will definitely help to incorporate the same in mainstream medicine in near future.
Effect of biomolecules on macrophage repolarisation in the treatment of Visceral Leishmaniasis

*L. donovani* affects the functioning of host immune system and increases the risk of concomitant infections. Mainly, infected macrophages transform into M2 polarization and cause severe immune suppression, through induction of Th2 polarization and IL-10 surge. While M1 repolarization from M2 state can hand round anti-leishmanial immune response through IL-12 and IFN-γ followed by iNOSII activation. Considering the therapeutic and commercial importance of proteinaceous biomolecules, the present investigation is aimed to investigate its role in the treatment of visceral leishmaniasis through activation of M2 to M1 repolarization of macrophages in BALB/c mice model.
Patent
Compositions of Eugenol Derivatives for treatment of Visceral Leishmaniasis. (Provisional Application: 201741028011).

Major Publications
RESEARCH HIGHLIGHTS

**Structural Studies on ALS Associated Mutants of Cu/Zn Superoxide Dismutase**

Misfolding and aggregation of Cu-Zn superoxide dismutase (SOD1) is the common pathogenic event for familial amyotrophic lateral sclerosis (ALS). We found that the wtSOD1 is structurally stable due to the correct coordination of Cu and Zn ions and the formation of an intramolecular disulphide bond. The origin of cytotoxic pathway and the toxicity mechanism are unclear due to the intricate folding and aggregation properties of SOD1. This project aims to study the molecular basis of SOD1 neurotoxicity caused by the mutations located far from the metal sites and dimer interface. We have analysed the structural stability and dynamics of SOD1 mutants, using biophysical and computational methods. The results obtained in this study provide valuable insights into the stability and folding of the ALS mutants. Interestingly, thermodynamics and MD data on V14 and E100 mutants exhibit the collapse of metal sites by perturbing the orientation of catalytically essential Arg residue. Further, our results clearly show that the far positioned mutation can also trigger metal loss and sticky intermediate fold, and possibly cascades the protein misfolding that results in ALS.
Structural studies on the antioxidant enzymes of *W. bancrofti* towards the structure based drug design against Lymphatic filariasis.

Lymphatic filariasis (elephantiasis), is a neglected tropical disease, caused by parasitic nematodes which are transmitted into the host through mosquitoes. The recent report by the World Health Organisation (WHO) indicates that over 1.4 billion people are infected with this disease across 73 countries and India alone has 40% of the global disease burden. In this project, we aim to investigate the three-dimensional structures of the antioxidant enzymes of filarial parasites, *W. bancrofti*, which accounts for 98% of the cases in India. Further, the comparison of human and *W. bancrofti* enzyme structures will provide the significant unique binding sites to block the parasite enzymes function with therapeutic small molecules. As an outcome, the specific targeting of the filarial parasite enzymes is expected to result in complete elimination of lymphatic filariasis by killing both microfilariae and adult worms and provide better treatment.

Major Publications

OBJECTIVES

- Structure function correlation of proteins involved in diabetic complications
- Correlation of the interaction of Phytochemical / nutraceuticals with respect to the target proteins involved in diabetic complication

RESEARCH HIGHLIGHTS

Structural studies on Diabetic Markers

The main focus of our group is on understanding the structural aspects of Diabetic Markers through X-ray crystallography. We proposed that the conformational change from the R2 state to T state of glycated haemoglobin would create steric clashes which may suppress the oxygen transport activity of hemoglobin. We are also focusing on crystal structure of glycated hemoglobin, albumin and many other proteins involved in diabetic complications.

Biophysical studies on structure and function of glycated proteins

The effect of non-enzymatic glycation on protein structure has been a major research area, but the role of specific Advanced Glycation Endproducts (AGEs) in such structural alteration and induction of fibrillation remains undefined. One of the main focus of our lab is to study the effect of specific AGEs such as carboxymethyllysine (CML), carboxy ethyllysine (CEL), and arg-pyrimidine (Arg-P) which are the major AGEs found in diabetes patients blood, which affects the structure and hence the function of diabetic markers. The following figures shows the different biophysical characterizations techniques (such as CD, SEM, TEM, Confocal imaging, spectroscopic analyses and Molecular Dynamics) we use to study/understand the structure - function aspect of glycated proteins.

**Structural basis for complementary and alternative Medicine**

The long term research focus of our group is to find the mechanism behind the Siddha medicinal practice in our country. Towards this goal, docking studies were carried out to understand the druggability of the bioactive compounds from traditional herbal formulations "Nilavembu Kudineer" and "Swasthya Raksha Amruta Peya" to heal chikungunya virus (CHIKV) infection. The efficiency of the novel chemical entities from "Nilavembu Kudineer" and "Swasthya Raksha Amruta Peya" to inhibit CHIKV infection were evaluated in silico. The binding affinity and the binding mode of chemical entities taken from herbal formulations with non-structural protein 2 protease were understood and our study provided a novel strategy in the development and design of drugs for CHIKV infection. Our investigation revealed andrographoside, deoxyandrographoside, neoandrographolide, 14-deoxy-11-oxoandrographolide, butoxone and oleanolic acid can act as potential lead compounds against CHIKV infection and there is a secure potential to derive anti-CHIKV drug from the investigated plants in future.

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**Structural studies on oligomerization of amino acids and peptides in relevance to chemical evolution and origin of life**

Oligomerization of amino acid monomers is the vital step in the formation of functional proteins. In spite of continuous efforts towards solving the puzzle of origin of life, the mystery of chemical evolution remains unsolved. Salt induced peptide synthesis (SIPF) presents the most plausible pathway. The structure of the copper alanine complex obtained through SIPF was studied by small molecule x-ray crystallography. The self-assembling properties of complex as nanostructures were studied using FE-SEM. Results showed the occurrence of racemization of amino acids. This is the first structural study for copper alanine complex formed through prebiotic peptide synthesis pathway. The aggregational properties of intermediate complex showed the formation of rod like crystals and nanospheres. The findings from our study revealed the possible mechanism of prebiotic oligomerization of amino acids on the primitive earth towards formation of longer peptides and functional proteins.

Major Publications
OBJECTIVES

• To develop designer micellar medium to perform green organic transformations
• To explore nano-palladium catalysis for diverse C-C/C-N bond forming reactions
• To design tunable organocatalysts for green organic transformations

RESEARCH HIGHLIGHTS

Design and Development of Designer Surfactants for Palladium Catalysis
Surfactants with tunable properties were designed and synthesized. Their applications in palladium mediated C-C and C-N cross-coupling reactions are being investigated.

Metal-free Organocatalysis for Diverse Isotope Labelled spirocycles Synthesis
Isotope labelled spirocycles exhibit excellent biological activity. Metal-free protocols were developed to access diverse isotope labelled spirocyclic derivatives. The scope of the reaction was extended to relay catalysis.
## Major Publications


RESEARCH HIGHLIGHTS

Generation, Characterization and Pre-clinical Evaluation of anti snake venom

Snake envenoming is a common medical emergency encountered in the tropics especially in rural areas. Presently, equine and ovine-derived Anti-snake-venom ASV is the only effective and medically accepted remedy for systemic snake envenomation. However, the high cost of generating antibodies in horses due to care of animals, maintenance of facility, management of grazing area, animal bleeding and plasma separation and side effects like anaphylaxis and serum sickness are the bonafide problems associated with conventional ASV therapy. In addition, there are some critical issues like species specificity, potency, affordability, availability and storage conditions. There is a need for identifying novel strategies and cost-efficient methods for the production of ASV at affordable price. Hence the proposed study will employ an alternate cost effective technology for generating ASV. As there is a need for monovalent ASV for specific treatment regime, feasibility to use monovalent ASV-IgY would also be monitored in this study.
OBJECTIVES

• To identify and characterise phytochemicals from medicinal plants.
• To isolate and modify the identified phytochemicals to develop plant based anticancer drug.

RESEARCH HIGHLIGHTS

We focus on anticancer activity of medicinal plants. Our group uses the techniques of GC-MS, LC-MS and other biochemical approaches to identify, characterise the phytochemicals and determine the anticancer property of medicinal plants. We decipher the possible mechanism of action of the active fractions of the medicinal plants through in vitro and in silico approaches. The research work involves pharmacognosy and identification of active principles. We reported the presence of biochanin A-O- rhamnoside, eleutherol and cinnamic acid-o-hexoside, tricin, 4-ohxy-2,3,4,6-tetramethoxychalcone, pinocembrin and acacetin from the selected medicinal plants for the first time. The fractions containing these phytoconstituents were found to be effective against breast cancer cells. The long term goal of our work is to isolate and modify the identified compounds, to develop molecular target for cancer.

Major Publications


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Research Areas  
Biofilms, Social interactions, and Pathogenesis in bacterial systems

OBJECTIVES
• To decipher the principles involved in the assembly of microbial biofilm community  
• Design & experiment innovative ways to disassemble medical & industrial microbial biofilms  
• To exploit microbial biofilms for environmental applications

RESEARCH HIGHLIGHTS
Targeting the cell collectives of bacteria by different approaches
Self-organized collective behaviour and cooperation is a well-known phenomena in higher organisms, like the division of labor in insects, fish schools, bird flocks, etc. However, bacteria were conventionally thought of as individual cells always competing for growth with their own kin and other species. But, it is now known that they too survive as cooperate by forming biofilm and producing public goods. Most of the chronic infections are caused by bacteria in the biofilm lifestyle. In this project, we hypothesize that biofilm formation is a surface colonizing strategy by the bacterial species. Thus the competing species that produce anti-biofilm compound was isolated and to identify the compound that could be a potential anti-biofilm agent against uropathogenic E. coli.

Detection of biofilm contamination in fresh fruits and vegetables by eNose
The bacterial contaminants on fresh produces survive and persist in-spite of application of various sanitation methods as they live in biofilm lifestyle. Biofilm formation of the pathogenic bacteria on fruits and vegetables are tested traditionally after their isolation through the enrichment method, and in vitro tests for biofilm formation include microtitre
plate assays, confocal or electron microscopy and image analysis. These procedures are laborious and expensive. However, there is no rapid, simple, cheap and accurate method for in situ detection of bacterial biofilms till date. This was an inter-disciplinary project, wherein we envisaged that pathogenic biofilm contaminants on fresh fruits and vegetables could be detected by exploiting their VOC biomarkers through electronic Nose technology.

**Exploitation of microbial biofilms to treat nitrogen in the wastewater**

Biological removal of ammonia occurs naturally by nitrification-denitrification, but the process is very slow. Whereas, the wastewaters in the industrial set-up is enormously produced to the tune of 1000-2000 litres per hour. The nitrogen removal process has to be fast and efficient before the discharge of wastewater to the environment. Microbial biofilms are resilient to stress conditions, thus we plan to exploit the biofilms and design a continuous reactor, wherein the nitrogen sensors will be designed that monitors the concentration of these compounds. Sequential removal of ammonia by aerobic nitrification and an anoxic denitrification is the most widely used method. Consortia of nitrifiers and denitrifiers will be used in the biofilm community. The main goal of the project is the real time analysis and removal of nitrate and ammonium ions with denitrification process.

**Major Publications**


OBJECTIVES

• To develop an integrated bioprocess and downstream processing for the biosynthesis of value added microbial products namely exo-polysaccharides and enzymes from cost effective substrates

RESEARCH HIGHLIGHTS

Biosynthesis of microbial pullulan using low cost substrates

Pullulan is a linear, un-branched, exo-polysaccharide produced by Aureobasidium pullulans. Due to its non-toxic nature, non-immunogenicity, high decomposition temperature (250-280°C), bio-compatibility and bio-degradability, it can be used as a starch substitute in low calorific food formulation and as a packing material in pharma industry. It forms a transparent film and is impervious to oxygen transfer and can be used as a packing and coating material in food and pharmaceutical industries. It can also be used as a molecular weight standard in size exclusion chromatography and high performance liquid chromatography. We attempt to produce commercially important pullulan using agro solid waste residues in solid state fermentation and minimize the solid waste disposal problem. Investigations on bio-synthesis of exo-polysaccharide, pullulan, from low cost materials namely wheat bran, rice bran, coconut kernel, jack fruit seed, cassava bagasse and palm kernel by Aureobasidium pullulans was carried out in solid state fermentation. Owing to the higher yield of pullulan, Asian palm kernel and cassava bagasse were identified as potential and low cost carbon sources. After identifying suitable medium variables/parameters involved in the production of exo-polysaccharide, sequential statistical optimization was performed to enhance the pullulan yield using Asian palm kernel and cassava bagasse in solid state fermentation.

Biosynthesis of bacterial cellulose using low cost substrate

Bacterial cellulose is an exopolysaccharide which is synthesized by plants and some species of bacteria. Bacterial cellulose (BC) is preferred over plant cellulose due to difficulties in extracting the polymer from plants. Moreover, cellulose produced by bacteria exhibits high tensile strength, water holding capacity and higher degree of polymerization. BC has a wide range of applications in food, medicine, cosmetics and paper industries. The objective of the work is to enhance the production of bacterial cellulose using low cost substrates. The maximum yield of bacterial cellulose was obtained under shaking.
conditions at pH 5.5 (18.5 g/L) when the production media contained yeast extract as the nitrogen source. The optimum C/N ratio was found to be 40. The production of cellulose in shaking cultures was higher than that of static culturing conditions.

Major Publications
**OBJECTIVES**

- To create an extensive database of SWI / SNF subunits and analyse the structure and function of different SWI / SNF subunits by structural bioinformatics approaches
- To study the characteristics of SWI / SNF targeted nucleosomes in the promoters of regulated genes
- To analyse the role of cancer-associated mutations in different SWI/SNF subunits

**RESEARCH HIGHLIGHTS**

Presently, the lab is focusing on the computational studies of a well-known tumor suppressor called SWI/SNF (SWItch/Sucrose Non-Fermentable) remodeling complexes. In the Initial phase, we have created a publicly available SWI/SNF database for the scientific community (SWI/SNF Infobase), which includes the subunit information from BAF and PBAF subfamily of remodeling complexes from 20 organisms spanning a wide evolutionary range of eukaryotes (http://scbt.sastra.edu/swisnfdb/index.php). A detailed annotation on each subunit, including basic protein/gene information, protein sequence, functional domains, homologs and missense mutations of human proteins have been provided with a user-friendly graphical interface.

From the *in silico* Screening for cancer-associated mutations in the HSA domain of the BRG1 (The ATPase subunit of SWI/SNF), we could identify six mutations (R466H, R469W, Y489C, K502N, R513Q, and R521P) that possibly induce a destabilizing effect on the Actin-related protein (Arp) assembly on the ATPase subunit. Molecular dynamics simulation studies of the wt and mutant HSA-Arp complexes (a total of 350 ns) provide molecular details about the destabilizing effect of mutations in the HSA-Arp Complex. We have proposed a functional architecture...
for SNF5-SWI3dimer sub-complex of SWI/SNF based on the crystal structure of the RPT1 and SWIRM domain interface. Functional screening of 171 cancer-associated mutations and polymorphisms from COSMIC and dbSNP followed by binding free energy estimation of wt and mutant complexes identified two hotspot residue mutations, D202Y at the RPT1(BAF47)-Swirm(BAF155) and R487C at the RPT2(BAF47)-Swirm(BAF170) interface which can alter the interface interactions drastically. Based on this study, a possible functional mechanism for these two Adenocarcinoma associated mutations, D202Y and R487C which are at the hotspot sites in disrupting the functional assembly of SWI/SNF subunits BAF47, BAF155 and BAF170 has been proposed.

Major Publications
OBJECTIVES

- Development of new inorganic and organometallic compounds and materials
- Homogeneous and heterogeneous catalysts for various organic transformations
- Luminescent compounds/materials for LED fabrications

RESEARCH HIGHLIGHTS

Inorganic /Organic Hybrid Materials for Heterogeneous Catalysis

The hybridization of inorganic and organic moieties on molecular to mesoscopic scales is a powerful tool for developing novel functionalized materials. Periodic mesoporous organosilicas (PMOs), a new class of hybrid materials, containing silica and organic groups as integral part of their structures, are well utilized as solid support for various applications. PMOs are often chosen as catalyst support for their innumerable advantages like high surface area, large pore volume and precise tuning of pore size, which are beneficial to enhance the catalyst loadings and to improve the dispersibility of active species, resulting in high catalytic performance. Presence of hetero atoms in the PMOs facilitate the incorporation of metal nanoparticles through strong interactions and hence the metal nanoparticles can be deposited only into the mesopores without any uncontrollable external deposition. In our laboratory, we have developed 2-thiazoline derived PMOs and subsequently loaded with palladium nanoparticles (Pd-PMOs). The Pd-PMOs are utilized as an efficient and sustainable catalyst to perform various organic transformation reactions.
Major Publications
OBJECTIVES

- To develop 3D bioprinting strategies for functional regeneration of tissues
- To develop multifunctional nano materials for diagnosis and treatment of cancer

Research Highlights

Skin Tissue Engineering

Electrospun defect-free poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) fibres were developed to evaluate the regeneration of skin. These fibres were similar to the natural ECM and our results demonstrate that PHBV fibres exhibited higher porosity, increased ductility, and faster degradation rate when compared with PHBV 2-D films.

The wound healing capacity of the PHBV fibers in the presence and absence of an angiogenesis factor were evaluated in a rat model. The wound contracture in the growth factor loaded PHBV fibres was found to be significantly higher when compared with PHBV fibers alone after 7 days. Furthermore, the presence of fibers promoted an increase in collagen and aided re-epithelialization. Thus our results demonstrate that the topography and mechanical and chemical stimuli have a pronounced influence on the cell proliferation, gene expression, and wound healing.

Nerve Tissue Engineering

Functional regeneration of peripheral nerves in larger defects still remains a challenge, as it requires complex guidance cues to enable the Büngner band formation towards the distal end of denuded nerves. In this study, we have developed a scaffold to integrate
the biofunctional signals with the biomimetic structures by developing aligned poly(lactide-co-glycolide)-RADA16-I-BMPH1 nanofibers and evaluated its in vivo efficacy for four months in rat sciatic nerve transection 10 mm model. Histology and immunohistology studies revealed that PLGA-peptide scaffolds promoted native organization of collagen assembly along with remyelination when compared to PLGA nanofiber scaffolds. Our results have proved that self-assembling peptide nanostructures on aligned poly(lactide-co-glycolide) nanofibers provided better cell-matrix communication with significant functional restoration of sciatic nerves. Hence they can be employed as potential candidate for peripheral nerve regeneration as it incorporates both biofunctional signals and biomimetic structural topography.

Development of Myocardial Patch
In this work, we have developed bioactive dual growth factor-loaded nanofibrous patch, which mimics not only the native cardiac extracellular matrix but also provides biological signals for homing and neovascularization.

The bioactive functional assessment of growth factors loaded in the patch was successfully tested in vitro and no compromise in the functional activity of growth factors was observed due to scaffold fabrication procedure. Moreover, the regenerative potential of the growth
factor loaded nanofibrous myocardial patch was evaluated in an acute myocardial infarction rabbit model. The functional improvement in the left ventricle was assessed by electrocardiography and echocardiography. Improvement of ischemic heart treated with nanofibrous scaffolds was evidenced through histopathological analysis and immunohistochemistry. The immunostaining of blood vessel markers confirmed the regeneration of blood vasculature demonstrating the effective repair in animals treated with the growth factor loaded nanofibrous matrices.

**Multi-functional Nanoparticles for Theranostics**
Antibody capped iron oxide nanoparticles were developed as theranostic nanocarriers for multiple therapeutics and diagnostics modalities for pancreatic cancer. Subcutaneous tumour xenografts of MIAPaCa-2 in SCID mice were developed and the tumour regression study at the end of 30 days showed significant tumour regression in the animal treated with anti-body capped iron oxide nanoparticles along with magnetic hyperthermia compared to control group. In vivo MRI imaging also showed the enhanced contrast in this group compared to control. Thus these multifunctional nanoparticles demonstrated synergistic effect of chemo and thermotherapy against pancreatic cancer treatment.
Major Publications
OBJECTIVES

• Study of weak non-covalent interactions in medicinally important organic molecules
• Structural studies on mycobacterial proteins
• Structure based drug design against various targets of pathogenic microorganism using computational approaches

RESEARCH HIGHLIGHTS

The role of conventional strong hydrogen bonding interactions and their importance have been well understood in many systems ranging from small organic compounds to macromolecular proteins, protein-ligand complexes, nucleic acids and protein-DNA complexes. Several weak non-covalent interactions such as C–H···O, C–H···N, C–H···π, O–H···π and N–H···π are also well established in modern supramolecular chemistry. This structural information is being successfully utilized in the design of molecules with desired properties. In view of this, our lab mainly focuses on the three dimensional structure determinations of medicinally important organic molecules to understand the biological activities. We use variety of theoretical approaches along with single crystal X-ray crystallography to understand the nature of various weak non-covalent interactions present in the crystals. Our lab is also focussing on the structure determination of novel proteins from mycobacterial organisms to understand the structure-function relationship. We also use variety of computational approaches to identify novel lead molecules against various pathogenic protein targets.
Major Publications
OBJECTIVES

- Synthesis of AA & AB type monomers containing flexible groups, bulky group & kinks and Synthesis of processable thermally stable polymer
- Polymers are studied for possible application as high temperature electrical insulations materials

RESEARCH HIGHLIGHTS

Polyimides are one of the most useful classes of high performance polymers. However, their applications are limited due to processing difficulties, because of the rigidity and strong inter chain interaction. In recent years, in the area of polyimides synthesis, efforts have been focused on the design and synthesis of processable polymers with the purpose of increasing properties such as electrical insulation, adhesion, gas permeability etc. Research work has been directed to synthesize polymers with structural modification, which disturb the regularity and chain packing thus providing better processability. The prime objective of our research is to synthesize monomers containing flexible groups (-O-, -SO2-, and -C=O), isopropylidene groups, pendant groups and 1,3-substituted phenyl ring. The structurally modified monomers are polymerized into polyimides, poly(ether-imide)s, poly(ester-imide)s and poly(amide-imide)s. The polymers are characterized and studied for possible application as high temperature electrical insulations materials for system operating at high temperature like motor, generator and transformer.
Major Publications


OBJECTIVES

- To carry out transition metal-free oxidative transformations with N-heterocyclic Carbenes (NHCs) as organocatalyst
- To circumvent the drawbacks associated with metal catalysis by developing alternate metal-free oxidation strategies
- To develop novel synthetic methodologies employing “Green Chemistry” principles

RESEARCH HIGHLIGHTS

N-heterocyclic carbene catalysed Oxidative Transformations

N-heterocyclic carbenes (NHCs) are the most promising organocatalyst in organic chemistry as they are found to be stable under oxidative conditions and due to their nucleophilic nature and strong $\sigma$-donating and $\pi$-accepting reactivity. There were several reports on oxidative organocatalysis mediated by NHCs like oxidative esterification of aldehydes, oxidation of aldehydes to carboxylic acids, oxidation of alcohols, oxidative amidation of aldehydes etc. In this context, the use of NHC as an organocatalyst for oxidative transformations can be considered as a promising alternative strategy for existing methods that employ toxic, expensive metals and reagents. Our focus is on NHC-catalyzed oxidative transformations for developing new synthetic strategies via nucleophilic attack of NHC as the key step and few important schemes are presented below:

- Upto 83% yield
- Upto 78 % yield
- >98% ee


Synthesis of biologically significant pyridine fused heterocycles
Due to their biological importance, pyridine fused heterocycles have attracted the attention of synthetic chemist, leading to the development of several synthetic strategies. Our work aims to develop a new synthetic approach for the transition metal free construction of imidazo[1,2-a]pyridine (IP) and other pyridine fused heterocycles from commercially viable and readily available starting material through metal-free catalysis/NHC oraganocatalysis. The synthesized compounds will be evaluated for wound healing potential through in vivo experiments as the pyridine fused heterocycles have proven anti-inflammatory, analgesic, antibacterial and antifungal activities.

Pyridine fused heterocycles:
Major Publications
OBJECTIVES

- To engineer the geometry, chemistry and mechanical properties of materials at the nanoscale for therapy, regeneration and diagnosis using the principles of self-assembly and nanochemistry
- To decipher the molecular mechanisms underlying the therapeutic or toxic effects

RESEARCH HIGHLIGHTS

Development of a nano-theranostic tool for pancreatic cancer therapy

Pancreatic cancer is a fatal disease with poor survival rates. The high mortality associated with pancreatic cancer arises due to a combination of late diagnosis, multi-drug resistance, invasiveness of the cancer and the existence of a stromal barrier that restricts the access of the chemotherapeutic agent to the cancer cells. The present work investigates the potential of a multifunctional theranostic chitosan nanocarrier loaded with gemcitabine and a hybrid multimodal imaging moiety of gold capped iron oxide nanoparticles in a three-dimensional model of pancreatic cancer (cancer-in-a-dish). The 3D tumour spheroids grown over 10 days developed resistance to free gemcitabine but the multifunctional chitosan nanocarrier was effective in reducing the viability of the cancer cells when compared with free drug and drug loaded carrier both in the 3D models as well as in vivo due to its ability to suppress the anti-apoptotic proteins and activate pro-apoptotic proteins.

Development of a sensor array for diagnosing diabetic retinopathy

Diabetes is a common malady among the global population that gives rise to additional complications that severely compromise the quality of life and lifespan. This collaborative project with clinicians from India and UK aims to develop a cost-effective, accurate nano-interfaced electrochemical...
sensor array as a screening tool for detecting the unique markers for predicting diabetic retinopathy. The array will be screen printed on flexible substrates that can be interfaced with portable units to enable screening of large populations.

**Deciphering the molecular mechanisms of Brahmi Nei – a traditional Siddha formulation, against Alzheimer’s disease**

*Brahmi Nei*, a polyherbal Siddha formulation was investigated for its potential to treat Alzheimer’s disease using in vitro and in vivo models. The studies reveal that the formulation shows a positive effect on the working memory of the animals. The cognitive abilities of the diseased animals showed significant improvement over a 28-day period after treatment with *Brahmi Nei* as evidenced from behavioural, biochemical and histopathological results. Microarray analysis reveals that the formulation acts on the oxidative phosphorylation pathway as well as on several targets that have been implicated in Alzheimer’s disease.

**Development of a polyplex for nano-immuno-chemotherapy of lung cancer**

Polymers with a neutral backbone and cationic side chains are employed to complex anti-VEGF si-RNA for inhibiting the expression of VEGF-A, a key inducer of angiogenesis in lung cancer cells. The complexation is tailored to ensure that the subtle balance of angiogenic factors is restored to facilitate immunotherapy. The polymer surface modified with MUC-1 peptide sequence will be employed to activate the immune cells against the MUC-1 over-expressing lung carcinoma cells. The combination of anti-angiogenesis and immunotherapy can lead to superior therapeutic outcomes.
Development of a micro-needle patch for anti-arthritic therapy

Microneedles offer a pain-free localized delivery system that is being evaluated for its skin toxicity and therapeutic efficacy to deliver drugs using Dunkin-Hartley guinea pigs in our lab. Two different polymeric solid microneedles developed at CENSE, IISc, Bangalore were evaluated for their skin toxicity and both were found to be biocompatible. Microneedle patches for delivery of anti-arthritic agents at the arthritic joints may prove to be invaluable for the painless treatment of juvenile idiopathic arthritis – a pediatric disease, that is among the prevalent childhood diseases in India. This facet is currently being investigated in our lab.

Development of a pH-responsive polyketal-based hybrid system for treatment of acute myeloid leukemia

This work attempts to synthesize polyketal polymers and its copolymers for pH responsive delivery of a chemotherapeutic agent and an adenovirus-associated virus to leukemia cells. This hybrid system integrates the high gene delivery efficiency of the viral particles for delivery the HSV-Tk suicide gene and the pH responsive release of the chemotherapeutic agent cytarabine for combination therapy against leukemia. The pH responsiveness of the carrier enables endosomal escape while ensuring co-delivery in to the leukemic cells for better cytotoxicity.

Development of a dual drug eluting stent for cardiovascular complications

The present study aims for the first time to utilize the pleiotropic effects of atorvastatin and fenofibrate entrapped in a uniform and defect-free coating of poly(L-lactide-co-caprolactone) (PLCL) on a stainless steel stent to overcome stent-associated limitations. The stent coating parameters were optimized using ultrasonic spray coating technique to achieve a thin, smooth and defect-free dual drug-loaded polymer coating on the stent. Significant reduction of thrombus formation and adhesion of LPS-stimulated
macrophages on the dual drug containing polymer-coated stent indicates that the drug combination possesses anti-thrombotic and anti-inflammatory effects. The combination did not adversely influence endothelialization but significantly retarded smooth muscle cell proliferation indicating its potential to overcome restenosis. A rat subcutaneous model was used to evaluate the biocompatibility of the coated stent and compared with the commercial stent. MicroCT, SEM and morphometric analyses revealed that the coated stents exhibited excellent histocompatibility with no inflammatory response.

**Development of a dual stimuli-responsive scaffold for cardiovascular regeneration**

In this study, polycaprolactone nanofibres sandwiched with cross-linked protein films were employed as cardiovascular scaffold. These polymers give adequate mechanical strength and mimic geometry of the extracellular matrix (ECM). We have incorporated piezoelectric nanotubes in the protein films so that even a slight mechanical stress will induce an electric charge, which stimulate the cardiac tissue. Cardiomyocytes are being cultured on this scaffold and functional regeneration is investigated using biochemical and electrophysiological techniques. Action Potential Duration (APD), Conduction Velocity (CV) are studied using the MEA system and are correlated with the contraction cycle. HERG channel antagonist known to cause QT prolongation and a contraction inhibitor are used to study the electrophysiological activity of the cells cultured on the scaffold. These scaffolds can be explored as a potential material for cardiac tissue engineering as they integrate mechanical, chemical and topographical cues to mimic the native environment.

**Development of chemo-responsive mesoporous silica nanocarriers for treatment of breast cancer**

Chemo-responsive mesoporous silica was developed by introducing disulphide caps on the highly ordered mesopores. The caps were lysed only in the glutathione-rich cancer cell microenvironment thus conferring cancer-cell specific cytotoxicity. The size of the silica particles influenced their localization and molecular
targets with the smaller particles internalizing better into the cancer cells and suppressing genes associated with cell survival, proliferation and invasiveness that was reflected in the in vivo studies.

**Exploring the potential of electrospun PVF fibers as a novel scaffold for neural regeneration**

Tissue engineering strategies are constantly in search of novel scaffold materials that can accelerate cell adhesion, growth and proliferation. In this context, poly(vinyl formal) (PVF), a biodegradable and water absorbing polymer derived from poly(vinyl alcohol) was explored as a potential scaffold material for neural regeneration. No prior attempts have been made to fabricate electrospun fibrous scaffolds from PVF for tissue engineering applications and this forms the focus of the present study. The electrospinning conditions were optimized to obtain defect-free PVF microfibres with an average diameter of 4.4±0.7 μm. The microfibres exhibited a uniform nanoporous surface and a solid core that augmented neuronal cell adhesion and neurite extension. The fibres were brittle and exhibited a 50% degradation in physiological pH and temperature. The viability of hippocampal neuronal cells cultured on the scaffold showed a progressive increase with time revealing its promise as a scaffold material for neural tissue engineering.

**Development of a dual drug loaded liposomal carrier against oral cancer**

This work investigates for the first time the effect of a nanoformulation of a plant polyphenol trans-resveratrol and doxorubicin hydrochloride (Dox) co-encapsulated in PEGylated liposomes on a p53WT head and neck cancer cell line and on a subcutaneous SCID mouse model of the same. Cytotoxicity evaluation revealed that the dual drug loaded nanoformulation had a slightly higher GI50 value than the free Dox treatment and this result was further explored by determining the combination index of the drug combinations. The formulation was also tested for its effect on various cell cycles and apoptosis related proteins and it was found that the formulation induced cell cycle arrest and apoptosis. The in vivo analysis
revealed that the formulation had comparable efficacy to that of the Dox-loaded liposomes and was also successful in retarding tumour growth. Importantly, the combination did not exhibit any locoregional toxicity unlike the Dox loaded liposomes. Protein analysis of tumour samples showed that the presence of resveratrol in this formulation downregulated cyclin B1, PCNA and survivin, and upregulated p53, which contributed to the synergistic action of the two drugs. Hence, the combination of Dox and trans-resveratrol seems to be a promising formulation in treating oral cancer.

Development of a dual peptide-tagged liposomal system for co-delivery of gadolinium-flavonoid contrast agent and a clot buster for treatment of cerebral ischemia

The development of an efficient and less toxic positive contrast agent based on gadolinium-quercetin may enrich the diagnostic potential of MRI towards brain disorders. Gadolinium incorporated drug loaded liposomal systems offer immense potential as a theranostic agent for brain disorders. Incorporation of stimuli-responsive component in the liposomes confers regulated drug release properties to the theranostic system. This work uses for the first time a novel gadolinium-flavonoid contrast agent developed in our lab for magnetic resonance and micro-CT contrast while the liposomal carrier will ensure stimuli-responsive release of a thrombolytic agent and neuroprotectant at the ischemic site to restore blood flow and minimize reperfusion injury.

Major Publications

OBJECTIVE

- Utilize Drosophila melanogaster as the model organism to identify and characterize targets that maintain organ size and tissue integrity

RESEARCH HIGHLIGHTS

Identification of candidates involved in Ligand-Independent Notch signalling pathway during tumorigenesis

In multicellular organisms, Notch signalling pathway is implicated in cell proliferation and differentiation. In humans, deregulation of this well-conserved pathway leads to several diseases and disorder, including tumor. In addition to the well-studied ligand dependent Notch signalling pathway, recent research has pointed that endosomal pathway mediated ligand-independent Notch signaling also to be involved in this process. Since the cellular components and factors mediating this process is not clear, using a central endosomal trafficking component as a bait, our lab has undertaken a genetic screening using Drosophila melanogaster to identify them. We have identified few previously known candidates and few novel previously uncharacterized targets implicated in this process. Validation of the interaction through a secondary screening and genetic characterization of the interacting factors are in progress.

Major Publications

OBJECTIVES

• Optimization of conditions for the extraction of antioxidant compounds from plant foods / by-products
• Identification and characterization of antioxidant compounds using spectroscopic techniques
• Evaluation of free radical scavenging activity of antioxidants in in vitro and in vivo models

RESEARCH HIGHLIGHTS

Antioxidant and antibacterial activity of nut by-product extracts

In India agro-food by-products such as shell cashew nut (Anacardium occidentale L.), shell of coconut (Cocos nucifera L.) and hull of groundnut (Arachis hypogaea L.) are available in vast scale at a cheaper cost. In this project, we have explored a suitable solvent system and conditions for the extraction of polyphenols from these by-products. Among the by-products, cashewnut shell was found to be a prominent source of polyphenols (3412.28 mg GAE/L) and gallic acid was identified as the major constituent. It exhibited strong antioxidant activity in terms of radical scavenging potential (IC-50 value 44 μg/ml) and antibacterial activity against food-borne pathogens like Escherichia coli, Salmonella enterica, Staphylococcus aureus, Shigella flexneri and Listeria monocytogenes. Further, food preservation potential of the extracts was investigated in meat and fresh-cut fruit models.
Bio-assay guided fractionation of anticancer plant Flacourtia indica

*Flacourtia indica* tree bark has been used by Indian traditional healers as anticancer drug, but not yet validated scientifically. In this project we have made an attempt to identify the active fraction, which possess high cytotoxicity against colon cancer cell line (HT-29). The extraction conditions for the preparation of extract with high phenolic yield were optimized using Response Surface Methodology (RSM). The physicochemical properties of the optimized extract such as yield, solubility, pH etc., were studied. The dose-dependent and time-dependent anticancer activities of extract were investigated in a colon cancer cell line (HT-29) through cell viability assay. The anticancer mechanism of action of the extract involving generation of reactive oxygen species (ROS) and cell wall degradation were experimentally proved. LC-MS/MS analysis revealed the presence of 10-deacetylbaccatin and picrotoxinin as the major phytochemicals, which might be responsible for the anti-proliferative activity exhibited by *F. indica* extract.

Major Publications

OBJECTIVES

• Utilization of HMF as sustainable raw material
• Development of supported catalysts
• Functional molecules for sensing and photonic applications

RESEARCH HIGHLIGHTS
Development of Polymeric Resin Supported Multi-Catalysts Derived from Sustainable Rawmaterials

Towards sustainable era, the project aims at development of resin supported multi-metallic complexes utilizing sustainable raw materials including amino acids and sugar derived 5-hydroxymethylfurfural (HMF). We have developed a conceptually designed and simple method for the dehydration of fructose on a solid support addressing several issues like diminishing the formation of humin, rehydration of HMF, selectivity and easy extraction. Further, HMF-derived hemi-salen ligand was utilized in synthesis of copper complex. The copper complex was loaded on polystyrene resin using solid phase peptide synthesis techniques. Resin supported copper complex was utilized as catalyst in various C-C bond forming reactions including (i) C-H arylation of BODIPys and (ii) dipyrromethane formation. These dipyrromethanes have been utilized as rapid colorimetric naked-eye Cu(II) chemosensor, based on C–H oxidation and chelation. Development of resin supported multi-catalysts for photo-catalytic activities are in progress.
Major Publications
10. Annes B, Vairaprakash P, Ramesh S. TfOH mediated intermolecular electrocyclization for the synthesis of pyrazolines and application in alkaloid synthesis. RSC Advance, 2018; accepted. (IF: 2.936)
OBJECTIVES

- Development of Novel drug delivery systems for the treatment of HIV infection
- Development of Paediatric dosage forms as Food and Milk Admixture

RESEARCH HIGHLIGHTS

Multiparticles for the Treatment of HIV Infection in Children

Engineered multiparticulate drug delivery system as food and milk admixture as once daily system is developed as a ‘once-daily’ system using Spray drying technique. This will enable to overcome the limitations of conventional dosage forms and thereby improve treatment adherence, dose flexibility, sustained release, bioavailability and therapeutic efficacy in the treatment of HIV/AIDS. The Anti-HIV drug loaded multiparticle drug delivery system is produced using different natural and synthetic polymers such as Chitosan and Polymethyl Methacrylate (Eudragit E100) and optimised using quality by Design concept. The spray dried multiparticle of Anti-HIV drug showed better encapsulation efficiency and with high yield.

Figure: 1. Scanning Electron Microscopy images of Anti-HIV Drug Loaded Chitosan (A) and Eudragit E100 (B) Spray dried Multiparticles.
Major Publications


**OBJECTIVES**

- To improve the properties of biologically relevant molecules for drug delivery
- To design catalysts for energy and environmental applications
- To understand reactions at the microscopic level using Density Functional Theory

**RESEARCH HIGHLIGHTS**

**Hydrogen storage – by multiscale simulations**

Hydrogen storage can enable the advancement of hydrogen usage in fuel cell technologies. However, the challenging factor is its high volumetric density. In our lab, we use multiscale simulation methods, which include the state-of-the-art density functional theory to design new porous materials. The stability of the materials is analysed using the *ab initio* molecular dynamics calculations (MD). To understand the reversible, adsorption kinetics of molecular hydrogen, we have used the Grand Canonical Monte Carlo (GCMC) methods. We have identified polyimidazole polymers and desecrate nanohoops to reversibly adsorb hydrogens in molecular form with high gravimetric density, satisfying the DAE requirement. Our achievement has resulted in the design of new organic supramolecular hosts for the storage of gases.

[a] isodensity surface of nanohoops for the storage of gases; [b & c] snapshots from GCMC simulations
Major Publications
OBJECTIVES
• To develop anticancer drugs that target mitotic kinesins such as Eg5, CENPE and understanding their mechanism of inhibition
• To develop antimicrobial drugs targeting various enzymes of non-mevalonate pathway, vitamin K2 synthetic pathway and other enzymes such as FtsZ

RESEARCH HIGHLIGHTS
Developing Inhibitors for Mitotic Kinesin Eg5 using in silico, in vitro and structure based methods
Kinesins are molecular motor proteins that travels along microtubules. They can transport a variety of cargo to their respective destinations in cell via movement along microtubules. At least 16 members of kinesin family are involved in mitosis at various steps. Kinesins are involved in spindle assembly, maintenance, chromosome segregation, mitotic checkpoint control and cytokinesis. Mitotic kinesin Eg5 is a validated cancer drug target with several allostert inhibitors in Phase I and II clinical trials. All structurally characterised allostert inhibitors of Eg5 target an extensively studied allosteric site. A recent study confirmed the existence of the second allosteric binding pocket. A new benzimidazole compound BI8 was found to bind to the already characterised site I and as well as a new site-II. This presents a new opportunity to develop new set of inhibitors that could be used either alone or in combination with existing Eg5 inhibitors.
Screening for inhibitors for MenH enzyme (Menaquinone biosynthesis)
Menaquinone (vitamin K2) is an important cofactor that is exploited in electron-transport pathways. The vitamin consists of a naphthoquinone moiety with a polyisoprenyl substituent, the length of which varies in different bacteria. Humans lack the enzymes that synthesize this vitamin and acquire it from diet or from intestinal bacteria. This absence contributes to the potential value of these enzymes as therapeutic targets, especially for important pathogenic bacteria such as *Mycobacterium tuberculosis* and *Staphylococcus aureus*. The biosynthesis of menaquinone has been studied extensively in *Escherichia coli*. The biosynthesis typically involves six to eight enzymes and in a number of cases the genes encoding these enzymes have been proven to be essential to the bacteria by genetic methods. We are currently targeting important enzymes of this pathways to develop novel antimicrobial drug.

**Major Publications**
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Research Areas
Polymer Synthesis and Characterization, High Temperature Polymers, Dendrimers

OBJECTIVES
• To design new monomers and study the structure – Property relationship in polymers
• Synthesize and investigate the properties of the engineering polymers such as poly(etherketone)s, poly(ethersulphone)s, aromatic polyimides, etc.
• Synthesis and properties of dendrimers

RESEARCH HIGHLIGHTS
Hyperbranched Polyetherimides and Polyetherimide Dendrimers

Hyperbranched polyetherimides and polyetherimide dendrimers are expected to show good thermal stability, good solubility, low viscosity compared to linear counterparts and provide possibility for further modification of properties by changing the functional groups at the periphery.

The objective of the study is to synthesize hyperbranched polyetherimides and polyetherimide dendrimers. New AB2 monomers are being prepared in our lab and polymerized to form hyperbranched polyetherimides. Polyetherimide dendrimers are being synthesized using 4,4’-Bis[(Trishydroxyphenyl)methyl]biphenyl as dendrimer core and nitrophthalimide derivative of 4-[1,1-Bis(4-benzyloxyphenyl)ethyl]aniline as dendron. The applications of these polymers as polymer supported catalysts and high temperature coatings will be studied.

Polyetherimide dendrimers and hyperbranched polyetherimides are ideal choice for polymer supported catalysts. Important precious catalysts such as platinum, palladium, silver, nickel, etc. can be attached to the functional groups at the periphery of dendrimers / hyperbranched polymers. This will enable the recovery and reuse of costly catalysts. The catalytic activity remain same as that of metal catalysts. These polymers can be easily separated from the products of organic reactions. These polymers are thermally stable and inert. Hence, these polymer supported catalysts will find applications in organic synthesis.
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Research Areas  
Protein-DNA Interactions and Computational Molecular Biophysics

OBJECTIVES
• To develop rational guidelines for engineering specificity of protein-DNA interactions  
• Delineate the interplay of different factors involved in determining specificity of protein-DNA interactions

RESEARCH HIGHLIGHTS

Delineating Osmolyte-induced Star Activity of Restriction Enzymes
Star activity of restriction enzymes has been thought to be induced by dehydration of protein-DNA interfaces. However, osmolytes, by altering the activity of water, also affect protein dynamics and DNA conformation independently. This project is aimed at delineating the interplay of water dynamics, protein dynamics and DNA conformation. The insights from this study may shed light on osmolyte-based engineering of protein-DNA specificity.

Effect of Protein Charge Distribution on DNA Conformation
How DNA changes conformation upon binding to proteins is the central question addressed in this project. By mutating and charge-neutralizing various charged amino acids in the vicinity of DNA in protein-bound complexes (EcoRI-DNA & NAEI-DNA), we find that the distribution of charges around the DNA plays a critical role in resultant DNA conformation. Further, we find that distantly-located charged residues may also affect DNA conformation. The changes in charge distribution also affect the protein dynamics indicating that DNA conformation may be determined by a complex interplay of direct effects of electrostatics and protein dynamics. These studies illustrate, not only the complexity of specificity in protein-DNA interaction, but also, provide insights into residues and factors to pay attention to while redesigning the specificity.
Major Publications


OBJECTIVES

- To develop a model for sustainable management of surface water resource
- To identify coastal zone hazards and suggest remedial measures
- To mitigate flood prone zones and suggest remedial measures

RESEARCH HIGHLIGHTS

Project “TANKS”

Tanks play a vital role in satisfying multiple needs of people. The technique is quite ancient, witnessed almost in semi-arid regions around the world. But in recent decades, the tank and their associated ecosystems are subjected to various natural (soil erosion, siltation, inadequate and unreliable rainfall, and drought) and anthropogenic (encroachments, dilapidated structures, poor maintenance) threats. To address the above-multifaceted issues, a comprehensive model has been framed for rehabilitating the tanks. The present research study has proposed a new shape-based model for precisely estimating the storage capacity of thousands of small and medium-sized irrigation tanks. The time series analysis on soil erosion using RUSLE model has enabled to identify the erosion zones and also the causative factors at micro-watershed level. The sedimentation rate analysis using radioisotopes namely 137Cs and 210Pb has alarmed the urge for restoring the system on a war footing. While, the mapping of supply channel deteriorating parameters has provided a ground level holistic measures to revive the system. The evaluation between runoff and storage capacity of tanks ensured that spending of millions of money against the restoration will be worth enough in satisfying multiple needs of the people through the year.

Study on the Cauvery River Sediments of Swamimalai, Thanjavur District, Tamil Nadu to Understand its Unique Characteristics that Enable it’s Application in Traditional Bronze Icon Industries

The “Chola bronze idols” manufactured in Swamimalai, Thanjavur district date backs to 500 years and at present around 1200 individuals from simple ‘jobbers’ to ‘master craftsmen’ are involved in the production of these idols. In idol making, the clay mould stage is unique, wherein a thin coating (average thickness of 5 cm) of alluvial clay (Tamil = vandal
mixed with water is applied to the wax model. These clay sediments are known to have a special quality, that it can withstand high temperature of above 1200 °C without developing any cracks, and further retain the imprints of finest details of the wax model on the clay layer. However, they seems to occur only on the banks of Cauvery river near Swamimalai, that too within a restricted stretch of about 1.5 km from Thiyagasamudram in the west to Thimmakudi in the east. Hence, in the present project an attempt has been made to analyse the physical and chemical characteristics of Cauvery river sediments in Swamimalai region and to ascertain the unique characteristics of the sediments that make them suitable for bronze casting by comparing them with the normal sediments.

**Major Publications**
1. Nasir N, Selvakumar R. Influence of land use changes on spatial erosion pattern, a time series analysis using RUSLE and GIS: the cases of Ambuliyar sub-basin, India. Acta Geophysica, 2018; 1-10. (IF: 1.24)
2. Selvakumar R, Ramasamy S.M. Inferring the role of integrated geomorphology and land use / land cover on tsunami inundation through factor analysis. Disaster Advances, 2017; 10(8): 1-10. (IF: 0.20)
OBJECTIVES
- To develop the layered two stage fibre reinforced concrete to enhance the impact strength
- To develop the preplaced aggregate fibre reinforced concrete with superior impact strength and to minimize drawbacks of the conventional FRC
- To develop an Innovative concrete technology for protection of civilian and military structures under terrorist attack

RESEARCH HIGHLIGHTS
Impact Behaviour of Self Compacting FRC Slabs Made with Recycled Concrete Aggregate
Recently, the research focus has shifted towards reusing concrete waste from construction and demolition has turned into large attractiveness in order to decrease the environmental impact due to natural aggregates exploitation and waste disposal. Moreover, self-compacting concrete (SCC) is categorized as a new generation of concrete with high flowability, which can spread easily under its self-weight and compact without any external vibration. In particular, in the last few years some researches have been made using construction and demolition in SCC, particularly with coarse recycled concrete aggregates. In recent years, SCC reinforced with fibres has been utilized for the construction of protective structures to resist impact and dynamic loads. Impact resistance of fibre reinforced SCC made with recycled concrete aggregate has not been extensively studied yet. To fill this knowledge gap, the behavior of SCC fibre reinforced concrete thin slabs made with recycled concrete aggregate under multiple, moderate-velocity impacts will be investigated via drop-weight impact experiments. The variables investigated are different dosage of steel (0.5%, 1.0%, 1.5% volume of concrete) fibres and different recycled aggregate (20%, 40%, 60%, 80% and 100%) replacement, with treated and untreated recycled aggregate. The fresh state properties of the reinforced mix compositions will have evaluated in terms of flowability and viscosity. Moreover, the hardened properties of specimens will be obtained by using, compressive strength, splitting tensile, flexural strength, and impact resistance.
Major Publications


OBJECTIVES

- To study the characteristics of recycled concrete aggregate and its influence on strength & durability characteristics
- To develop concrete mixture proportions with 100% RCA as coarse aggregate that achieves equivalent compressive strengths and workability as the conventional concrete
- To study the impact resistance of fibre reinforced SCC made with recycled concrete

RESEARCH HIGHLIGHTS

Impact behaviour of RCA based SCC Slabs

Environmental issue of dumping waste concrete and reduction in the natural resource exploitation may be solved by recycling the construction and demolition waste (CDW) as recycled aggregate. Dynamic loading arising from earthquakes, global terrorism activities, vehicle collisions on transportation structures, airport runway due to aircraft take-off and landing, wind gust and machine dynamics has made the high impact resistance capacity civil and military infrastructures indispensable and this has enticed many researchers. With this focus, the work has been framed to study the effect of replacing natural aggregates with recycled concrete aggregates (RCA) derived from CDW on the impact resistance of fibre reinforced self compacting concrete (SCC) under multiple, moderate-velocity.

Major Publications

OBJECTIVES

- To determine the Uranium and associated water quality parameters in drinking water
- To treat the wastewater using cost effective techniques
- To convert the solid waste into useful matters

RESEARCH HIGHLIGHTS

Partial Distribution of Uranium and Associated Water Quality Parameters in Drinking Water of Ariyalur, Pudukkottai, Nagapattinam, Thanjavur and Thiruvarur Districts of Tamil Nadu

Uranium is a naturally occurring silvery-white, radioactive element generally found in rocks, soil and water. Uranium is placed in actinide series of the periodic table, and it has an atomic number of 92 with three isotopes of uranium 234, uranium 235, uranium 238. Owing to its high solubility nature, it forms very stable complexes with carbonate, sulphate, carbonate and hydroxyl ion, phosphate in neutral and alkaline solutions. In general, a notable amount of Uranium is found naturally in certain rocks. Further, activities like mining use of phosphate fertilizers, colouring of ceramic pieces, wineglass and so on leads to the concentration at few places. In recent decades, Uranium has become a very important fuel to the nuclear power reactors. Hence, the Department of Atomic Energy has proposed to prepare a spatial distribution map of Uranium throughout India. As a part of the above network project, mapping has been carried out for five districts of Tamil Nadu namely Ariyalur, Nagapattinam, Pudukkottai, Thanjavur and Thiruvarur (Figure 1). For the same, pre and post monsoon groundwater samples were collected and the Uranium and other associated water quality parameters were analysed. Subsequently, map on the spatial distribution of Uranium concentration for the study area has been prepared using GIS Software. From the map, notable quantity of Uranium concentration is witnessed at some locations within the study area (Figure 2).
Major Publications


OBJECTIVES

- Development of low-cost natural adsorbents
- Development of portable water treatment technology
- Development and evaluation of suitable bioreactor for the biosorption of heavy metals

RESEARCH HIGHLIGHTS

Dual Power Portable RO Plant

Dual power portable RO plant is first of its kind. It has the provision to operate with hand, leg and electricity. The method involves development of a novel mechanism to converts rotary motion to reciprocating motion of two cylinders which will suck water from a source and send out pressurized water to RO- membrane chamber which will purify the water. This helps the user to get potable water in extreme condition with manual mode and does not have to struggle to move the pistons with hand power when electrical power is there.
Major Publications
OBJECTIVES

• Analyse and Design of Water Distribution Networks and its components
• Assessment of dry and wet periods of a region using drought indices
• Evaluation of urban growth effects on surface runoff characteristics

RESEARCH HIGHLIGHTS

Evaluation of Urban Growth Effects on Surface Runoff

Evaluation of land cover/use change and its impact on hydrological design aspects plays a vital role in assessing the capacity of existing storm water conveyance systems and its capability towards the anticipated peak flow. This research attempts to illustrate an application of Soil Conservation Service (SCS-CN) method for runoff estimation using continuous time series rainfall. And also, the present work proposes a Land use factor based on the Curve Number to correct the infiltration rate according to the prevailing land cover/use. Indian remote sensing (IRS) satellite data for the years 1989, 1992, 1995, 1998, 2001, 2004, 2007, and 2010 are used to evaluate the growth of Tiruchirapalli city, India city and to assess its impact on surface runoff. The Geographical information system (GIS) is used to prepare the different layers belonging to various land covers identified from remotely sensed data. The sub-watersheds are created using Digital Elevation Model (DEM) prepared by ARC GIS software. The single storm event and 50-year return period rainfall data are used as a hydrological input to the model to evaluate the increase in runoff over the years due to change in the land cover of the study area. The study reveals that the impact of land cover/use change is more significant for longer duration storm than short duration storm at the same magnitude. Further, it is noticed from the study that the runoff depth and runoff co-efficient is large for short duration rainfall than long duration rainfall at the same magnitude.
Optimal design of water distribution network is generally aimed to minimize the capital cost of the investments on tanks, pipes, pumps and other appurtenances. In which minimizing the cost of pipes is usually considered as a prime objective as its proportion in capital cost of the water distribution system project is very high. Minimizing the capital cost of the pipeline alone may result economical network configuration, but it may not be a promising solution in terms of resilience point of view. Resilience of the water distribution network has been considered as one of the popular surrogate measure to address ability of network to withstand failure scenarios. To improve the resiliency of the network, the pipe network optimization can be performed with two objectives in which minimizing the capital cost as first objective and maximizing resilience measure of the configuration as secondary objective. In the present research work, these two objectives are combined as single objective and optimization problem is solved by differential evolution technique. The research illustrates the procedure for normalizing the objective functions having distinct metrics. Two of the existing resilience indices and power efficiency are considered for optimal design of water distribution network. The proposed normalized objective function is found to be efficient under weighted method of handling multi-objective water distribution design problem. The numerical results of the design indicate the importance of sizing pipe telescopically along shortest path of flow to have enhanced resiliency indices. The following plot shows the how
Resilience Index vs Cost Pareto Curve

Major Publications
OBJECTIVES

- To design an offloading framework using optimization strategy for an edge computing environment
- To design an IoT Gateway by employing containerization and Uni-kernel to support diverse IoT applications

RESEARCH HIGHLIGHTS

Designing Offloading framework for edge environment to support diverse IoT applications

IoT applications employ cloud data centre for processing the data generated by the edge devices like smartphones and tablets. Due to the proliferation of IoT devices, cloud computing is encountering the increasing challenges concerning bandwidth requirements and latency response. With the advent of Edge Computing, a middle layer between cloud and End devices, a part of the computational load can be offloaded to the edge nodes as computational capabilities are currently untapped in edge nodes. The objective of my research is to design a suitable optimization strategy to decide the offloadable components in an application by considering the nearby edge devices like smart phones, SBC or On Board Unit (OBU) in car. Besides the container based lightweight virtualization is analyzed to port the offloadable component to the nearby devices. To do this Single board Computers (SBC) like Raspberry Pi and Intel Edison board are employed and the test bed result indicates that by adapting container virtualization in the edge environment the performance of the IoT devices is improved and the communication overhead is reduced. The outcome of this research work is to develop an integrated framework to support diverse IoT applications in edge environment.
Major Publications
OBJECTIVES

• Develop algorithms for satellite and medical images
• Develop procedures for Computer vision and its applications
• Develop methodologies for machine learning operations

RESEARCH HIGHLIGHTS

Object detection from Aerial images using fusion and segmentation

Object detection in satellite images is a challenging task. The challenge level is derived based on the resolution of the satellite images. A satellite images is not always sufficient for object detection with higher accuracy unless the study image is having high-resolution. A satellite with mono-band sensors is capturing the images single resolution. Multi-sensor satellite images are acquired with different resolutions and suitable for different applications as per their resolution. The need of high-resolution satellite image is satisfied by fusing different resolution images of the same area to reduce the cost of data and waiting time. Since the multiple resolutions are combined together, the resultant image produced as high-resolution image and it can be used for multiple applications as well multi-feature extractions. The object recognition algorithms have failed to identify the objects by using low resolution images but our proposed algorithms are producing the high-resolution images for study and analysis. The image fusion is used as preprocessing operations whereas segmentation and feature extraction are used post-processing operations. The feature extraction process is carried out followed by segmentation which is done based on color and texture. The proposed work is designed as an unsupervised fusion and segmentation algorithms. The analysis will results in detecting the objects like building, barren land, vehicles, water resources, and vegetation.
**Major Publications**

1. Ifjaz Ahmed M, Vaithiyanathan V, A Hybrid (IIHS-LSM) approach to detect vegetation, Indian Journal of Geo Marine Sciences, 2017; 46(11); 2258-2264. (IF: 0.172)
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Research Areas  
Information Security, Data Security and Privacy, Data Mining and Machine Learning, IOT security and Cyber security

OBJECTIVES

• Focus on the challenges and vulnerabilities of Information security and cyber world  
• Contribute to the solutions of the real time problem of cyber world  
• Apply novel techniques to enhance the product

RESEARCH HIGHLIGHTS

Correlating resources and expenditures of TN schools with ML algorithm  
To Developed a tool to enhance public schools in Tamilnadu. Data from various schools are collected and correlated with the existing resources and expenditure using Apriori machine learning algorithm.

Fig.1.1 Correlation analysis of TN schools

A Smart IoT based Irrigation management system for short term crops

Irrigation Management System  
Framework architecture

Soil and sensor connection

Moisture sensor’s readings
• An IoT based secure irrigation management system has developed for short term crops.
• Various irrigation methodologies adopted automatically through moisture sensors.
• Various secure mechanisms applied on data to enhance security and ownership.
• Water conservation analysis have done by past historical data to achieve efficiency.

Major Publications
4. B. Priyatharcini, G. Roshini and R. Kavitha, Ring Signature based One Time Key Exchange for Secure Multimedia Sharing on Social Networks.
7. Srividhya S. and R. Kavitha Raju, Brain Tumor Detection using Advanced Clustering Algorithm,BVICAM2018 IEEE conference proceeding, will be published in IEEE Explore.
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Research Areas  
Internet of Things, Embedded Systems & Security in Embedded Systems

OBJECTIVES

- To design and develop low power wireless sensor nodes with optimized multivariate statistical techniques
- To design and develop IoT framework for real time data monitoring with cloud storage and mobile application services

RESEARCH HIGHLIGHTS

Design and Development of Internet of Things Frameworks for an Intelligent Embedded Systems

In this research work, low power IoT (wireless sensor) node will be designed using Low cost and Low power microcontrollers as processing unit with various commercially available sensors. Single board computers (SBC) (Raspberry Pi 3) will be used for designing head node. In the second stage, a light weight multivariate analysis will be implemented on raspberry pi 3 board for processing sensor data from the end nodes. Unsupervised and supervised learning will be used for clustering and analysing the pattern of real time data. In the third stage, wireless connectivity between head and server will be established using MQTT. It will be utilized to enable highly scalable solutions without having the dependencies between the data producers and consumers. The server uses the internet and connects to the cloud for establishing the external data storage. The data analytics part can also be made to run on the cloud based on the demands of the application. Finally, a mobile application will be developed with location based service and connection to the cloud storage.

Figure 1. Generic model of research work

Figure 2. Process Outline
Major Publications
OBJECTIVES

- Decision support and visualization of Assets, Natural Resources and Infrastructure Information
- Spatial Data Models, Feature extraction and analysis on images; and representation of Geospatial Metadata supporting Knowledge discovery and Interchange

RESEARCH HIGHLIGHTS

EPRIS

Space Based Information Support for Decentralized Planning (SIS-DP) project has been initiated by National Remote Sensing Centre (NRSC) of ISRO under the support of National Natural Resources Management System (NNRMS). The Goal of the project is to Empower the Panchayati Raj Institutions (PRIs) and the Stakeholders with Space Based Information Support for Decentralized Planning and Governance in the country.

Bhuvan Panchayat plays a key role towards digital empowerment of the citizen, services & governance - A way forward for Digital India. As part of that SASTRA Deemed to be University was assigned with the mobile-based asset mapping at Trichy District. For that, an Android-based mobile application 4.0 is used. To carry out the work, at the Panchayat levels, three Project Assistants were appointed. These Project Assistants were assigned a set of Panchayats at Block level.

The Project assistants with the support of the local service oriented people were collecting the assets under different types. They collected nearly 25000 assets which are grouped under 3 Major Category and 19 classes with 60 different types of assets at various panchayats.
Major Publications


OBJECTIVES

- Develop algorithms for solving problems in computer vision and Image processing by implementing it in VLSI platform

RESEARCH HIGHLIGHTS

Ultrasound based assessment of tissue biomechanics to enhance the clinical management of foot related pathologies
The goal of the research work is to develop a computer aided assisting tool for early detection of Diabetic foot ulcer using Ultrasound images of foot. The objectives of the project are:

- Develop a load bearing platform for weight bearing ultrasound scanning of the foot
- Develop a post processing algorithm for 3D imaging of the foot
- Develop and validate the testing protocol that enables the quantitative assessment and mapping of the mechanical properties of the soft tissues of the foot
- Validate the applicability of this new system within the clinic

Development of Digital area scene matching algorithms
The navigation of a cruise missile at the terminal phase of its flight should be of high accuracy as it marks the successful completion of the entire mission. The objectives of this project are:

- Develop a scene matching correlation system which uses a camera to image the terrain beneath the weapon and then digitally compares the image with the stored image produced by satellite or aerial reconnaissance
- Register the image captured from camera with the reference image
- Image registration helps to measure the position error of the vehicle very accurately and use this to correct the inertial and TERCOM errors. The DSMAC (Digital Scene Matching Area Correlation) used in several blocks of the Tomahawk was indeed accurate, but produced operational side effects, not unlike TERCOM, which was the need to program the missiles to fly over terrain with easily matched features in proximity to the target
Development of Hardware Security Module based on microcontrollers

The idea of this research work is to design and analyze the power, timing and memory requirement of a Hardware Security Module (HSM) designed around standard commercially available low-power/high speed micro-controllers. The analysis can be done around RSA, AES-256, 3-DES, SHA-3 and MD-5 standard algorithms which will be compiled and loaded as instructions in memory for the micro-controller to execute. The data to be encrypted is buffered data. The objectives of this project are:

• Design board consisting of the micro-controller interfaced to an external memory (if required), a UART interface (RS-232 signaling) for communication between PC and board
• Develop the firmware required for UART communication, accessing memories, secure key access (the keys should be stored in a protected environment and firmware protection should be there for preventing unauthorized access), algorithm downloading in a secure manner (administrator authentication via password), debug-monitor.
• Development of Schematics for 5 types of micro-controller, PCB Design, PCB fabrication, Component Procurement, PCB Assembly and testing, porting debug-monitor and algorithms on boards.

Major Publications


7. Deebak B.D., Muthaiah R, Thenmozhi K, Swaminathan P.I, Analyzing secure key authentication and key agreement protocol for promising features of IP multimedia subsystem using IP multimedia server-client systems. Multimedia Tools and Applications; 2016; 75 (4); 2111-2143. (IF: 1.541)

8. Muralidharan D, Muthaiah R, Bus Based Synchronization Method for CHIPPER Based NoC. Scientific Programming, 2016; article no. 1907521. (IF: 0.224)


OBJECTIVES

- Develop algorithms for Medical Image analysis
- Develop methodologies for Remote Sensing applications
- Develop Machine Learning algorithms for divergent domains

RESEARCH HIGHLIGHTS

Research on Developing Methodologies to Analyse Dermoscopy Images and to Detect the Melanoma Skin Cancer

Melanoma is one of the types of skin cancer which should be diagnosed at its early stages to save the patients’ lives. But, this type of skin cancer will look like a normal mole and it is tedious to distinguish whether it is benign or malignant. Generally, clinicians suggest biopsy performed by a trained technician in a sophisticated lab. It is invasive, time consuming, and not cost effective.

Instead, Clinicians and Dermatologists can use ABCD analysis in common to identify the lesion based on its appearance. ABCD stands for Asymmetry, Border Irregularity, Color variegation and Diameter. If they suspect the lesion to be malignant, they will use biopsy for confirmation. The objective of this research work is to propose novel methodologies to analyze the images of the skin lesions; to detect or diagnose the melanoma using ABCD parameters extracted using advanced Image Processing, Soft Computing and Machine Learning algorithms.

Melanoma skin lesions
A non-invasive method of diagnosis is attempted such that the developed applications can assist the dermatologists to confirm the diagnosis.

- Scan-line method and Fuzzy relational method are proposed to quantify the asymmetry of the skin lesion (as asymmetry is the first parameter analysed in ABCD)
- Texture based analysis and detection is done by representing an image as a phylogenetic tree
- Computer aided diagnosis system for melanoma detection can be developed with the following steps: i) Preprocessing, ii) Segmentation, iii) Feature Extraction, iv) Classification, and v) prediction.
- Preprocessing: Enhanced filtering algorithms are developed using conventional median filtering along with range analysis and similarity coefficient analysis.
- Segmentation: Algorithm named, Normalized Otsu’s Segmentation is developed. A hybrid segmentation algorithm is proposed using Active contours and morphological operations.
- Feature extraction is carried out by deriving feature vector from the image. Feature vector comprises of shape features, statistical features, entropy-based features, and frequency domain features
- Classification is done using machine learning algorithms such as ANN, ANFIS, SVM, ensemble classifiers and deep learning.
- The developed system is validated with the real time images acquired from the hospitals and the accuracy of 93.62% is achieved.

**Major Publications**

OBJECTIVES

- Find efficient algorithms for secured user authentication
- Propose efficient algorithms for optimal/near optimal solutions for problems arising in big data analytics and multi agent systems using machine learning/evolutionary computing techniques

RESEARCH HIGHLIGHTS

Secure Authentication in Mobile Banking

Securing the mobile banking applications against user authentication attacks has been a major concern for the banks that offer mobile banking services. While the users enter their credentials into their mobile banking applications, the attackers may acquire them through shoulder surfing, key-logging, smudge attacks, Man-in-the-Middle attacks, public WiFi attacks etc.

This project is on proposing comprehensive, efficient and secured authentication methods for protecting the customers of banks. Proposed solution improves the security of the user authentication by curbing the possibility of attacks. The user-friendliness of the proposed methods is substantiated by conducting user surveys with the help of a well represented sample of users and then statistically verifying the survey results. Security and correctness of the methods are theoretically justified. Following is one of the interfaces proposed for mobile banking application. The interface will be associated with a novel algorithm that transforms the user’s PIN into a one time number before transferring to the server:

![PIN interface diagram]
A recommender System for customers of private taxi Services
In Indian cities, public road transport system, public trains and metros are operating well beyond their capacity. State-sponsored mass transit systems are unable to keep pace with people requirements. Private enterprises haven’t been able to do enough, and dated regulations have not allowed them to do enough to try to fill the breach. Private taxi services have increased and there is a surge of taxi majors like Ola and Uber. The services offered by them, are not always satisfactory for the customers because of delays, discomforts in travel and the like.
In this project, new methodologies/algorithms are proposed for the estimation of demand considering the factors like seasons, geographic area and the gender and age groups of customers etc. Real data from the taxi service providers from a city and build a recommender system are collected using advanced Big data analytics methods such as predictive analytics and user behavior analytics.

Optimal or Near Optimal Solutions for Optimization problems in Multi Agent Systems
In this work, problems in Multi Agent Environments, which boil down to multi-objective optimization will be identified. Appropriate machine learning / evolutionary computing techniques will be used to give optimal/ near optimal solutions for those problems.

Major Publication
1. Rajarajan S, Priyadarsini PLK. A Novel PIN Number Based User Authentication Scheme. The International Arab Journal of Information Technology, In press (IF: 0.724)
**OBJECTIVES**

- Classify the satellite cloud images for predicting the cyclone intensity.
- Increase the classification accuracy by applying our proposed technique in less processing time.

**RESEARCH HIGHLIGHTS**

**Satellite Cloud Image Classifications For Few Meteorological Applications**

With the recent advancement in satellite imagery technologies it is possible to obtain images of atmosphere with different parameters then accordingly used for weather predictions. Cyclone progress is estimated with different evolutions such as pre storm stage, initial stages, cyclone formation and severe etc. The progress is identified by different patterns exhibit by cloud images. These patterns are classified with Dvorak technique which is normally based on expert human judgment. However various techniques have been adopted such as using ANN, SVM have also produced good classifications results.

The processing of pixels and identifying the neighbourhood pixels with same intensity level with more accuracy is proved to be more helpful in identifying the patterns. Since cloud motions are dynamic in nature the patterns which occur in one region may not be same for next few minutes and subsequently it may change over the time.

In order to classify the patterns and to recognize the intensity of cyclone with less processing time the segmenting of images should be done very fast. Our new proposed methodology using Hypergraph for fast segmentation would provide promising result in terms of classification and also with reduced time factor for multiple nodes would be connected through an edge. Since cloud movements are not static in nature the closeness parameters are also needs to be considered. In that aspect incorporation of fuzziness would be more fruitful to obtain results. Based on that, the severity of cyclone can be estimated whether it is low or moderate or severe.
Major Publications


OBJECTIVES
• Design a framework for Computer Aided Diagnosis System in Medical Image Analysis
• Design a prototype for Big Data related problems using Hadoop

RESEARCH HIGHLIGHTS
Optimal Path Detection between a Pair of Ground Locations

In a battlefield, it is mandatory to avoid confronting enemy points and navigate between mission points in the field. Also in such a scenario, navigating in the most optimal path (in terms of cost and safety) will be desired. The nature of battlefield terrain also decides the cost of the path being planned. The solution would be to plan a shortest path by assigning priorities to the terrain type. The main objective of the project is to develop a Guidance system to find optimal path between a pair of ground location where the path difficulty is decided according to type of terrain. Each type of terrain will be assigned cost such that the final path chosen will be the path with least cost. The planned path must confine to certain criteria like least path cost, no collision with obstacle points, less energy consumption.

Major Publications


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Research Areas
Cloud Computing, Artificial Intelligence and Design of Heuristics

OBJECTIVES
• Design scalable heuristics for economic virtual resource allocation in cloud data centres
• Improve profits for cloud service provider

RESEARCH HIGHLIGHTS
• Proposed the first direct Vector Bin-Packing heuristic (MCBVP) for energy-efficient virtual machine placement in cloud data centres
• MCBVP is highly scalable and demonstrated the placement of more than 1010 VMs

Major Publications
OBJECTIVES

- Develop a speech translation system from English to Dravidian languages in order to overcome the language barrier
- Forecast the behaviour of the speaker perceived by the listener from non-verbal behaviour

RESEARCH HIGHLIGHTS

Speech based automatic personality perception using spectral features

Automatic personality perception is the prediction of personality that others attribute to a person in a given situation. The aim of automatic personality perception is to forecast the behavior of the speaker perceived by the listener from nonverbal behavior. Extroversion, Conscientiousness, Agreeableness, Neuroticism, and Openness are the speaker traits used for personality assessment. In this work, a speaker trait prediction approach for automatic personality assessment is proposed. This approach is based on modeling the relationship between speech signal and personality traits using spectral features. The experiments are achieved over the SSPNet Personality Corpus. The Frequency Domain Linear Prediction and Mel Frequency Cepstral Coefficient features are extracted for the prediction of speaker traits. The classification is done using Instance based k-Nearest neighbor and Support Vector Machine (SVM) classifiers. The experimental results show that k-Nearest Neighbor classifier outperforms SVM classifier. The classification accuracy is between 90 and 100%.

Speech translation system for English to Dravidian languages

The Speech-to-Speech Translation (SST) system, is mainly focused on translation from English to Dravidian languages (Tamil and Malayalam) has been proposed. Three major techniques involved in SST system are Automatic continuous speech recognition, machine translation, and text-to-speech synthesis system. In this paper automatic Continuous Speech Recognition (CSR) has been developed based on the Auto Associative Neural Network (AANN), Support Vector Machine (SVM) and Hidden Markov Model (HMM). The HMM yields better results compared with SVM and AANN. Hence the HMM based Speech recognizer for English language has been taken. We propose a hybrid Machine Translation (MT) system (combination of Rule based and Statistical) for converting English to Dravidian languages text. A syllable based concatenative Text To Speech Synthesis (TTS) for Tamil and Malayalam has been proposed. AANN based prosody prediction has been...
done for the Tamil language which is used to improve the naturalness and intelligibility. The domain is restricted to sentences that cover the announcements in the railway station, bus stop and airport. This work is framed a novel translation method for English to Dravidian languages. The improved performance of each module HMM based CSR, Hybrid MT and concatenative TTS increases the overall speech translation performance. This speech translation system can be applied to English to any Indian languages if we train and create a parallel corpus for those languages.

**A novel whispered speaker identification system based on extreme learning machine**

Whispered speech speaker identification system is one of the most demanding efforts in automatic speaker recognition applications. Due to the profound variations between neutral and whispered speech in acoustic characteristics, the performance of conventional speaker identification systems applied on neutral speech degrades drastically when compared to whisper speech. This work presents a novel speaker identification system using whispered speech based on an innovative learning algorithm which is named as extreme learning machine (ELM). The features used in this proposed system are Instantaneous frequency with probability density models. Parametric and nonparametric probability density estimation with ELM was compared with the hybrid parametric and nonparametric probability density estimation with Extreme Learning Machine (HPNP-ELM) for instantaneous frequency modeling. The experimental result shows the significant performance improvement of the proposed whisper speech speaker identification system.

**Major Publications**

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**Research Areas**  
Machine Learning Applications, Data Analytics, Medical Image Analysis, Optimization Techniques and Wireless Sensor Network

**OBJECTIVES**

- Design a framework for Computer Aided Diagnosis System in Medical Image Analysis
- Design a prototype for Big Data related problems using Hadoop

**RESEARCH HIGHLIGHTS**

**Online Sensor Validation in Nuclear Plant**

A sensor validation model was developed for thermocouple sensor fault detection and classification in Fast Breeder Test Reactor using data-driven method. Several approaches were proposed to detect the sensor fault and classify its pattern. In one approach, the fault is detected using singular value decomposition (SVD) based approximation method and the faulty signal is analyzed by symbolic dynamic filter. The SVD is used to reconstruct the data, which mapped the data to a normal data by eliminating noise and outlier. The residual is generated by the error of reconstructed data from the actual data and fault is detected if the residual exceeds predefined threshold value. The faulty signal is analyzed by probabilistic finite state automata (PFSA), which is built after partitioning the signal space into a set of symbols. In the second approach, the fault is detected by deep learning based classifier (DBN) and the faulty signal is analyzed by composite generalized likelihood ratio test (GLRT). The deep learning techniques is used to classify the abnormal data from normal data. The faulty signal is identified by the maximum squared error of the faulty signal from the mean of normal data. Fault types are classified by composite GLRT based on the magnitude of the fault parameter. The output of the identified fault types through the proposed algorithm as given below in a diagrammatic form.

![Diagram showing signals from different types of failure of thermocouple.](image-url)
Major Publications


OBJECTIVES
- Development of the light weight crypto systems suitable for power constraint devices
- Hardware realization of the light weight cryptography
- Modelling towards optimized utilization of cloud resources

RESEARCH HIGHLIGHTS
Security enhancement for Digital India Initiative
A cashless society is a society where currency notes or cash are not used in monetary transactions. It is a hypothetical situation in favour of alternative means of exchange. Cashless societies in the past were based on the barter system where people exchanged their livestock for food crops or other goods. However, the present concept of a cashless society or country is a new thing. Here cashless transactions are made with the help of digital currencies like the bitcoin. In a truly cashless society, legal tender (money) is exchanged and recorded only in the electronic digital forms. Card-based payments have a growing share of retail payments, as non-cash payments in both e-commerce and traditional commerce. There are different types of cards, according to their characteristics (debit and credit) and their holders (consumer and commercial). Card schemes are set up as four-party or three-party schemes providing a framework for schemes' fees and rules. Using cards for payments generates costs, which are distributed in the form of fees among the participants in the scheme. Interchange fees are designed to cover a portion of these costs, and they are paid by the merchant’s bank to the cardholder’s bank, per transaction. The project proposes security enhancement for card based payment.

Major Publications


OBJECTIVE
Design computationally intelligent techniques for dimensionality reduction, classification, and prediction to address the various research challenges in multiple fields like Network Security, Applied Cryptography, and Bioinformatics.

RESEARCH HIGHLIGHTS

Getting ready for Offensive and Defensive Cyber Security: Country’s readiness to fight Cyber Terrorism
The security measures to prevent cyber-attacks can be exterminated through the design of a novel cyber security framework. This framework integrates various approaches such as machine learning, statistics and information theory, etc. to build a more effective and cost sensitive IDS for protecting the users from known and zero day threats. The most important objective of this research work is to develop an automated intrusion detection model which analyzes the behavior of massive volume of network traffic which analyzes the behavior of massive volume of network traffic from various sources like wired and wireless users, network emulators etc for the identification of unknown threats or variants of known threats. Big data analytics proves to be a promising technology for processing and mining the meaningful information intended for knowledge discovery from large volume of data. It provides a user friendly, open source platforms like Apache Hadoop and Spark which has a collection of tools like HDFS, Hbase, Hive, Mapreduce, Sqoop, etc. or real time data collection, storage and processing in a distributed environment. It also supports various machine learning algorithms (Apache Mahout), through which an efficient clustering and predicting model can be developed for identification of threats and also the source of the attack.

A Big Data Analytics Framework for Epilepsy prediction using Brain Computer Interface
In recent years, Electroencephalogram (EEG) based analysis technique has been the predominate choice of researchers for diagnosing Epilepsy. Advances in the field of bioengineering and computational techniques with respect machine learning and data mining techniques, provides a strong foundation for the development of an efficient and a robust learning model for the identification of normal and abnormal patients based
on the EEG signals. In general, the EEG signals collected from abnormal patients were used to train the learning model after the identification of the informative features with the help of a suitable feature selection technique. Once the learning model completely learns the patterns of the abnormal users, the real time signal are fed into the model to obtain its decision regarding the current state of the patient. The high dimensionality and massive nature of multi-channel EEG signals makes feature selection an essential step not only to improve the accuracy of the learning model but also to minimize the computational complexity and implementation cost. The development of intelligent techniques in the big data –cloud platforms like IBM Bluemix deals with imprecision, learning and evolution in solving computational problems in the field of data science. Hence, in this project, a multi-task oriented knowledge discovery framework is proposed which utilizes MapReduce programming model in IBM Bluemix environment to handle high dimensional EEG signal dataset.

A Big Data Analytic Framework for Intrusion Detection in SCADA System
Cyber physical systems (CPS) are large scale, organized, heterogeneous systems consisting of sensors, actuators, control units, network components etc has a significant applications in various fields. In recent years securing CPS against various cyber threats has been an important topic of research which led to the several research works across the globe. Supervisory Control and Data Acquisition (SCADA), a subgroup of CPS. The major target of the malicious users on SCADA systems is to compromise the integrity, availability, timeliness, scalability of the components. This emphasizes the need for an Intrusion Detection System (IDS) to identify the compromised nodes through which catastrophic failure of SCADA systems and further critical consequences can be avoided. However the design of an effective IDS model for the SCADA system is critical task due to the massive volume of traffic generated by its components. For example, around thousands of temperature, pressure, flow, level, etc. sensors were deployed and monitored regularly at short time intervals to ensure the safe functioning
of nuclear reactors. In addition to the large volume of network traffic, cyber-attacks have become more sophisticated in nature due to which most of the traditional IDSs fail to provide perfect solution. Hence, in this work we aim to build robust and intelligent IDS that consist of higher level of abstraction through which a decision with higher level of accuracy can be taken in less time.

**Major Publications**

OBJECTIVES

- Develop a novel recommendation system for addressing key issues of Cold-Start, Sparsity, and Diversity
- Build a better decision-support model for the personalization Point-of-Interest recommendation

RESEARCH HIGHLIGHTS

Travel Recommender System

Recommender Systems (RSs) are developed as information filtering systems to make personalized predictions based on the priorities and preferences for the suggestion of relevant items to users. Predicting interesting locations for the generation recommendations from Location Based Social Network (LBSN) is crucial due to variety, size, and dimensions of data. The growing demand for effective TRSs extends the scope for the development of user behavior based recommendation approach. As a significant solution to the existing limitations of TRSs, we have developed an Activity and Behavior induced Personalized Recommender System (ABiPRS) as a hybrid approach to predict persuasive POI recommendations. The proposed ABiPRS is designed to support travelling user by providing an effective list of POIs as recommendations. As an extension, we have designed a new group recommendation model to meet the requirements of the group of users by exploiting relationships between them. Further, we have developed a novel hybridization approach for aggregating recommendations from multiple RSs to improve the effectiveness of recommendations. The proposed approaches are evaluated on the real-time large-scale datasets of Yelp and TripAdvisor.

Architecture of Activity and Behavior induced Personalized Recommender System
Major Publications

OBJECTIVES

- Design distributed algorithm for virtual backbone construction for power effective network.
- Design power efficient data aggregation with fault tolerance in WSN

RESEARCH HIGHLIGHTS

**Semi graph based Connected Edge Dominating set – For Virtual backbone construction in WSN**

The wireless sensor network is an infrastructure less network which does not possess any centralised nodes to govern the detection of node position, route establishment and data transmission in the network. The batteries are used as the power source which is limited in power capacity, replacement of the battery is not possible due to the harsh environment of the WSN application. Since the communication between the nodes consumes most of the nodes power, the topology-based power control mechanisms play a vital role in energy consumptions. So, to generate the topology-based energy control selected nodes are used to generate a virtual backbone connection which reduces the unwanted routing of data. Connected Edge Dominating Set (CEDS) based algorithm is used to frame the virtual backbone network. The virtual backbone link generated by the CEDS algorithm suffers a disadvantage due to NP-Hard problem. To overcome this problem, a novel distributed algorithm is introduced to generate size and power effective network. The proposed Connected Edge Dominating set based Semi graph model is used to generate network topology with lesser construction cost and reduced network sizes compared to the traditional topology framing algorithms for both random and uniformly placed nodes. The performance ratio of the algorithm proposed is measured as \((4+\ln\Delta')|\text{opt}| + 1.2\), were the \(|\text{opt}|\) represents the network size framed using CEDS based semi graph model. The time complexity is measured as \(O(m)\), The message complexity is measured as \(O(mn+m\Delta')\)
which is considered to be linear, where \( n \) is the total number of vertices in the semi graph. The performance of the network is simulated using the NS2 simulator, and the performance metrics were studied.

**Major Publications**

OBJECTIVE
Design and Develop a novel IoT solution for Edge Computing platform using Blockchain, Gated Recurrent Unit and Role based access control for Cloud platform

RESEARCH HIGHLIGHTS

IoT Solution for Edge Computing Platform
Currently, one of the areas of research is in Edge computing, which deploys distributed nodes and gateways across vast geographical areas, ultimately moving the subset of cloud functions closer to the edge and the IoT devices. This is to facilitate real-time decision making which increases efficiency and scalability. Blockchain (Fig. 1) creates a distributed trust and security structure that can be used to safeguard network resources and transactions. The aim is to build a blockchain-based security fabric that is autonomous, real-time, decentralized, deployable, and adaptive, comprehensively satisfying the challenging requirements of a global industrial IoT.

Fig. 1 Use of Blockchain in IoT
A hybrid IDS mechanism has been designed which is capable of identifying the network components, perform deep packet inspection to extract payload and do integrity check of the sensor and actuator data in Industrial Internet of Things (Fig. 2). The automatic generation of rules is done by a combination of CART and roll forward validation techniques. A variation of LSTM (Long Short Term Memory) GRU (Gated Recurrent Unit) based on neural networks is used for addressing the scalability of network devices.

Fig. 2 Typical IIoT setup

An integrated framework is designed to support diverse IoT applications in edge environment that analyses the offloadable components to the nearby devices. The optimization strategy is decided by adapting container virtualization in the edge environment which improves the performance of the IoT devices and reduces communication overhead.

A secured framework is also designed for sharing data in cloud computing environment to facilitate flexible access control for data stored in third party storage that preserve privacy of both user and data. This system designed is efficient as it provides scalable search over encrypted data for multiple owners and user. Also, a proactive self prediction model that uses classification ensemble model to fine tune the predicted label has been designed. This improves prediction accuracy using clustering approach and also recommends scheduling techniques for failure recovery.
Major Publications
2. A.Joy Christy, A.Umamakeswari, RFM Ranking – An effective approach to customer segmentation, Journal of King Saud University – Computer and Information sciences, (Accepted for Publication), 2018.
3. M.Surendar, P.Balakrishnan, and A.Umamakeswari, Roll Forward Validation based Decision Tree Classification for Detecting Data Integrity Attacks in Industrial Internet of Things, Journal of Intelligent and Fuzzy Systems, (Accepted for Publication), 2018. [IF:1.261]
OBJECTIVES

• To develop lung cancer detection and classification system using Computer Aided Image processing and Data mining classification techniques on CT Images
• To classify the output either Cancerous or Non Cancerous
• To assist doctor in identifying lung cancer in early stages and can be cured

RESEARCH HIGHLIGHTS

Efficient Computer Aided Diagnosis on CT images for lung cancer detection and classification

Medical image processing on Lung CT images involves detection of cancer and classification of various stages of cancer for diagnosis and treatment. Detecting cancer in CT Images needs special skills and techniques because they are difficult to detect especially in early stages. Suspected cancer region nodes in CT image are segmented through image segmentation techniques using MATLAB. Using feature extraction, various features from segments are extracted for mathematical analysis. Extracted features are given as input to pattern recognition classifier system to classify a suspicious node is cancer or non cancer. If the suspicious node is cancer, it is classified on various stages. Proposed system is aimed to generate more accurate results by finding more true positives and reducing false positive. Results will help doctors to confirm and classify the cancer stages. Early detection of cancer can be cured or extend the survival rate of patients.

Major Publications

OBJECTIVES

- To develop algorithms for secure communication of multimedia objects
- To develop techniques to mitigate attacks on various image formats
- To realize and analyze security algorithms on s/w and h/w platforms

RESEARCH HIGHLIGHTS

Secure Communication

Digital Imaging and Communications in Medicine (DICOM) is one among the significant formats used worldwide for the representation of medical images. Undoubtedly, medical-image security plays a crucial role in telemedicine applications. Merging encryption and watermarking in medical-image protection paves the way for enhancing the authentication and safer transmission over open channels.

Image Steganography

Information security, though having different areas of interest, is fairly specific and confined to secure digital data transmission. Currently, there are many data security techniques addressing various aspects of secured information sharing. Amongst those, one that is sufficiently epic, successful and challenging is steganography in spatial and transform domain.
Image Encryption
In this technological era, it is highly essential to protect the digital medical data from the fraud and forgery as they are transmitted over the public channel. Also with the increased data traffic, it is hard to transmit the entire bulky medical data. New methods have come into the scene to reduce the traffic while maintaining the sufficient level of security. Partial encryption is one of the methods which selectively encrypt the bulky medical image. Meanwhile, if the same medical image is needed to be reused for another diagnosis, then it is recommended to protect the entire medical image.

Major Publications
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Research Areas
Nanoelectronics, 2D materials, Quantum Transport, Semiconductor Device Modeling, Compact Modeling

OBJECTIVES
• To understand the physical properties and electrical transport mechanism in 2D layers by using quantum simulation tools
• To understand the potential of different 2D layers as nanoscale-MOSFET channel material

RESEARCH HIGHLIGHTS
A Computational Study of Phosphorene for Nanoscale MOSFET Application
Today, the Si based semiconductor industry is facing a real challenge to maintain the scalability of devices that will provide faster, reliable and low power consuming circuit blocks. The possible solution includes new device structure or new device channel materials replacing the conventional MOSFET. Recently, monolayer of Phosphorus (phosphorene), a p type semiconductor material, had been experimented with a carrier mobility of 1000cm²/V .s and with a current on/off ratio of (10⁴). It looks to be a promising material for future CMOS circuits. On the basis of the observation made, this project is exploring 2D phosphorene by applying Density Functional Theory (DFT) and non-equilibrium transport equations for future implementation in a nano MOSFET.

Figures: Top- zigzag phosphorene nanoribbons (ZPNRs) Structure. Left- Negative Differential Resistance behaviour observed in antidot ZPNRs. Inset is showing the device structure.

Analysis of contemporary transistor geometries for Analog/RF application using 2D layer as channel material
Tunnel Field Effect Transistor (TFET) is a favourable device that offers lower leakage current, low subthreshold swing (SS) and has the ability to operate at a very low supply voltage. It depends on band-to-band tunnelling (BTBT) process for the flow of carriers unlike
the traditional MOSFETs which use thermionic emission over the barrier. Additionally, the fabrication techniques for TFET is compatible with the existing CMOS fabrication flow, making it suitable for semiconductor industry. In this project, initially different form are investigated of TFET structure such as asymmetric short gate architecture with gate engineering are investigated and the Analog/RF performance has been analysed. In the next step, a similar structure in Analog/RF domain while depositing a thin layer of 2D material (phosphorene) on the channel has been tested.

Major Publications
OBJECTIVES

• To detect the pesticides at lower detection limit in nanomolar range: In order to attain low detection limits are optimized the enzyme concentration and enhance the electron transfer rate by using appropriate size and shape specific nano-interface
• To fabricate low cost electrodes for effective detection of pesticides: TCO thin film

RESEARCH HIGHLIGHTS

Theoretical Characterization of Nanoparticles

Amino acids act as structure-directing agents in shaping the metal and metal oxide nanoparticles. Amino acids also guide the formation of thin films and modify the properties of the coated surface like hydrophobicity. In this work the potential of few amino acids, which could be the driving force behind the interaction, have been deduced. The variation in potential has been noted and it depends on the distance between particles. With this internal potential characterization of nanoparticles, their structure factor could be determined which can theoretically validate the bond formation.
Pesticide Detection by Enzymatic and Non-Enzymatic Methods

Excessive and unsafe usage of pesticides lead to adverse effect on human beings, plants, animals and aquatic life. Endosulfan, categorized as class-I pesticide by World Health Organization, is a highly toxic pesticide, is currently being used across countries though it has been banned. Considering the decrease in current intensity observed in DPV, the stalling behaviour of chloride ions in α-endosulfan indirectly confirms its presence. The figures of merits were estimated to be with the linear range of 4-20 nM.

Major Publications


OBJECTIVES

• To Design and Characterize Next Generation Communication Systems
• To Develop and Test Reconfigurable Prototypes for Wireless Communication
• To Develop algorithms for Secure Wireless Communication

RESEARCH HIGHLIGHTS

Wireless communication is widely being acclaimed as one of the tremendous innovations of technology, yet its efficiency is being slacked due to the problem of spectrum scarcity, as the demand for its spectrum is always increasing. Cognitive radios are a good fit for overcoming inefficient usage of the available radio spectrum, allowing secondary users to utilize the spectrum when the licensed primary users are not using it. This requires secondary users to continuously observe their spectrum utilization to prevent interfering with the primary users’ transmissions termed as spectrum sensing. However, an adversary can exploit this to gain unfair use of the spectrum. Such an attack is known a primary user emulation attack (PUEA) which is the main attack in the physical layer of the cognitive radio. To avoid this attack, a method of authenticating the primary users’ signal is required. Hence the research focus is to explore the various methods, to sense the spectrum in an efficient manner and in addition to mitigate the PUEA in the physical layer of cognitive radio.

Major Publications

3. Avila J, Thenmozhi.K Helper node based effective spectrum sensing and defense against physical layer attack in cognitive radio network. Biomedical Research, 2017; 286: 2830-2835. (IF: 0.21)
OBJECTIVES
• To develop nanoparticles through hydrothermal & surfactant mediated growth
• To deposit the prepared nanoparticle as thin / thick film on various substrate for gas sensing application
• To analyse the electron transport property during gas-solid interaction through DFT approach

RESEARCH HIGHLIGHTS
Experimental and Computational Study on DSSC
The overall objective of the work is to analysis the light harvesting property of the metal oxide based dye-sensitised solar cell. In this work, nanostructured metal oxide will be deposited over the glass substrate by liquid phase technique. Additives such as cationic, anionic and zwitterion surfactant will be utilised to control the size and shape of the nanostructured metal oxide during synthesis in liquid phase technique. Also DFT approach will be made on the dye adsorbed metal oxide nanostructure to analysis the optimised structure, HOMO-LUMO levels, electrostatic potential (fig.a,b,c,d) and optical absorption of the system to analysis the light harvesting property. Based on the computational studies, an optimised condition will be arrived at to fabricate DSSC. The outcome of the work will gives an insight atomic level interaction of Photon-dye-MOS structure and help to design the solar cell with better efficiency.

TiO₂-dye optoelectronic studies

Nanostructured MOS For Gas Sensor Application
The overall objective of the work is to optimise the liquid phase technique such as spray pyrolysis and hydrothermal to obtain size and shape selective metal oxide nanoparticles for toxic gases and vapour detection applications. Different surfactant mediated growth will be utilised to obtain various size and shape of the nanoparticles and its influence on gas / vapour detection at ambient and elevated temperatures. The size-shape selective metal oxides such as ZnO and MnO₂ will be directly deposited
over the substrate and the gas detection will be studied through chemi-resistive method. Various characterisation will be done to analysis the crystallinity, morphology and compositional purity of the obtained metal oxide. The following figure shows (a) XRD, (b) FESEM, (c) Optical absorbance and (d) FTIR results of TiO2 nanoparticles

Major Publications
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Research Areas  
Process Control, Fault diagnosis  

OBJECTIVES  
- To design suitable optimal controllers for chemical process system  
- To study the performance of soft computing based algorithms for fault conditions in PV system  
- To develop a benchmark for the closed loop performance of the controller under faulty conditions  

RESEARCH HIGHLIGHTS  
Detection of Islanding condition in Grid Connected PV System  
Grid connected PV systems is well recognized all over the world despite the fact that there have been some drawbacks about connecting them to the electrical grid. One of the main challenges of integrating distributed generation into the power grid is islanding, which occurs when a part of the electrical power system is disconnected from the rest of the grid and is still energized by a DG unit. If islanding is not quickly detected, it can present serious safety and hazardous conditions. This work addresses issues involved in detection of islanding condition for the grid connected PV system using suitable fuzzy algorithm for PV based diode clamped multilevel inverter. A digital Gustaffson–Kessel fuzzy clustering algorithm is implemented on a FPGA to keep the current injected into the independent source (grid) sinusoidal and to achieve high dynamic performance with low THD of output voltage and output current. Here, the grid tied PV-based DCD-MLI is effectively integrated and utilized for achieving the energy efficiency. Considering the significance of the aforementioned PV-based inverter, the PV source can be fully utilized and integrated in specially designed buildings where the available PV energy can be easily harvested by using the proposed PV-based inverter.
Optimal Frequency Estimation of Coriolis Mass Flow Meter Using Two Parameter Kautz Function

Coriolis Mass flow meter, based on Coriolis principle is used for measuring the flow of fluid in terms of mass. Mass of the fluid is affected by the density which in turn affects the frequency of the flow. Since CMF is a resonant system, the frequency of the oscillating signal measured by the sensor gets varied by changing the fluid flow rate which changes the mass considerably. To adapt with changes in frequency and to get the optimal frequency value for particular flow, optimal kautz functions is used. Kautz function is a set of orthonormal functions that approximates the resonant system with less number of parameters. In this work, parameterizing the kautz functions in terms of poles. Since frequency has the direct relationship with poles, measuring the optimal poles indicates the frequency measurement. To get optimal pole, optima states are obtained using state observer (State feedback) and get the optimal control law which directs the kautz model to get the optimal pole and gives the optimal frequency subsequently.

Major Publications
1. Raajan N.R, Nandhini K, Balasubramanian G. Classification of Selective and Non Selective EEG Using Selective Information. National Academy Science Letters, 2018; (IF: 0.519)
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Research Areas
High Voltage Engineering, Power Systems

OBJECTIVES
• Partial discharge pattern classification, location identification, denoizing of partial discharge signals
• Pollution performance tests on line insulators and application of thermal imaging for insulator condition monitoring
• Microbial inactivation system using high voltage impulse signal

RESEARCH HIGHLIGHTS
Partial Discharge Analysis on Transformer Insulations
Deterioration in the performance of oil filled transformers is directly associated with the degradation of the insulation system like transformer oil and oil impregnated pressboard under different operating conditions. The dynamics of degradation process depends on electrical, thermal, combined stresses and other related factors such as moisture, temperature, pressure, etc. Partial Discharge (PD) activity in different insulation samples were measured under different test conditions. The insulation samples include new untreated transformer oil, aged transformer oil, thermally treated oil, oil impregnated pressboard samples and nanofluid based mineral oil. PD measurement in insulation samples is mainly intended to analyze the effect of test voltage magnitudes, effect of constant applied voltage for longer time duration, effect of accelerated temperatures and effect of nanofillers on PD. From the experimental investigations, it is evident that the PD activity is more pronounced in naturally aged transformer oil samples and oil samples that are subjected to accelerated ageing conditions. In addition, PD activity is appreciably less in nanofluid based mineral oils. Further, the dynamics of PD activity was also analyzed using statistical and computational tools.

**PD activity at different voltages in aged oil sample**

![PD activity at different voltages in aged oil sample](image)
PD activity in aged oil sample for longer aging time

Variation in PD magnitude w.r.t ageing temperature

PD Activity in Nanofluid based Mineral oil


OBJECTIVES
• To investigate adsorption of gas/vapors on monolayer nanostructures
• To study the switching properties of nanostructures in molecular devices
• To explore the mechanical properties of nanomaterials under high pressure films that will be used to fabricate disposable and cost effective electrodes

RESEARCH HIGHLIGHTS
First-principles investigation on the adsorption properties of gas/vapors on two dimensional monolayer group-V molecular devices
The emission of toxic gases/vapors leads to the threat of human life and nature. In order to check the environment quality and safety, proper monitoring of toxic gases/vapors in the atmosphere that too in parts per million/billion (ppm/ppb) is required. To monitor the toxic gas/vapor in the atmosphere a sensitive and selective nanosensor is required. Using exfoliated monolayer the band gap can be tailored, which leads to the application of monolayer group-V nanostructures as chemical Nanosensors. The exfoliated monolayers of phosphorene, arsenene and antimonene are being studied to ascertain its structural stability and electronic properties. Moreover, monolayer of group-V elements may be of n or p-type depending upon its geometry, which can be fine-tuned to detect the presence of oxidizing and reducing vapors. The density functional theory approach will give the perception on the adsorption characteristics of toxic gases/vapors in atomistic level.
Major Publications
OBJECTIVES

- Studying the occurrence of collective behaviour in coupled nonlinear systems
- Identifying exact solution for nonlinear systems
- Studying the dynamics of parity-time symmetric optical systems

RESEARCH HIGHLIGHTS

Study of Collective Behaviour In Coupled Nonlinear Systems: Routes and Quantification

Feedback is the powerful regulatory mechanism that controls almost all functions of an organism or the biological systems. The importance of feedback become more clear if one look onto the control mechanisms that underlies the cell signalling, animal development, genetic networks, neural networks and so on. The feedback loops are necessary to maintain homeostasis of the body, that is to maintain the temperature, pH and so on at the proper level. Thus, any problem in the feedback loops disturbs the homeostasis of the body and which in turn leads to illness. Feedback technique has also been used for treatment purposes, for example, for the treatment of Parkinson’s disease. The recent research, deals with the usefulness of feedback mechanism in overcoming oscillation quenching, is the phenomenon that arises due to the interaction of oscillatory systems. This type of oscillation quenching is responsible for cardiac arrest, hypothermia, coma, Ohtahara syndrome and so on. Thus the understanding and proper handling of feedback can aid to maintain the body in a normal condition.

Synchronization in Complex Networks: Application in Neurophysics and Spintronics

The studies on complex networks and coupled systems have now given good understanding of the rich collective dynamical patterns displayed by a variety of natural networks including biological and chemical networks. In such biological and chemical networks, the important tools that controls/regulates their dynamics are the positive (attractive) and negative (repulsive) interactions. Due to the above reasons, the studies of complex networks with counteractive effects like positive-negative, attractive-repulsive and activator-inhibitor are found to be interesting over years. In this project, the dynamical behavior in a networks
of oscillators with combination of attractive and repulsive interactions have been investigated and also armed and aim to unravel the mechanism underlying various collective dynamics observed in nature. Interestingly, it has been identified that the identical system behaves as a non-identical one which exhibits symmetry breaking states such as chimera and oscillatory cluster states as shown in Figure. Symmetry breaking states can help to understand the unihemispheric sleep of mammals and birds, also has potential application in social networks and power grid blackouts.

**Major Publications**


OBJECTIVES

- Soliton propagation and modulational instability in nonlinear optical fibers
- Signal extraction from noisy environment using deep neural networks
- Quantum concept of Internet of Things

RESEARCH HIGHLIGHTS

Audio Signal Extraction from Noisy Environment

M/s Verdant Telemetry, an industry based at Cochin, has provided the data in CSV format of the software defined radio (SDR) system, operating in the HF range between 2MHz and 30 MHz, developed by them. The SDR system is capable of capturing data coming from the ionosphere. The drawback with this output data is that it gets affected with noise. The project emphasizes on the extraction of audio signal from the noise present in the demodulated output of the SDR system using deep neural network and uncertainty quantification.

Major Publications

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Research Areas  
Nonlinear Dynamics, Collective Dynamical States, Complex Networks

OBJECTIVES  
• Study of nonlinear dynamical systems and identify their nature of transition in the systems  
• Study of distinct collective dynamical states in complex networks. TiO₂/ZnO film.

RESEARCH HIGHLIGHTS  
Study of collective dynamical states in nonlinear dynamical networks is of great interest in many areas of science that include physics, chemistry, biology, neuroscience, socio-economic systems, and engineering. Understanding the evolutionary aspects of dynamical systems and networks influenced by nonlinear forces has led to several new concepts and ideas in the past few decades. Bifurcations, chaos, synchronization, oscillation quenching state, spatiotemporal patterns, explosive synchronization etc. are some of the notions which have emerged out of these studies. In this connection, one of the collective dynamical state behaviour characterized by coexisting coherent and incoherent domains is termed as a state. The existence of a new type in a nonlocally coupled ensemble of identical oscillators driven by a common dynamic environment has been identified. The latter facilitates the onset of phase-flip bifurcation/transitions among the coupled oscillators of the ensemble, while the nonlocal coupling induces a partial among the out-of-phase synchronized oscillators at this onset. This leads to the manifestation of coexisting out-of-phase synchronized coherent domains interspersed by asynchronous incoherent domains elucidating the existence of a different type of state. In addition to this, a rich variety of other collective such as clusters with the phase-flip transition, conventional, solitary state and complete synchronized state which have been reported using different coupling architectures are found to be induced by the employed couplings for appropriate coupling strengths have also been identified. The robustness of the resulting dynamics in the indirect environmental coupling plays a crucial role in facilitating complex collective dynamics such as decoherence, coordinated rhythms in biological systems and quorum sensing.

Major Publications  
OBJECTIVES

- To develop algorithms for secure communication of multimedia objects
- To develop techniques to mitigate attacks on various image formats
- To design fault-tolerant systems

RESEARCH HIGHLIGHTS

True Random Key Generator using FPGA

Field Programmable Gate Arrays (FPGAs) are being employed in most of the information security applications. A number of elements such as clock jitter, delays, PLLs and multiple clock frequencies supported by on-chip reconfigurable platform promise an attack cum tamper resistant TRNG based on FPGA. In this work, PLL based TRNG architecture is implemented on FPGA with dynamic clock selection process. Linear Feedback Shift Register and Galois Field Multiplier are post processing functions. Statistical and hardware analyses of the developed TRNG is a part of this work. The generated true random key is employed for image encryption and decryption on FPGA. This work will also explore the communication of encrypted keys and images between two FPGA units.

Major Publications

OBJECTIVES

- Design and Characterization of Next Generation Communication Systems
- Design, Develop and Test Reconfigurable Prototypes for Wireless Communications and Radar Systems

RESEARCH HIGHLIGHTS

Low Frequency Antenna for Airborne Radar

RES (Radio Echo Sounding) techniques are widely used in glaciology to study the properties of glaciers, such as the total thickness, possible layering and heterogeneity, the characteristics of the ice-bedrock interface, and possible sub glacial lakes. Typical frequencies used for bedrock sounding in the polar zones are in the range 50 - 150 MHz, but for surveying the mountain glaciers lower frequencies should be used, this is due to their higher temperature that affects the attenuation of the radio waves. A sounding frequency of 10, or better 5 MHz, would experience less attenuation, but that increases the antenna dimensions, that makes it impossible to be safely mounted under a helicopter. This work focuses on the reduction of antenna size without much change in its characteristics.

Antenna Design and Simulation

a) Multibeam Steerable Antennas

Design of an array with pattern reconfigurability and beam steering on multilayer structure with minimum number of RF switches is the main objective of this work. A single antenna element in the array consists of a dipole element and two parasitic elements,
designed in a multilayer dielectric structure. The length of the parasitic elements can be reconfigured using RF switches. Switching the length of the parasitic elements in various configurations, the main lobe of the single antenna of the array is shifted in three directions. This leads to the three modes of operation. By configuring the switches of every antenna in the array the main lobe of the array shifts the direction. The main lobe of the antenna array in a particular mode is made steerable by changing the phase shift between the antenna elements. Simultaneously changing the length of the parasitic elements by switches and changing the phase shift between the antenna elements in the array, the main lobe is made steerable in any of the three modes. These antennas are very useful in sector antenna applications.

b) Nanoantennas for harvesting waste thermal energy from hot automobile exhaust system
Energy harvesting from the bodies at higher temperatures has been attempted by many in the past. Our interest is to design a rectangular patch antenna which can harvest energy from thermal radiation of an automobile exhaust system. It consists of an exhaust manifold, catalytic converter and tailpipe. When the vehicle is in motion, the surface temperature of the three components varies drastically. Our aim is to harvest energy from these components by designing three nanoantennas with different frequencies depending on the surface temperature of the components. Modelling and simulation of the antenna are performed in EMPro 3D EM simulation software using Finite Element Method (FEM) EM field solver.

TransIonospheric Radio Wave Propagation
The ionosphere is a dynamic and frequency selective fading channel which influences the radio waves passing through it. Solar wind impact on earth’s magnetosphere drastically changes the electron-ion precipitation over the polar cap. The fluctuation in the amplitude of the radio waves passing through the ionosphere is attributed to the irregularities of a few hundreds of meters to kilometers while the variation in phase is generally due to small-scale irregularities. The variation in the electron density which is seen in the refractive index is also critical. The ionospheric irregularities respond to complex dynamic driving mechanisms and the global characterization of its response is a challenge. The ionosphere varies on various timescales from 11-year solar cycle with
its associated magnetic field variations to minutes or hours due to eruptions on the
disc of the Sun. Continuous study of the effect of the dynamic ionosphere is essential
for establishing reliable satellite communication links, precise land surveying and
navigation. Apart from TEC variation, Ionospheric Scintillation study is important to
understand the characteristics of the propagation media in the near-earth environment.

**Major Publications**

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   and mid latitudes for the recent solar minima and comparison with IRI-2012 model.
   *Advances in Space Research* 60 (2017) pp. 363-374 (IF: 1.401)

2. Stefano Urbini1, Achille Zirizzotti, James Arokiasamy Baskaradas, Ignazio Ezio Tabacco,
   Lili Cafarella, Antonella Senese, Claudio Smiraglia, Guglielmina Diolaiuti,
   Airborne Radio Echo Sounding (RES) measures on Alpine Glaciers to evaluate ice thickness and
   bedrock geometry: preliminary results from pilot tests performed in the Ortles Cevedale
   Group (Italian Alps), *Annals Of Geophysics*, 60, 2, 2017 (IF: 0.915)

3. A. Zirizzotti, L. Cafarella, S. Urbini, J.A. Baskaradas and A. Settimi,
   Assessment of Electromagnetic Absorption of Ice Core Measurements, *IEEE Transactions on

4. María G. Molina, Enrico Zuccheretti, Miguel A. Cabrera, Cesidio Bianchi,
   Umberto Sciaccia, James Baskaradas, AUTOMATIC IONOSPHERIC LAYERS
   pp. 1360-1372 (IF: 1.401)

5. B. Zolesi, C. Bianchi, A. Meloni, J. A. Baskaradas, A. Belehaki, D. Altadill, E. Dalle
   Mese, “SWING”: A European project for a new application of an ionospheric network,
   *Radio Science*, 16 - May 2016. (IF: 1.58)
OBJECTIVES

- Design and Development of Chemical sensors for exhaled breath analysis
- Design and Development of enzymatic and non-enzymatic bio sensors using developed screen printer electrodes

RESEARCH HIGHLIGHTS

Chemiresistive Gas Sensors for Exhaled Breath Analysis

Breath analysis is the new and emerging field of research with great clinical potential for disease diagnosis. The prime advantage of exhaled breath analysis is totally non-invasive and relatively easy to perform even for sick and elderly patients. The identification of Volatile Organic Compounds (VOCs) like acetone, acetaldehyde, ammonia, ethanol, etc., in human breath, sweat and urine particularly act as the fingerprints for diseases like diabetes mellitus, chronic obstructive pulmonary diseases, kidney malfunction and lung cancer. Hence, this research work aims to develop low cost, handheld chemiresistive e-nose for breath analysis to diagnosis several diseases by utilizing nanostructured metal oxides. The step by step procedure to fabricate a sensor is shown in the schematic.
Flourine Doped ZnO as Acetaldehyde Sensor

An acetaldehyde sensor to be used at room temperature using fluorine-doped ZnO nanostructured thin film has been fabricated. The investigations have been carried out to study the influence of fluorine doping on the structural, morphological, optical, electrical and room temperature vapour sensing characteristics of ZnO thin film. The film deposited with 4 wt.% fluorine-dopant concentration was found to be highly selective towards 100 ppm of acetaldehyde with a maximum response of 4.8 at room temperature. Response and recovery times were observed to be 18 and 25 s respectively towards 100 ppm of acetaldehyde.

PVP/ZnO Nanofibers for Ammonia Detection

Polyvinylpyrrolidone (PVP)/Zinc oxide (ZnO) composite nanofibers were developed using electrospun technique and their morphological and sensing characteristics were investigated by Scanning Electron Microscope and Keithley electrometer. The influence of morphological variation on gas sensing properties is the major focus of this work. The sensor showed better response towards the ammonia biomarker at room temperature.
Major Publications

5. Amudha J, Amarnath T, Ramachandra BL, Gumpu MB, Nesakumar N, Jayanth Babu K, Vedantham S, Uma Maheswari K, John Bosco Balaguru R. Fabrication of An Electrochemical Biosensor with ZnO Nano flakes interface for Methylglyoxal Quantification in Food Samples. Food Science and Biotechnology, 2018; 27: 9–17 (IF: 0.78)
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Research Areas
Transparent Semiconducting and Conducting Oxide Thin Films for Energy-Related Applications, Sculptured thin films for En-

OBJECTIVES
• Development of DSSC using the 1D, 2D & 3D nano-sculptured TiO₂ photoanodes
• Fabrication of the optimally developed, chemically & thermally inert electrochromic smart windows, having enhanced device lifetime and fastest coloration/bleaching
• Development of complex 3D nanostructured oxide thin films for enhanced sensing

RESEARCH HIGHLIGHTS
Pseudo-periodically Nano-sculptured Photo-anodes for Dye-sensitized Solar Cells (DSSCs)
A more focused research is the need of the hour in the photo-anodes of DSSCs, mainly due the optical properties, flat band potential, electrical resistance, corrosion resistance and microstructure of the photo-anode. Currently, there are only two general strategies to address this challenge;
• Discovering / exploring new materials which satisfy the unique criterion for DSSCs
• Designing new morphologies of the existing materials to improve the DSSCs’ performance

The work proposed was motivated by the potential improvement in the efficiency of the dye sensitized solar cells focused on the second issue, by preparing the nanostructures with high surface area and high aspect ratio (ratio of length to thickness of the nanostructure), since the semiconductor photo-anode must provide large active interface both for the attachment of the sensitizer and also for the contact with the electrolyte. Hence, we are working on the development of 1D, 2D, & 3D nanosculptured photo-anodes of different materials to enhance the efficiency of the DSSCs has been under progress. The nano-sculptured thin films of materials are prepared by the glancing angle deposition (GLAD) technique with sputtering as given in the diagrams below and it has been proposed to prepare the nanosculptured films having the morphology.
shown in the diagrams. The above work was implemented by developing a GLAD system which involves the manipulation of 2-axis orientation of the substrates (as shown in the above figure) in-situ deposition. Since the GLAD sputtering deposition is performed with the deposition rate ~ 1 – 10 Å/s, the substrate orientation should be precisely controlled and monitored through the real-time feedback of substrate orientation. Hence, a computer controlled GLAD apparatus is required for the preparation of nano-structures with improvement in structure and quality. In the present research, the GLAD apparatus has been indigenously developed and automated for the precise control of the substrate orientations.

Major Publications


OBJECTIVES

- To optimise the preparation condition for selective growth of nanostructured metal oxide materials
- To enhance the gas sensing performance of nanostructured metal oxide through surface modification

RESEARCH HIGHLIGHTS

**Metal Oxide Nanowires For Vapour Detection**

The overall objective of the work is to prepare metal oxide nanowires for detecting explosive and flammable vapours. In this context, ZnO and SnO\(_2\) of high aspect ratio has been deposited on glass substrate by liquid phase technique. The preparation condition of SILAR such as dip–with drawl speed, dip duration and temperature of cationic and ionic solution were optimised to obtain uniform, less cross-link growth of ZnO nanowires. The obtained ZnO were found to be poly-crystalline in nature as observed in the XRD pattern (a) and FESEM (b) shows uniform growth of nanowires with less crow-links. The obtained ZnO nanowires were tested for various vapour detection by chemiresistor method and found to show good response towards ammonia (c) at ambient temperature. Also it was observed that the charge transfer towards detection is due to direct adsorption of ammonia over ZnO nanowires.

**Surface Modification Of Nanostructured ZnO For Ammonia Detection**

The overall objective of the research work is to fabricate a hand-held ammonia detection device using surface modified nanostructured ZnO as sensing element. Using spray pyrolysis technique, ZnO will be deposited over commercially available ceramic tube consisting of nichrome wire as heating element. Suitable metal and metal oxide will be functionalised over the prepared ZnO surface to enhance the sensitivity and selectivity towards ammonia vapour in mixed environment. FESEM (a) and XRD pattern (b) of
Gold functionalised ZnO is shown below. ZnO deposited ceramic tube will be tested for various cross-sensitive vapours at elevated temperature. The optimised ZnO nanomaterials to selectively detect ammonia vapour will then be fabricated in a TO-package. A suitable interfacing and microcontroller based display device will be developed to operate for real time application. The outcome of the work can be utilised to monitor ammonia in the farm field.

Major Publications
OBJECTIVES

- To design and develop electronic nose for food & environmental quality applications
- To fabricate screen printed electrodes and design electrochemical sensors for health care, water and food quality applications

RESEARCH HIGHLIGHTS

Design & Development of Electronic Nose for Fish Quality Assessment and Detection of Biofilm Contamination in Fresh Fruits and Vegetables by eNose

Design and development of eNose have been successfully accomplished to assess the quality of fish, shrimp, apple and broccoli samples. A three-step process namely bacterial culture study, GC-MS analysis, and data classification schemes have been employed to confirm and correlate the response of eNose for the assessment of freshness or spoilage levels of fish, shrimp, apple and broccoli. The validation study for fish and shrimp quality assessment has been carried out at the fish quality monitoring and certification centre, Fisheries College and Research Institute, Tamil Nadu Fisheries University, Tuticorin, Tamil Nadu.
Clinical Validation of Nano-interfaced Electrochemical Biosensor to Detect Methylglyoxal (MG) in subjects with Pre-diabetes and Type-2 diabetes Mellitus (T2DM) with Neuropathy

Methylglyoxal (MG) is a predominant precursor for advanced glycation end products (AGEs) due to its protein glycation reactions, which are the major causes of diabetic complications. MG is explored as a significant biomarker towards the prediction of diabetic complications. With this background, a non-enzymatic electrochemical biosensor has been developed to detect MG in human blood plasma samples. Validation of the MG sensor performance will be carried out through comparison with ELISA results of the blood samples obtained from diabetic and pre-diabetic subjects. Clinical validation of the sensor will be performed in blood samples provided by Apollo Hospitals, Chennai. Statistical analysis of the ELISA and sensor results will help to understand the influence of MG on onset of diabetes across a population of 400 members. Relation between the free and bound MG with the stages of diabetes will be correlated so as to derive conclusions for undertaking preventive measures.

Development of Multifunctional Textiles by Modifying Textiles with Nanostructured Metal Oxide Materials for UV Filter Applications

The surge in skin cancer cases across the globe has forced the scientific community to develop solutions to protect humans against the ill effects of ultraviolet (UV) radiation. Nowadays, functionalized cotton textiles are employed to protect humans against UV radiation. In this context, nanostructured metal oxide modified cotton fabrics towards the enhancement of ultraviolet protection factor (UPF) as well as wearable gas sensors have been developed. The surface of carbon cellulosic fabric has been modified by sol-gel and sputter seed layer-coated sol-gel techniques. Subsequently, UV-blocking and gas sensing properties of the modified textile samples have been investigated. The seed layer
initiated sol-gel modified cotton fabric showed a maximum UV protection factor (UPF) of 378. Also, room temperature gas-sensing performance of the functionalized cotton fabric towards volatile organic compounds such as acetaldehyde, ammonia and ethanol vapours was investigated.

Fabrication of Screen Printed Electrodes for Biosensing Applications

According to World Health Organization (WHO) report, cardiovascular disease (CVD) is the major cause of death across the globe every year. Design and development of biosensors for the detection of CVD markers could be one of the substantial contributions of the scientific community to serve the society. In this background, acetic acid functionalized graphene quantum dots (fGQDs) nano-interfaced electrochemical biosensor has been developed for the detection of cardiac Troponin I (cTnI) biomarker. The interaction of cTnI with fGQDs was investigated using cyclic voltammetry (CV) for early diagnosis of Acute Myocardial Infarction (AMI). The amine to amide conversion during the hydrogen bonds between N-H group of cTnI and functionalized COOH sites on GQDs enabled the detection of cTnI biomarker. The same sensing mechanism was confirmed using Fourier Transform Infrared Spectrometer (FTIR).
Design and Development of Electrochemical Biosensor with Nano-interface to Detect Heavy Metal Ion Elements in Water

Detection of heavy metal ions less than WHO permissible limits help in promoting human health, avoids malnutrition in children, keep away the pregnancy complications and other related issues in women residing in both rural and urban areas.

Selective detection of heavy metal ions based on the inhibition percentage was achieved. The role of permeability and potential dependent factor was examined for the first time. Simultaneous detection of heavy metal ions and arsenic species was achieved by utilizing the highly electroactive ruthenium bipyridine – graphene oxide nanocomposite. The electro-oxidative behaviour and metal to ligand charge transfer behaviour was utilized. Utilization of hand-held potentiostat for the detection of arsenic species exhibited good sensing characteristics. The portability of the potentiostat can be utilized. On-site qualitative and quantitative analysis of heavy metal ions in water samples.

Standardized the protocol of fabricating F-doped CdO nano cauliflower structured thin film and the same has been utilized for the detection of arsenic ions.
Major Publications


5. Manju Bhargavi G, Murugan V, Uma Maheshwari K, Rayappan JBB. Amperometric determination of As(III) and Cd(II) using a platinum electrode modified with acetylcholinesterase, ruthenium(III)-tris(bipyridine) and graphene oxide. Microchimica Acta, 2018; 185(6): 297-305. (IF: 5.705)


8. Prabhakaran S, Rayappan JBB. Monomer: design of ZnO nanostructures (nanobush and nanowire) and their room-temperature ethanol vapor sensing signatures. ACS Applied Materials and Interfaces, 2017; 9 (43): 38135 – 38145. (IF: 8.097)


10. Ganesh Kumar M, Rayappan JBB. ZnO nanostructures; ultrahigh sensitive room temperature acetaldehyde sensor. Sensors and Actuators B: Chemical, 2016; 223: 343-351. (IF: 5.667)
OBJECTIVES

- Design electrical machines to suit the needs of Electric Vehicles
- Design and test power electronic circuits (Inverters, Converters etc.) and controllers to meet the demands of machines and auxiliary units of Electric Vehicles

RESEARCH HIGHLIGHTS

EVER Laboratory mainly focuses on EHV’s to meet the demands of the future. It is well-equipped with hardware such as Opal RT Real time Simulator Hardware Set up, 1 – HP PMSM, Diode Clamped Multi Level Converters, DSO and software such as Driver and Interfacing Software – Opal RT, Matlab etc., to facilitate the research activities which include the following:

- Optimal Design of Electrical Machines, SCIM, PMSM, IPMSM, SRM etc., used in EVs
- Utilization of Renewable Energy for EV and validation of the design using software / prototype
- Design of novel control strategies for EV, develop control algorithms for their improved performance and Testing of algorithms with the Opal RT system

A project titled “OPAL-RT Based Implementation of Diode Clamped Multilevel Inverter Fed PMSM Drive” has been carried out, in which, a real time model for a three level diode clamped inverter fed PMSM drive system with SPWM current control has been developed in MATLAB / Simulink. Its operation has been analyzed and validated using the Opal RT Real time Simulator.

Presently, a research titled “A Novel Solar Photovoltaic Power Source and a Solar Thermal Collector for Electric Vehicle Industry” is under progress. The objective of the research is to analyze the performance of the EV model with the designed solar power source at Standard Test Conditions (STC) and at real-time
Major Publications


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Research Areas
Control, Navigation and Path Planning in Robotics, Biosignal Processing

OBJECTIVES
• To build an autonomous mobile robot that can localize and map the unknown environment while navigating
• To develop an algorithm on motion and path planning
• To design a robotic fish that can navigate and map the underwater features

RESEARCH HIGHLIGHTS
Simultaneous Localization and Mapping of Unknown Environment Using Multisensor Fusion Technique in Mobile Robots
The mobile robot is loaded with multiple sensors, whose data can be fused in real time for navigation and mapping of the environment that is totally unknown. Gas sensors that show variations in resistance in the presence of gas are fitted in the mobile robot. These sensors identify the concentration change of gases specific gases in the environment. Any gas leakage can be identified and the concerned source can be rectified.

Major Publications
OBJECTIVES

- To detect damaged weld products using A-scan signals and B-scan images
- To perform the classification and characterization of welding defects

RESEARCH HIGHLIGHTS

Classification & Characterization of Welding Defects using Ultrasonic A-scan Signals & B-scan Images

Welding is an integral part of component fabrication in industry. Even though the science and art of welding are more than 100 years old, defects continue to occur during welding. Codes of practice require that the welds be tested and evaluated. Conventionally ultrasonic testing has been widely applied in industry for the detection and evaluation of the flaws/defects in the weldments. With advances in sensor and signal/image analysis technologies, the last two decades have seen extensive developments in the field of ultrasonic testing. We have advanced techniques such as Time of Flight Diffraction (TOFD) which has better probability of detection for linear defects. A major irritant during the application of TOFD, especially for the testing of steel weldments, is the presence of noise. A variety of approaches has been used internationally for the suppression of such noise and each has its own merits and demerits. The work is aimed at classifying and characterizing the defect in the weldment for a tangible outcome.

Fig. 1: A-scan Signal (Slag)  
Fig. 2: B-scan Image (Slag)
Major Publications
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Research Areas  
Condensed Matter Physics, Materials Science, Nano Science and Molecular simulation

OBJECTIVES
• To study the structure and properties of nanoparticles and nanocomposites

RESEARCH HIGHLIGHTS
Computational study on nanomaterials

The wettability of the gold nanoparticles and the micro structure and dynamics of their interfacial water molecules were found to vary with the shape of the gold nanoparticles such as sphere, cube, rod and wire. The structural properties of the graphene-gold hybrid nanostructures were found to be influenced by the capping layer of the gold nanoparticle. The interaction between the two mixed monolayer gold nanoparticles has resulted in the formation of an aggregate characterized by interdigitation of thiol chains. The interactions between the fullerene and gold nanoparticle have resulted in the translocation of fullerene and in the formation of nanocomposite. The structure and thermal properties of gold-silver bimetallic gold nanoparticles in water were studied. The formation of graphene-fullerene nanocomposite constituting graphene and self-assembly of bucky balls has been demonstrated.

Figure 1: Snapshot of gold nanoparticles of various shapes at the end of the simulation. A- sphere; B-cube; C-rod; D-wire [Water molecules are not shown for the sake of clarity]
Thermal and magnetic properties of metal oxide nanoparticles

Four different shapes of zinc oxide nanoparticles in powder form were synthesized by simple chemical method. Zinc oxide nano sphere, rod and flower with rod shaped petals (Flower-A) were prepared using wet chemical method. Zinc oxide nano flowers with flat petals (Flower-B) were prepared by carbon reduction method. Synthesized nanoparticles were characterized by Scanning Electron Microscopy, X-ray Diffraction pattern and UV-vis spectroscopy. Their electrical, magnetic and thermal properties were studied. The vibration sample magnetometer measurements confirms the ferromagnetic behaviour of all prepared four different shapes of zinc oxide nanoparticles.

Figure 2: SEM images of zinc oxide nanoparticles of various shapes A- sphere; B-rod; C-Flower-A; D-Flower B

Major Publications

OBJECTIVES

- To study the accelerated aging characteristics of Silicone rubber insulation material using inclined plane test under AC and DC high voltage fields
- To study the aging characteristics of nano composites Silicone rubber insulation
- To develop guidelines to carryout DC tracking studies of Silicone rubber insulators

RESEARCH HIGHLIGHTS

Surface Degradation Studies of Silicone Rubber Insulation for High Voltage AC Applications

In polymeric insulators, the effect of tracking is predominant and the investigations of the degradation at different environmental conditions are necessary. In this study the electrical tracking and erosion tests are carried out using the Inclined Plane Test (IPT) method as per IEC 60587 to investigate the performance of surface tracking behaviour of High temperature vulcanized (HTV) silicone rubbersamples. IPT test was carried out on virgin samples, thermally aged samples and water aged samples under a.c voltage fields. X-ray diffraction (XRD) and Attenuated Total Reflection Fourier Transform Infrared Spectroscopy (ATR-FTIR) analysis were employed to investigate the chemical changes in the material due to tracking and erosion.
Major Publications


OBJECTIVES

- Work towards establishing the Centre of Excellence in semiconductor device modelling
- Develop inter-disciplinary research with other departments especially in the field of magnetic tunnel junctions and quantum dot

RESEARCH HIGHLIGHTS

Realization of Advanced Passivated Contacts for Silicon Heterojunction Solar Cells
After calibration of standard Silicon HeteroJunction (SHJ) solar cell, slightly modified Molybdenum oxide based SHJ solar cell is simulated in collaboration with PV-lab, IMT, EPFL, Switzerland. The schematic structure along with the corresponding simulated band diagrams are shown below. The band diagrams show the possible hole collection mechanisms: i) Defect assisted transport ii) Direct band to band transport. Using these models, it is estimated that the performance degradation in MoOx based SHJ solar cells while annealing, is due to the decrease in work function and increase in defect density inside the MoOx film. Currently, we are studying TiOx, NiOx based photo-charge carrier collection mechanisms are being studied with Technical University of Denmark.

Simulation and Ion Implantation Process Development for High Efficiency Mono-crystalline Silicon Solar Cells
The objective of the work is to develop a simulation model for ion implant and thermal annealing process for mono-crystalline silicon solar cells. A blanketed solar cell structure for simulation is chosen due to its pattern free FF which is expected to give the initial understanding about implantation technique. The simulated solar cell
structure is 180 μm thick, 1040 μm wide, <100> orientation and base doping resistivity is 2 Ω cm (5.7×10^{15} \text{ cm}^{-3}) crystalline silicon wafer shown in Fig. 1a and 1b.

The base ion implantation models are calibrated (Fig. 2) using the reported experimental data which enables the selection of proper models to describe the dopant transport, activation, damage evolution and dose loss. Input parameters (from simulation) have been provided to BEL, Bangalore and the experimentally implanted wafer is shown below.

**Major Publications**


OBJECTIVES

• To develop a lab for the fabrication of domain engineered ferroelectric crystals for nonlinear optical application
• To demonstrate nonlinear optical processes using the fabricated device
• To develop new domain engineered QPM devices for commercialization

RESEARCH HIGHLIGHTS

Fabrication of Domain Engineered Lithium Niobate Crystal for Multiple QPM Frequency Conversion

In this project, the QPM fabrication facility has been developed which is the second available facility and the first in the academic institute in India. The in-home developed room temperature electric field poling setup and the UV aligner for wastage/breakage free QPM device fabrication have been optimized. Periodically poled lithium niobate (PPLN) was successfully fabricated using the indigenously developed low-cost QPM fabrication facility. A linear far-field diffraction method setup was also developed and evaluated the quality of the fabricated QPM devices. Now, the lab developed under this project is capable of fabricating various engineered QPM devices.

Major Publications


Microscopic images of the fabricated PPLN device


OBJECTIVES

• To study the performance of soft computing based algorithms for fault conditions in PV system
• To study the islanding condition for a grid connected PV system

RESEARCH HIGHLIGHTS

Detection of Islanding condition in Grid Connected PV System

Grid connected PV systems is well recognized all over the world despite the fact that there have been some drawbacks about connecting them to the electrical grid. One of the main challenges of integrating distributed generation into the power grid is islanding, which occurs when a part of the electrical power system is disconnected from the rest of the grid and is still energized by a DG unit. If islanding is not quickly detected, it can present serious safety and hazardous conditions. This work addresses issues involved in detection of islanding condition for the grid connected PV system using suitable fuzzy algorithm for PV based diode clamped multilevel inverter. A digital Gustaffson – Kessel fuzzy clustering algorithm is implemented on a FPGA to keep the current injected into the independent source (grid) sinusoidal and to achieve high dynamic performance with low THD of output voltage and output current. Here, the grid tied PV-based DCD-MLI is effectively integrated and utilized for achieving the energy efficiency. Considering the significance of the aforementioned PV-based inverter, the PV source can be fully utilized and integrated in specially design buildings where the available PV energy can be easily harvested by using the proposed PV-based inverter.
Detection of Islanding Condition for Grid Connected Photo Voltaic Inverter Based On Voltage Harmonics

Major issue in connecting distributed generation system with utility grid is islanding, islanding is a condition in which failed power line is energized through local distributed energy resources. If islanding is not detected, it can create unsafe and hazardous state in distribution line. This study presents an anti islanding detection technique based on harmonic content in voltages at the point of common coupling. This is a purely passive method of island detection and does not have any effect on power system quality and has only smaller non detection zone. Harmonic content in voltages at the point of common coupling (pcc) and inverter is monitored and if it increases beyond a threshold value islanding is detected. Harmonics is caused only due to voltage source inverter used and hence this technique performance is not affected by system parameters. Voltage harmonics based anti islanding technique is tested under nonlinear loads and its performance is verified by simulation using matlab simulink. A hardware test setup is developed for experimental verification of voltage harmonics based passive anti islanding technique and results are presented.

Major Publications
OBJECTIVES

- Tuning the porosity and surface area of aerogel materials for energy storage devices
- Tuning the power density of lithium–ion battery & energy density of supercapacitor

RESEARCH HIGHLIGHTS

Aerogel anode materials for lithium-ion battery applications
Silica aerogels are potentially important materials and are effectively used for various applications ranging from a thermal insulator to targeted drug delivery. Pure silica and lithium-ion doped composite aerogel consist of ferrites and silica are prepared using high-temperature high-pressure supercritical drying technique. The synthesized materials are characterized. N2 adsorption/desorption measurements are used to find out the surface area and pore size distribution of the aerogel. The conductivity of the sample is measured using a frequency response analyzer. The high conducting composites with the high surface area is used as lithium-ion battery electrode material. The electrode materials are mixed with carbon black, PVDF binder using NMP solvent. The slurry is coated over copper foil and dried at 110°C for 12 h. The compressed foils are cut into the desired diameter. The lithium-ion cell is fabricated in the glove box, and the cell performance is studied using battery charge/discharge measurements.
Polyanion type aerogel cathode materials for lithium-ion battery applications
Polyanion-type materials are most suitable electrode materials for lithium-ion batteries due to their structural stability, safety, and suitable operating voltages. Polyanion type aerogel cathode materials are prepared using high-temperature high-pressure super critical drying method. The prepared materials will be characterized and suitable materials will be used for battery fabrication.

Major Publications
OBJECTIVES

• Understand various mathematical concepts and hence utilize them for image processing applications, thereby providing solutions for everyday societal problems.
• Collaborate with academic, industry and non-governmental organizations falling under the matching areas for carrying out competitive research

RESEARCH HIGHLIGHTS

Real Time Video Analysis for Crowd Counting & Monitoring

Mahamaham is a Hindu festival celebrated every 12 years in the Mahamaham tank located in the South Indian town of Kumbakonam in Tamil Nadu, India. Hindus believe that all the holy rivers of India converge at the tank on this day. A purificatory bath in this tank on this day is considered holy and sacred and more than a million people congregate for the occasion. A million people congregating in a small place poses a great challenge for the district administration. The Mahamaham event in the year 1992 brings back tragic memories, when about 50 people died due to stampede. In 2016, the district administration decided to leverage technology for crowd monitoring. It was demonstrated that algorithms achieved 99.3% accuracy levels in crowd calculation. The request of the district collector to SASTRA was taken up by the team that included faculty members and students. That about 1.4 million people took the holydip during the days of mahamaham has been confirmed through the calculations carried out. Thanks to the real-time alerts, the district administration intervened, controlled the crowd and it was a sigh of relief for everyone to see such an event of mammoth scale passed out without any casualty. SASTRA Deemed University reached out again with their technology expertise in crowd analytics, but this time it was a different event - Thiruvannamalai Karthigai Deepam and the team performed its best yet again.
Major Publications


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Research Areas
Image Processing, High Voltage Engineering

OBJECTIVES
- Hydrophobicity measurement of polymeric insulators using image processing.
- Pollution performance tests on line insulators and
- Application of thermal imaging for Insulator condition monitoring.

RESEARCH HIGHLIGHTS
Condition Monitoring of Overhead Porcelain and Polymeric Insulator under different Contamination
Overhead insulators play an important role in electrical transmission network. When insulators are subjected to operation in open environment their insulation strength decreases. Mixture of pollutants added with the humidity forms a layer on the surface which increases the conductivity that leads to the flow of leakage current leading to flashover. Artificial test is conducted in the laboratory as per the standard IEC 60507 to analyze the performance of insulator. In this analysis, porcelain and polymeric insulators are subjected to power frequency test under different pollution condition. Thermal image analysis is also carried out for porcelain and polymeric insulator under different pollution condition for condition monitoring. Hydrophobicity of polymeric insulators are also analysed using image processing to identify surface degradation.

Major Publications
RESEARCH HIGHLIGHTS

On-line On-load FRA approach for fault diagnosis of transformers

Frequency Response Analysis (FRA) is a condition monitoring and fault diagnostic technique of Transformers. Conducting FRA in transformers On-line and On-load can be very useful, as it minimizes power outages and time required for diagnosing. Motivated in this context, a research work was carried out, with an objective of developing On-line On-load FRA (OLOL FRA) setup for diagnosis of faults in large transformers.

Investigations were carried out with a 315 kVA distribution transformer. With emulated interturn shorts, the usefulness of both FRA approaches in identifying, locating and assessing the severity level of shorts in winding was checked. Analysis of results proved again that, the OLOL FRA methodology developed and implemented was capable of diagnosing faults.

Major Publications
OBECTIVES
• To study propagation channel and evaluate different adaptive algorithms for multipath mitigation and comprehensive spectrum management
• To develop active/passive radio/radar prototypes as proof of concept for the next generation interoperable Communication Systems, Intelligent Transport System and Smart Cities

RESEARCH HIGHLIGHTS
Enhanced Malicious Detection Method Using Security Aware Trusted Multipath Routing Protocol in MANETs
Adhoc networks are wireless networks that offer unlimited portability with no hidden foundation. It depends on the collaboration of all the partaking hubs. Because of their open nature and absence of base, security for MANETS has turned into a many-sided issue than the security in different systems. The routine security components of ensuring a wired system are not adequate for these systems. Henceforth a second level of protection to distinguish and react to the security issue called an Intrusion location framework is required. In this the Intuitionist Fuzzy TOPSIS (IFT) based trust deduction model with standard AOMDV convention (AOMDV-IFT) is proposed. It is utilized to diminish the undesirable overhead of adjoining position trust check based steering convention (AOMDV-SAPTV). From the security investigation, anticipated directing convention is opposed the pernicious assaults, for example, Black gap, Gray opening, Wormhole, Rushing and Sybil assaults etc. From execution investigation, anticipated steering convention gives lower normal postponement and vitality utilization, higher malevolent recognition proportion and throughput.

Major Publications
1. Nassem MT, Britto KRA, Jaber M, Chandrasekar M, Balaji VS, Rajkumar G, Narasimhan K, Elamaran V. Preprocessing and signal processing techniques on genomic data sequences. Biomedical Research, 2017; 28; 10205-10209. (IF: 0.219)
OBJECTIVES

- To fabricate the nano-structured TiO2/ZnO based Acetaldehyde/Ethanol sensor.
- To improve the sensitivity of the sensor to detect presence of very low level Acetaldehyde/Ethanol in air.
- To improve the selectivity by changing the surface nature of the nanostructures.

RESEARCH HIGHLIGHTS

Characterization of Nano-Structured TiO2/ZnO Thin Film for highly selective Acetaldehyde/Ethanol Sensing.

The main objective is to design a TiO2/ZnO based Acetaldehyde/Ethanol carcinogen sensor for the sake of human safety. Acetaldehyde is one of the most widely found carbonyls in air. Occupational Safety and Health Organization (OSHA) has defined exposure of 25 ppm of acetaldehyde for 8 h potentially hazardous for humans. Acetaldehyde is classified as a carcinogen and its inhalation above permissible concentration can lead to intensive irritation in eyes and respiratory organs, nausea, headache and some serious disorders. Hence, the need of acetaldehyde sensor is unavoidable due to the necessity; hence preparation and characterization of TiO2 based Acetaldehyde/Ethanol sensor is highly needed for the society.

Major Publications

OBJECTIVES
• Device Modeling Group explores the modeling of the semiconductor materials and devices
• Next generation semiconductor devices need new materials and structures for low power and high speed applications

RESEARCH HIGHLIGHTS
RF Stability Performance of Phosphorene multigate MOSFET
This project aims to examine multigate MOSFET structures having different geometries of phosphorene layers (i.e. nanoribbons, nanotubes) to obtain cut-off frequency (fT) >12GHz and max frequency (fmax) >20GHz in RF circuits using Quantumwise and TCAD simulation. Since multigate MOSFETS produces improved analog/RF performance, inclusion of phosphorene layers will further enhance its characteristics. RF stability of the device also need to be studied for the design of RF circuits. The stability factor describes the instable oscillations due to input or output impedance of the transistor. A stability model can help to optimize the device geometry for RF circuits.

Major Publications
1. Madheswaran M, Ramesh R, Kannan K. Hot-carrier reliability on the optical characteristics of gate stack gate all-around (GSGAA) MOSFET considering quantum mechanical effects. Optik, 2016; 127: 2694-2702. (IF: 0.835)
OBJECTIVES

- To investigate the effect of Control and Estimation algorithms in enhancing the performance of Electric Vehicle Systems
- To implement and test the effectiveness of Artificial intelligence based probabilistic decision-making algorithms in solving Mobile Robots Navigation and Control problems

RESEARCH HIGHLIGHTS

Optimal control and Estimation algorithms in Electric Vehicle Technology

Electric vehicle (EV) technology is moving towards a radical shift in both energy and transportation sector. This research project addresses issues involved in finding optimal tuning parameters for the speed control of traction motors. Optimal selection of PI controller parameters is necessary to improve the overall efficiency of the traction motors which results in optimal battery management strategies. The present work is more oriented towards Permanent Magnet Synchronous Motor (PMSM) and its control. Realizing a controller that guarantees optimal performance of PMSM in the presence of different loading and disturbance condition is a challenging task. The project team is now applying novel estimation algorithms in finding the state of charge of the batteries for designing suitable battery management systems for Electric Vehicle applications. The feasibility of employing Model Predictive Controllers for traction motor control applications is also investigated in this project.
Performance of Bayesian Algorithms in Probabilistic Robot Applications
Mobile Robot navigation and control is a challenging problem due to the probabilistic nature of both systems and sensor noise. It is difficult to simultaneously map the environment and localize the robot (SLAM) in a consistent manner. This research project addresses issues with a specific focus on improving the performance of the standard SLAM algorithms by suitable pre-processing techniques in a probabilistic Bayesian framework. This project aims to improve the performance of EKF-SLAM by providing accurate measurement of pose change and innovation factor. The acquired sensor measurements are fused based on the accuracy which is evaluated in run-time using novel metric called Map Spread Factor (MSF). The project team is now focussing on integrating Visual SLAM with conventional SLAM methods by tackling the challenges involved in the Data association problem using novel Computer Vision and machine learning algorithms.

Predictive Control and Fault Diagnosis in Process Automation Systems
Process industries are operating under severe energy constraints and are constantly seeking improvements in providing automation solutions to stay competitive in the market. This research work investigates the strategy involved in identifying suitable MPC algorithm for embedded devices using model based engineering approach. The research team addresses issues involved in verifying the performance of the MPC algorithm in embedded device for process control applications in terms of transient performance, disturbance rejection, control effort expended and the computational time elapsed to solve the optimization algorithm online. The research focus is also oriented towards finding suitable algorithms for addressing packet drop out issues while using embedded devices for stable controller and process operation. The experimental set up used for this analysis is a four-tank coupled system.
Major Publications
OBJECTIVES

- Tuning the frequency in Spin Torque Nano-Oscillators (STNOs)
- Output Power enhancement in STNOs
- Construct: Magnonic Logic gates, Spin filters, Phase shifters

RESEARCH HIGHLIGHTS

A Complete Study of Spin Torque Nano-Oscillators

Theoretically a spin torque nano-oscillator (STNO) with tilted polarizer (TP) with the help of two independent variables (β and θ) has been devised. For a particular value of β, the angle between the free layer magnetization and easy axis of magnetization can be varied from 0° to 90°. The maximum operating frequency 124.5 GHz and corresponding power of 1.478 μW/GHz/mA² is obtained for β = 60° and θ = 90° with the applied current density of $10 \times 10^{10}$ Am⁻². Moreover, our results allow great freedom in choosing the detailed layer structure of the TP STNO and these findings pave a new route for the implementation of nanoscale microwave sources for future generation integrated electronics.
Major Publications
OBJECTIVES

- To synthesis and grow single crystals of organic, semi-organic and metal-organic materials
- To investigate different crystal growth methods and their influences on the quality of the crystals

RESEARCH HIGHLIGHTS

Nonlinear Optical Applications of Semi-Organic Solutions

Solutions of organic and semi-organic materials are presently receiving much attention for their nonlinear optical applications. In particular, optical limiting behaviour of organic solutions is highly reported in the recent years. In this viewpoint, have been focused and investigated L-arginine hydrochloride (LAHCl) solutions at different concentrations. It has been observed from the experiments that the nonlinear absorption is increasing with increase in concentration of the solution. Thermal aberration rings are formed by tightly focused Gaussian LASER beam and also the beam suffered a self-phase modulation. The observed RSA has been effectively used to verify the optical limiting behaviour of LAHCl solutions. Further, negative theoretical value of third-order nonlinear polarizability has confirmed the self-defocusing behaviour of LAHCl.

Reverse Saturable Absorption & Self-Defocusing Effects of Organic Single Crystals

4-Nitrobenzoic acid (4-NBA) organic single crystals are systematically studied for nonlinear optical applications. The charge transferable mechanism in 4-NBA has been explained theoretically using density function theory. Optic plane of 4-NBA has been observed along <100> direction. The crystal exhibited a positive type nonlinear reverse saturable absorption (RSA) and the absorption
increases at focus and decreases away from the focus of the LASER beam. Further, it is observed that nonlinear absorption (imaginary part of third-order nonlinear susceptibility ($\chi(3)$)) is dominating over nonlinear refraction (real part of $\chi(3)$).

**Major Publications**
OBJECTIVES

- To develop lightweight algorithms for secure communication of multimedia objects
- To develop techniques to mitigate attacks on various image formats
- To realize and analyze lightweight security algorithms on Embedded platforms

RESEARCH HIGHLIGHTS

The main focus of our work is to provide information security solutions to address Confidentiality, Integrity and Authentication on resource constrained embedded devices like microcontrollers. Lightweight Cryptography, Steganography and Watermarking are the predominant domains which have been considered to address the aspects of information security.

Realizing various custom designed lightweight schemes to encrypt offline images using stand-alone embedded hardware for secured image sharing and healthcare applications are one of the major research work carried out by our team. Algorithms for secured communication of confidential data such as encryption keys are also implemented on embedded microcontroller platforms. The security aspects our algorithms are evaluated using statistical / analytical methods in addition to attack analysis. Suitability of our algorithms to run on embedded platforms is analyzed with their performance metrics.

Major Publications

OBJECTIVES

- Explore on functional nanomaterials including thin films and coatings to meet diverse applications, such as, semiconductors, sensors, energy production/storage, tribological and biological applications

RESEARCH HIGHLIGHTS

E-nose for methane sensing
This project aims in exploring various vanadium oxide hierarchical nanostructures using dc magnetron sputtering & chemical vapour deposition technique and find its possibilities to employ in sensing methane gas. The project is intended to develop an e-nose for detecting ammonia and methane gases at lower operating temperature.

Micro-sensors for detecting hydrogen
This project aims in developing MEMS based sensor array to detect hydrogen, ammonia and humidity, for which different metal and metal-oxide nanostructures are being investigated to achieve a superior sensing performance.

Metal-oxide films for micro-bolometer application
Vanadium oxide and nickel oxide films based lab-scale bolometer array has been fabricated and a temperature coefficient of resistivity value of – 4.0 %/C has been achieved. Besides these samples had a very low resistivity.
Micro-sensors for detecting hydrogen

E-nose for explosives and toxic gas detection
A wireless sensor kit was developed for detecting toxic gases and vapours which uses metal-oxide films as the sensing layer. The developed sensor sensed ammonia, methane and other targeted gases and vapours.

Nanocomposite DLC films for tribological application
Transition metal (Ti, Ni, Ag, Cr) doped DLC films were synthesized by PLD technique. The films exhibited high mechanical strength, good adhesion with the substrate surface and had ultra-low friction values.
Major Publications


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Research Areas
Image Processing and Antenna

OBJECTIVES
• Detection of early stage lesions in Diabetic Retinopathy using image processing techniques
• Classification of clinical features of Diabetic Retinopathy using Neuro-Fuzzy systems
• To analyze certain features in palm print images and prediction probable disease

RESEARCH HIGHLIGHTS

Diagnosis of Diseases using Palmistry
Palmistry, the HAST SAMUDRIKA is a part of science, known as SAMUDRIKA SHA ASTRA. This science forecasts a person’s future by observing his hand geometry and palm prints. Medical Palmistry, the major branch of Palmistry facilitates the diagnosis of diseases on keenly focusing one’s palm. The texture, shape and color of palm and nails are reflecting the health condition of a person. The positions of lines, mounts and some special symbols are exhibiting several medical features of internal organs of human body and thus lead to diagnose various diseases.

An application of digital image processing and analysis technique can be useful in healthcare domain to predict diseases for human being. The research activity is based on design and implementation of an automated system to detect various health conditions of patients. The images of human palm will be the input to the system. By applying digital image processing techniques on input images, certain features in the image will be identified.

Detection of early stage lesions in Diabetic Retinopathy
It is important that everyone has to undergo eye screening and it is not the matter of young or old ages. A diabetic is a disorder that causes serious complications in various organs of the human body. It also affects the eye and so it is called diabetic retinopathy (DR). The early signs of DR includes Microaneurysms (Ma), Hemorrhages (HE) and Exudates and in the advanced stage new blood vessels will start growing and which are fragile in nature. If DR is untreated early, blindness will occur. This project focuses mainly on automatic detection of early lesions of Diabetic Retinopathy like Microaneurysms (Ma), Hemorrhages (HE) and Exudates using image processing techniques and Rotation Forest classifier (ROF) is used for classification and detection of severity of this eye disease. Finally comparison is made with the results from classifiers like KNN, SVM & ROF.
Major Publications


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Research Areas  
Nanostructure synthesis, photocatalytic activity, density functional theory

OBJECTIVES

• Synthetisation of nanocomposites by simple and inexpensive methods
• Evaluation of photocatalytic activity (Organic dyes, textile effluents)
• DFT simulation for designing & validating the results from the experimental studies (photocatalytic activity) and to develop prototype for photocatalytic materials

RESEARCH HIGHLIGHTS

Design of layered materials for Photocatalytic dye degradation - DFT Analysis
Designing of layered materials such as MoS2, Graphite, hexagonal BN and Silicene and its composites for the evaluation of visible light photocatalytic activity by performing density functional theory (DFT) simulation. Tuning the opto-electronic properties of these composites can be achieved by proper doping or making defects on the composite structures.

TMO & TMC nano materials and nanocomposites for Photocatalytic dye degradation
Nanomaterials of Transition metal oxides (TMO) and Transition metal chalcogenides (TMC) are prepared by facile and inexpensive methods for the evaluation of photocatalytic dye degradation. Evaluation of photocatalytic activity of the prepared materials against various dyes and textile effluents have been performed using a photocatalytic reactor. Variations of the solution pH, particle size and doping effect are employed on the nanomaterials for dye degradation.
Major Publications
OBJECTIVES
• Detection of early stage lesions in Diabetic Retinopathy using image processing techniques
• Classification of clinical features of Diabetic Retinopathy using Neuro-Fuzzy systems

RESEARCH HIGHLIGHTS
It is important that everyone has to undergo eye screening and it is not the matter of young or old ages. A diabetic is a disorder that causes serious complications in various organs of the human body. It also affects the eye and so it is called diabetic retinopathy (DR). The early signs of DR includes Microaneurysms (Ma), Hemorrhages (HE) and Exudates and in the advanced stage new blood vessels will start growing and which are fragile in nature. If DR is untreated early, blindness will occur.

This project focuses mainly on automatic detection of early lesions of Diabetic Retinopathy like Microaneurysms (Ma), Hemorrhages (HE) and Exudates using image processing techniques and Rotation Forest classifier (ROF) is used for classification and detection of severity of this eye disease. Finally comparison is made with the results from classifiers like KNN, SVM & ROF.

Major Publications
OBJECTIVES

• To Obtain optical multiband receiving method (OMBR) to support >100-Gb/s data rate
• To achieve the record optical signal-to-noise ratio sensitivity of 21.2 dB

RESEARCH HIGHLIGHTS

Increasing data transmission rate with optical OFDM in the real time simulation environment by overcoming practical difficulties

With recent increase in interest on wireless access to WAN – data networks at high data rates, all possible forthcoming designs on mobile communication systems are said to have high data rate for transmission. Optical OFDM, an outstanding modulation technique, has the feasibility of attaining high data rates, especially, due to it’s high, attractive and unlimited virtual ISI. A promising transmission based on the concept of multi-carrier at a time will surely withstand high data rates. Input for such growth has been given by parallel development aside on terms of extra-ordinary high speed data rate networks. Mobile environment is a great barrier to the development of high speed data networks. Phase modulation has been introduced in this scenario in order to get back the dispersion that has been wasted at higher order. In this approach proposes increased number of subcarriers at data rates of 35km/h. OFDM-QAM Modulation has also been employed to achieve simultaneous transmission. A bit-error rate performance calculation comparison has been undertaken as such is the direct result of comparing it with signal transmitted. The result is simulation done with mat lab and noticeable at high SNR.

Major Publications

OBJECTIVES

• To develop algorithms for secured communication of multimedia objects
• To develop techniques to mitigate attacks on various image formats
• To realize and analyze security algorithms on software and hardware platforms

RESEARCH HIGHLIGHTS

True Random Key Generator using FPGA

Field Programmable Gate Arrays (FPGAs) are being employed in most of the information security applications. A number of elements such as clock jitter, delays, PLLs and multiple clock frequencies supported by on-chip reconfigurable platform promise an attack cum tamper resistant TRNG based on FPGA. In this work, PLL based TRNG architecture is implemented on FPGA with dynamic clock selection process. Linear Feedback Shift Register and Galois Field Multiplier are post processing functions. Statistical and hardware analyses of the developed TRNG is a part of this work. The generated true random key is employed for image encryption and decryption on FPGA. This work will also explore the communication of encrypted keys and images between two FPGA units.

Major Publications

OBJECTIVES

• Studying the spatiotemporal dynamics of the networks before and after the occurrence of the synchronization
• Dynamics and mechanism of the spread of phase and generalized synchronization in complex network

RESEARCH HIGHLIGHTS

Epileptic Seizure Dynamics, Prediction and Control: A Network Dynamics Perspective

Epilepsy -- an abnormally enhanced hypersynchronized activity of the neurons represents one of the most common neurological disorders which affects about 1% of the global population. To understand how seizure evolve and progress, an understanding of the dynamics, mechanism of epilepsy and seizure development is required. In order to develop more efficient therapies, the pathophysiology underlying epileptic seizure should be better understood. In human epilepsy, however, the exact mechanisms underlying seizure dynamics, initiation, spreading and termination are still uncertain. There is now growing evidence that an improved understanding of seizure dynamics can be achieved when considering the epileptic seizure as network phenomena. In this project, I will investigate and understand the dynamics of the onset and spreading mechanism of the epileptic seizure through a complex networks analysis are being investigated. The main objectives are to identify the dynamics behind the hypersynchronized activity of the neural oscillators during the epileptic seizure. Also an important issue in epileptology is the question on whether epileptic seizure can be predicted at earlier before its onset. Motivated by this, the possibility of the early prediction of seizure in network of neuronal oscillators using the idea of generalized synchronization and the relation with phase synchronization are also planned for investigation.

Emergence of Common Generalized Synchroniztion Manifold in Networks of Structurally Different Time-Delay Systems

Present studies revealed that generalized synchronization and phase synchronization occurred simultaneously in a network of nonlinear time-delay systems with various network configurations. In addition, the generalized synchronization spread in the network for the first few nodes of the network which is known as partial generalized synchronization (PGS) state and for stronger coupling strength global generalized synchronization (GGS) emerged. The figures given below depict the emergence of partial and global generalized synchronizations and their relation with phase synchronization.
Influence of time-delay feedback on extreme events in forced Lienard system

A periodically forced Lienard system is capable of generating frequent large amplitude chaotic bursts for a range of system and external forcing parameter values known as mixed mode oscillations and particularly, if these large chaotic bursts occurred infrequently and randomly then they are characterized as extreme events. A numerical analysis of the effect of self-time-delay feedback on these extreme events in this system have been studied and interestingly found that extreme events can be completely eliminated from the system dynamics even for very small values of delay feedback strength. Figure represents the temporal dynamics and the corresponding phase portraits of the Lienard system for different values of strength of feedback with appropriate system parameter values.

The number of extreme events are reduced and the probability of the occurrence of high amplitude events is transformed from a long-tailed statistics to the localized structure as a function of the feedback strength are shown in the figure to corroborate the results. Further, it has been shown that the autonomous Liénard system loses its conservative nature when adding delay feedback and only dissipative nature remains in the entire phase space which is the basic mechanism behind the elimination of large events. Also, a new type of delay induced damping behavior named as anomalous damping has been revealed in which the amplitude of the oscillations suddenly vanished when the total energy of the system becomes zero.

Major Publications

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Research Areas
Luminescence Quantum blinking, thin film opto-electronics, Hybrid Super-capacitors and Spin-Dependent Tunnelling

OBJECTIVES
• Thin film opto-electronics devices
• Hybrid Super-capacitors
• Spin-Dependent Tunnelling

RESEARCH HIGHLIGHTS

Rare-earth doped Tungstate nanostructures using Soft-chemical route for Opto-Electronic application

Scheelite structured Ca$_{0.5}$Y$_{1-x}$WO$_4$:xEu$_3+$,$\text{M}^+$ ($\text{M} = \text{Li, K and Na}$) is successfully synthesized by hydrothermal method. Elemental mapping analysis evidenced for the incorporation and uniform distribution of all the elements in the bi-pyramid-like architectures. PL emission spectra show hypersensitive electric dipole transition $\text{5D}_0 \rightarrow \text{7F}_2$ at 617 nm for Ca$_{0.5}$Y$_{1-x}$WO$_4$:xEu$_3+$,$\text{M}^+$ ($\text{M} = \text{Li, K and Na}$) show characteristic red emission in the visible region.

The effect of alkali cations (Li, K and Na) on Ca$_{0.5}$Y$_{1-x}$WO$_4$:xEu$_3+$ was analysed in detail. From the results, it is evident that the red emission peak intensity of Ca$_{0.5}$Y$_{1-x}$WO$_4$:xEu$_3+$ using Na$^+$ ions as charge compensator is greater than that of Li$^+$ and K$^+$ ions and Na$^+$ ions has the remarkable charge compensation effect. From the CIE chromaticity diagram, it is suggested that Ca$_{0.5}$Y$_{1-x}$WO$_4$:xEu$_3+$,$\text{Na}^+$ phosphor materials are suitable best candidates for display applications.

A study on Hybrid supercapacitors: storage mechanism, criteria of formation, components, electrochemical profile assessment, design, fabrication and applications

Hybrid supercapacitors with their constantly increasing energy densities without altering their power density have been trend of recent years. The hybrid supercapacitor delivers greater specific capacitance in comparison to the existing EDLC and pseudocapacitors. Generally their asymmetric behaviour acts as an enhancer in its respective capacitance properties. This approach marks a new beginning towards the much needed pollution free, long lasting and proficient energy storing performance. Corresponding to their utilization
in hybrid electric vehicles and similar sort of power necessity based devices; the research in developing new advanced storage devices finds an enormous and vast future ahead. The most significant factor for the application demands considerably higher ratio of surface to volume. This review points towards the development of hybrid supercapacitors with different electrode materials, electrolyte materials, storage mechanism, electrochemical profile assessment, fabrication and applications.

Spin-resonant tunneling in CdTe/Cd1-xMnxTe double barrier heterostructures with zero external field

The spin-dependent resonant tunneling in CdTe/CdMnTe double barrier heterostructures has been theoretically investigated. The transfer matrix method was employed to study the spin transport properties with zero external field. The effect of Dresselhaus spin orbit coupling was accounted in the symmetrical heterostructure. The influence of barrier width and barrier height on the Polarization efficiency, Barrier transparency and Dwell time of Light holes and Heavy holes were studied.

Major Publications
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Research Areas  
Wireless Communication, Communication Security  

OBJECTIVES  
- To Design and Characterize Next Generation Communication Systems  
- To Design, Develop and Test Reconfigurable Prototypes for Wireless Communications and Radar Systems  
- To Develop algorithms for Secure Communication of Multimedia objects  

RESEARCH HIGHLIGHTS  
Wireless Communication, Communication Security  
Rapid growth in Wireless Communication enables the researchers to provide solutions by adapting different strategies in transmission techniques with a motive to improve the data rate in addition to facilitating reduction in BER. Multicarrier and Single carrier Multiple Access techniques such as OFDMA and SCFDMA have been used to improve the performance of the Wireless communication system. Though wireless communication has been one of the most acclaimed innovations, a major problem of spectrum scarcity has tampered the efficient utilization of the system, as the spectrum needs have been constantly increasing. In order to combat this issue, Cognitive radio is used so that the available spectrum can be effectively and efficiently utilized by the unlicensed user. Cognitive radio senses the free spectrum available and utilizes it in an effective manner. With the tremendous growth and increased use of wireless technology for communication, it has become imperative to protect the data against channel noise and potential hackers. So there is a need to provide more robust security solutions.  

The research focus is on  
- Development of algorithms for enhanced spectrum sensing and security in Cognitive Radio systems  
- Development of image encryption algorithms for efficient and secured transmission of medical images for telemedicine applications
Major Publications
10. Avila J, Thenmozhi K. Authentication scheme to combat a primary user emulation attack against cognitive radio users. Security and Communication Networks 2015;8(18):4242-53. (IF: 0.904)
OBJECTIVES

- To develop an integrated prototype of solar and wind based renewable power generation resources
- To address the power quality issues through active power line conditioners
- To design and implement various control strategies for power electronic converter

RESEARCH HIGHLIGHTS

The utilization of Variable Frequency Drive (VFD) has become popular in recent years because of the unprecedented development in power electronics. When a VFD is connected to the utility, harmonics and interharmonics are introduced into the supply. The effect of harmonics and interharmonics on the power utility is a serious concern and has to be mitigated. Passive filters active filters and hybrid filters are used on the supply side to minimise the harmonic and interharmonic contents in the source current. Hybrid filter is found to be the best method in mitigating the harmonic and the interharmonic components in the supply side of the VFD and its performance is analyzed using MATLAB / Simulink. The performance of the induction motor is improved using a closed loop speed control that employs a Model Reference Adaptive System (MRAS) of speed estimation. Harmonic voltages resulting from high frequency switching in PWM (Pulse Width Modulation) waveform and related voltage spikes can burn pin holes in the insulation. To overcome this issue, a nine level Reverse Voltage Topology (RVT) Multi Level Inverter (MLI) is employed instead of a voltage source inverter. To mitigate harmonics and interharmonics, the hybrid filter is replaced by an isolated zeta converter in the DC link. A closed loop speed control is used to enhance the performance of the motor using MRAS speed estimation method. The response of the proposed VFD derived from the MATLAB/Simulink is validated using hardware prototype model employing FPGA processor.

Major Publications

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Research Areas
Control of Unstable systems, Sensor design in Oil quality Analysis

OBJECTIVES
- Controller design for unstable processes with time delay
- Testing the quality of used cooking oil with sensor design
- To carry out study on Moringa extract added model oil

RESEARCH HIGHLIGHTS

Experimental Investigation of Oxidative Stability in Model Oil Using its Physicochemical Properties
Research is on the design of Indigenous inter-digitized sensor for capacitance measurement and correlating the measured parameter with other physico-chemical properties with which oxidative stability of oil could be analyzed. An experimental study has been carried out and extended with the addition of nano particles and the oil solution as sample. The oxidative stability of oil and improvement of testing method in this study has been analysed and can be further extended to liquids like beverages, lubricant oil and etc.

Design of Controller for Unstable Processes with Time Delay
Typical unstable processes like Integrating process, Inverted pendulum, CSTR processes can be modelled as UFOPTD or USOPTD process. Controller design for such complex natured processes can be carried out with the obtained USOPTD or UFOPTD models. Designed controller has to be tested in the control of actual process that is unstable in nature. The time delay factor involved in such unstable processes elevate the dynamic control problem to challenging levels.

Experimental Study on Model Oil with Added Moringa Extracts for Improved and Long Shelf Life
Moringa (Moringa oleifera) seed kernels contain a significant amount of oil that is commercially known as “Ben oil” or “Behen oil”. Moringa seeds, harvested from their pods, yield approximately 30-40% of non-drying moringa oil. The oil is edible and closely resembles olive oil in its fatty acid composition. The free fatty acid content varies from 0.5 to 3%. The seed oil contains approximately 13% saturated fatty acid and 82% unsaturated fatty acid. It has a particularly high level of oleic acid (70%) as compared to other vegetable oils.
It is a non-drying nutty flavoured oil with a clear or slightly pale yellow consistency. Moringa seed oil is clear and odourless. Due to the numerous antioxidants in it, the oil does not become rancid for several years after it is produced. This makes it the most sought after for a number of health and beauty applications. It is viable for use as cooking oil, however low level of production do not make it conducive for everyday use as a dietary product. With high oleic level the oil has good research scope in it.

**Major Publications**

OBJECTIVES

- Numerical modeling of fiber laser
- Nonlinear fiber optic sensor
- Generating ultrashort pulses/broadband laser sources using photonic crystal fiber

RESEARCH HIGHLIGHTS

Supercontinuum

It is studied novel physical phenomena of supercontinuum generation (SCG) related to the temporal and spectral changes of pulse propagating through specific photonic crystal fiber (PCFs) with highly nonlinear liquids is being studied. The effects of the input pulse parameters, such as pulse energy, peak power, pulse duration, and central wavelength, on the modulational instability (MI) and SCG have been investigated. The quality of the SCG has also been checked using coherence analysis.

Pulse Compression

Conditions for designing pulse compressor for pulse compression on the basis of self-similar technique, which opens the way for a pedestal free and high compression factor of ps and fs pulses will be investigated. The SCG induced pulse compression techniques to generate pedestal free ultra-short pulses, based on self-similar analysis, assisted by tapered softglass/liquid PCFs will be analysed. The effects of the input pulse parameters, such as pulse energy, peak power, pulse duration, and central wavelength, on the SCG induced pulse compression will be investigated. SC induced pulse compression in tellurite softglass PCFs. Since an optical cycle is short in the IR region, a goal of 10-15 cycle pulses would be realistic.
Major Publications


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**Research Areas**
Earthquake forecasting – Solid tides & Outgoing longwave radiation

**OBJECTIVES**
- To develop “Earthquake forecasting model” by analyzing atmospheric precursors and solid earth tides and its real time simulation to enhance the quality of power supply

**RESEARCH HIGHLIGHTS**

Earthquakes occur more often during the time of vertical upliftment produced by solid earth tides and act as a triggering mechanism. Prior to the occurrence of devastating earthquakes due to increased tectonic activity, anomalous variations are observed in the atmospheric parameters like surface latent heat flux (SLHF), relative humidity (RH), Air temperature (AT) and Outgoing Longwave Radiation (OLR) flux. These atmospheric parameters are satellite-based measurements and can be used as an effective tool to identify the earthquake preparation process. These anomalous atmospheric parameters are highly transient nature and spread to several thousands of square km and are observed few days to a few weeks prior to the occurrence of devastating earthquakes. The possible reason for the observation of anomalous atmospheric parameters may be due to the emanation of radon gas from the voids of the rocks along the seismically active zones. The radioactive radon from the voids of the rocks moves up and ionizes atmospheric air molecules at the earth’s surface. This ionized air attracts the water vapour, which condenses over the ionic air molecules and hence abnormal level (above $+2\sigma$) of latent heat is released into the atmosphere at the surface of the earth. Also, it leads to the drop of relative humidity below the $-2\sigma$ level and when the heat energy moves vertically up into the atmosphere due to the convection process, anomalous OLR flux above $+2\sigma$ level is observed.

**Major Publications**
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Research Areas
Process Control, Medical Instrumentation

OBJECTIVES
• Develop different control algorithms for cement milling process
• Analyze ECG, EEG signals and publish quality papers in peer review journals

RESEARCH HIGHLIGHTS

Design of Layered Materials for Photocatalytic Dye Degradation- DFT Analysis

Cement ball mills in the finishing stage of the cement industries consume highest energy in the cement manufacturing stage. In order to increase the profit margins, suitable controllers that result in good productivity and product quality with reduced energy consumptions are required for the cement ball mill grinding process. The real-time input and output data are taken from the cement ball mill grinding process. From the data different polynomial based models such as Auto Regressive eXogenous (ARX), Box-Jenkins (BJ) models, and state space models are developed. Using the obtained model, Generalized Predictive Controller (GPC) and model predictive controllers (MPC) are designed for the cement ball mill grinding process. The regulatory responses for different grindability variations in the clinker are analyzed in the real-time simulator.

Major Publications
OBJECTIVES

- To bring out the technical mastery of Chitra Banerjee Divakaruni through her selected work

RESEARCH HIGHLIGHTS

An analysis of narrative techniques in the selected works of Chitra Banerjee Divakaruni

Chitra Banerjee Divakaruni, born in 1956 to educated parents in Kolkata and clearing her B. A. in English from Calcutta University, she moved to California for her Ph.D. programme under the guidance of Stephen Greenblatt, the founder of New Historicism in literary studies. She has to her credit till date, four collections of poems, two short story collections, eight novels, four fantasy novels for young readers and many non-fiction articles. Her writing in multiple genres has appeared in over forty anthologies and more than fifty journals and magazines, including Atlantic Monthly and New Yorker. Her fiction is translated into twenty languages and has received prestigious awards, including The American Book Award, and PEN Oakland Josephine Miles Literary Award. Divakaruni is also a social activist. She is the founder President of MAITRI, a helpline for South Asian woman facing domestic violence and also works for PRATHAM, an organization dedicated to removing illiteracy in India. Divakaruni admits that the service she does influences her writing. All her writings, be it verse or prose, aim at promoting better awareness among women of their rights and duties at home and the world. The researcher proposes to reveal the technical mastery of her selected works.

Major Publications

OBJECTIVES

- Effect of Heat and Mass transfer in a fluid (Nano / Dusty) flow over a surface / channel
- A Study on Instability and Transition of fluid flows

RESEARCH HIGHLIGHTS

Research has been carried out over Heat and Mass transfer in Newtonian fluid flows over a vertical plate under the influence of induced Magnetic field. Navier – Stokes equations of motion are solved numerically by means of 4th order Runge – Kutta shooting technique. Influence of mixed convection boundary layer flow over velocity, temperature and concentration profiles are plotted. It is noticed that magnetic effect enhances the heat transfer rate. Mixed convection parameter plays a vital role in non-Newtonian fluid flows too.

Major Publications

5. Murty AVSN, Srinivas MN, Sastry DRVSRK. New scheme for one dimensional wave equation. International Journal of Civil Engineering and Technology, 2017; 8: 1128-1131. (CiteScore: 2.76)
OBJECTIVES
Discrete wavelet transforms

RESEARCH HIGHLIGHTS
Wavelet Solutions to Steady and Unsteady State Reaction-Diffusion Problems with Action of Biosensor Response at Enzyme Kinetics

The wavelet based algorithms like Haar, Legendre, Chebyshev and Ultraspherical wavelets have been applied to solve the steady and unsteady state reaction-diffusion problems with action of biosensor response at enzyme kinetics. Mathematical models for biosensors at enzyme kinetics and diffusion limitation are discussed. The developed models are based on the reaction–diffusion equations, containing a nonlinear term related to non-Michaelis–Menten kinetics of the enzymatic reaction. We have introduced the wavelet-based analytical algorithms like Legendre and Chebyshev to solve the reaction-diffusion problems with action of biosensor response at enzyme kinetics. Our results are compared with Runge-Kutta method, Adomian Decomposition Method (ADM), Modified Adomian Decomposition Method (MADM), Homotopy Perturbation Method (HPM), numerical simulation with MATLAB and Homology Analysis Method (HAM). For smaller values of $k$ and $M$, we get the results very closer to the results obtained by RKM, ADM, MADM, DTM, HPM and HAM. Accuracy and efficiency of the proposed wavelet methods have been confirmed by means of convergence, stability, comparative study and computational run time. The local existences, the global behavior of the solutions of the associated parabolic type partial differential equations and the link with the existence of stationary solutions have been established.
Major Publications


OBJECTIVES

- To provide Computational models using higher Mathematical methods at reduced computational cost to a few Engineering projects
- To develop Novel Mathematical Methods to construct Hybrid techniques leading to customised software codes for interdisciplinary research

RESEARCH HIGHLIGHTS

Hypergraph for Intrusion Detection System

Hypergraph (HG) is an exciting tool in the design of computational framework for widespread problems in area of Data Science ranging from image processing to Big data analytics. Extensive literature survey reveals that problems such as elegant data representation, dimensionality reduction, outlier detection, prediction of uncertainty & missing data, design of novel learning algorithms in Data Science applications can be attempted by employing HG techniques. Design of Intrusion detection systems is an vibrant area of research where all the above said issues exist. In this work, we attempt to apply HG techniques to provide feature identification, selection and extraction techniques, to expose hidden attributes and extract hidden features using versions of Hidden Markov models, to provide for parallelization using Dual HG techniques for while processing data and to make Rough Set Theory concepts to co-exist in the development of approximation algorithms in single/multiple Intruder Detection System (IDS).

Figure 1: Generation of Initial Population; (a) Random Population; (b) Construction of Hypergraph and Application of Hyper-Clique Property; (c) Initial Population
Mathematical modelling for computationally attractive convergent schemes, techniques and Heuristics for Intrusion Detection in SCADA Systems

Cyber physical systems (CPS) are partially modelled systems applications ranging from pervasive medical system ton nuclear and thermal reactors. Supervisory Control and Data Acquisition (SCADA), a subgroup of CPS consists of similar components such as sensors and actuators as nodes so called as Remote Terminal Units (RTUs). The major focus of the malicious users on SCADA systems is to compromise the integrity, availability, timeliness, scalability of the components. This emphasizes the need for compact data representative tools like Hypergraphs, semigraphs, etc., classifier designs such as ANNs, PNNs and their versions, hybrid Combinatorial Optimization schemes and number theoretic transforms to ensure security.

An Intrusion Detection System (IDS) needs to identify the compromised nodes through which catastrophic failure of SCADA systems and further critical consequences which need to be avoided detecting/tracking Mathematical identities. However the design of an effective IDS model for the SCADA system is critical task due to the massive volume of traffic generated by its components. The large volume of network traffic, cyber-attacks have become more sophisticated in nature causing the most traditional IDSs fail to provide perfect solution. Hence, in this work we aim to build robust and intelligent IDS (using the above (1) to (4) Mathematical entities) that consist of higher level of abstraction through which a decision with higher level of accuracy can be taken in less time.

Development of Wavelet and Hypergraph modelling framework for Epilepsy prediction using Brain Computer Interface

While high dimensional EEG data sets are available for diagnosing Epilepsy, due to their severe non linearity Novel and computationally attractive techniques are not adequately studied. Moreover signals from scalp based EEG are used for predictions show inadequate. While Machine learning techniques provide results with reasonable degree of accuracy, information for better and diverse predictions with different parameters still remain posing considerable challenges. Hence a set of Discrete Mathematical models and Discrete Wavelet
models are proposed in this project with the following objectives:
1. To examine the capability of various types of wavelets for better representation of Brain signals and explore the possibility of designing hybrid schemes to process brain signals towards the fixed goals and targets
2. To design novel Hypergraph based network architectures driven by supervised and unsupervised learning schemes to understand the complex relation between the Epilepsy types
3. To extract topological and geometrical features of EEG signals that can better describe various types of Epilepsies
4. To create learning models to take appropriate decisions regarding the current state of the patient
5. To process the high dimensional and massive nature of multi-channel EEG signals with linear algebraic techniques not only to improve the accuracy of the learning model but also to minimize the computational complexity and implementation cost

Ultrasound based assessment of tissue biomechanics to enhance the clinical management of foot related pathologies

The goal of this Research work is to develop an assisting tool to the Clinicians for early detection of Diabetic Foot Ulcer (DFU) using Ultrasound images of foot. The objectives of this project are:
1. To develop a load bearing platform for weight bearing ultrasound scanning of the foot
2. To develop a post processing algorithm for 3D imaging of the foot, using Variational calculus principles and to integrate with Gradient descent algorithms to process at faster rate
3. To develop and validate the testing protocol that enables the quantitative assessment and mapping of mechanical properties of soft tissues of the foot
4. To validate the applicability of the new system within the clinic
Development of Computational Intelligence Techniques for Partial Discharge Identification, Localization & Denoising in Transformer Windings

The goal of this research work is to develop Techniques and algorithms for De-noising Partial Discharge (PD) Signatures obtained during measurement and locate the PD inside the transformer winding. The objectives of this project are:
1. To develop algorithms for de-noising of Partial Discharge (PD) Signatures obtained during measurement, using techniques such as Wavelet Transform, Wavelet Transform based Genetic Algorithm, Empirical Mode Decomposition, Singular Value Decomposition and Hankel Transforms
2. To develop a linear algebraic technique based on Hankel matrix completion which can accommodate Singular Value Decomposition and Expectation Maximization to estimate data drop outs during denoising
3. To locate PD pulse patterns during impulse testing using the features (t, dq/dt,n) without using the lumped parameter model network after noise removal using hyperbolic S-Transform based PNN and versions of hidden Markov models
4. Random Forest based Classifier for Noise Type Identification
Hypergraph based Computational Model for High Dimensional And Large Scale Anomaly based Threat Detection in SCADA Systems

While advancements in Information and Communication Technology (ICT) have paved the way for new computing techniques, the day-to-day new born intrusions and cyber threats poses considerable challenges to the cyber community. Though Intrusion Detection System (IDS) has been used as a standard method to protect the critical infrastructure from cyber-attacks, Mathematical modelling with Hypergraphs have not been examined adequately. A wide variety of HG properties are expected provide elegant representation of data that can undergo processing with much less computing time. As SCADA applications involve in power grids, electric and gas utilities, nuclear power plants & reactors, etc., design and development of an efficient and real time IDS for SCADA systems is a mandatory one in present day environments. Most of the existing IDS models suffers from high false positive rate due to High Dimensional High Sample Size (HDHSS) datasets. Hence, in this research work, we propose a novel the hypergraph based computational model (Sec_CPS) to achieve a defense in depth for SCADA systems in terms of improved detection rate and minimal false alarm rate. The key elements of the proposed approach are
1. Design of a HG based learning schemes for Identification of outliers, informative features & samples with minimal time complexity,
2. Performance enhancement of the learning model
3. Design of Wavelet based clustering techniques to obtain the reference points of normal behaviours
4. Development of Distance metrics based score function – schemes for the identification of anomalies in the network traffic
Major Publications
OBJECTIVES
To analyse Mahasweta Devi’s selected works as illustrative of her commitment to social justice and protection of environment

RESEARCH HIGHLIGHTS
Analysis on the Selected Works of Mahasweta Devi
A recent social activist, Mahaswetha Devi with her hundred odd novels and innumerable articles and short stories is worthy of being added to the canon. Her fictional and non-fictional writings give voice to the voiceless tribals in Bihar, West Bengal and other region of India. Her transmutation of authentic social data into creative material would guarantee her a place in the criteria of great literature. She identifies in the tribals many human and humane values which have gradually vanished among the Mainstream Indian population. Particularly, their close affinity to nature and their lack of will to fight for their own legitimate rights in spite of their capacity to hard work have appealed to the social sensibility of Mahasweta Devi and she uses her creative potential to promote social awareness about ecology and justice for the marginalized. The present research analyses her selected works as illustrative of her commitment to social justice and protection of environment.

Major Publications
OBJECTIVES

• Investigate and analyze some single server priority queueing systems with working vacations
• To find energy efficient routing algorithm for heterogeneous WSN

RESEARCH HIGHLIGHTS

Queueing Models
Queueing theory is the mathematical study of waiting lines or queues. It is an important branch of Mathematics with applied probability, statistical distribution, calculus, matrix theory and complex analysis. It also falls under the area of decision science. Examples where queues are common is jobs waiting to be processed in a communication system, aircraft waiting for landing (take-off) in a busy airport, merchandise waiting for shipment in a yard, calls waiting in a call centre, engineering and industrial plants etc. Queues are experienced in supermarkets to check out, vehicles waiting in traffic intersection, patients waiting in doctor’s clinic for treatment, units completing work in one station waiting to access the next in a manufacturing unit of multiple work u stations and so on. Current research is based on Generalizing and analyzing the various priority queueing models and extending in many directions with vacations.

An Energy Efficient Routing Protocol for WSN
Sensor Nodes are capable to sense and communicate the activities of real world parameters such as pressure, heat, humidity, weather, temperature and so on. Wireless Sensor Networks consist of numerous small, cheap, resources constrained sensor nodes. Most wireless sensors have difficult with limited energy sources such as battery power. The capability of the node is limited; the cumulative energy of the entire network is considered for the required application in WSNs. A significant amount of energy dissipates due to control messages overhead, which results in a shorter network lifetime. To design Energy efficient protocols and algorithms being a major design goal in wireless sensor networks. Clustering provides an effective way to extend the lifetime of a wireless sensor network (WSN).
Major Publications
6. Prabu M, Narasimhan D, Raghuram S, An Effective tool for optimizing the Number of test paths in Data Flow testing for Anomaly Detection, Computational Intelligence, Cyber security and Computational Models, 2016; Volume 412, 515-518.
OBJECTIVES
Peristaltic flow of Newtonian/Non-Newtonian ionic liquids in a micro asymmetric channel

RESEARCH HIGHLIGHTS
Electroosmotic flow of Non-Newtonian nanoliquids via peristaltic pumping: A perturbation solution/Homotopy perturbation solution

The study of electroosmotic flow of biorheological fluids has been employing in the advancement of diversified biomicrofluidics systems. The convective boundary condition is applied on the channel walls. The authentic assumptions of Debye–Hückel linearization, long wavelength and small Reynold’s number are employed in the dimensional conservative equations. The influences of various emerging parameters are graphically computed for axial velocity, pressure gradient, thermal temperature, nanoparticle volume fraction, skin friction coefficient and Nusselt profiles. Figs.1-2 are clearly represented that the geometry of the problem and their fluid flow in form stream lines. The present model does not only provide a deep theoretical insight to interpret the electroosmotic flow systems, it will also be applicable in designing the emerging tool for biomicrofluidic devices/systems under peristalsis mechanisms.

Fig.1. Geometry of electroosmotic flow regime
Fig.2 Stream line for electroosmotic flow regime.
A theoretical investigation of a EMHD boundary layer flow over a stretching sheet

The laminar two-dimensional viscous incompressible fluid obliquely impinging on a stretching sheet is formulated and the governing equations describing the problem are transformed into a nonlinear ordinary differential equations by suitable similarity transformations. The geometry of the problem is shown in Fig.3. The resulting equations for this investigation are solved analytically by using the Homotopy perturbation method. Homotopy perturbation method is also validated with numerical solution obtained by BVP command of MATLAB. The main finding of this model is that EMHD mechanisms can control the DNA fibres from a cell. These results can motivate to genetic engineer the DNA analysis which may be utilized in the observation of the interaction between the chromosomal DNA and proteins.

Major Publications
OBJECTIVES

- To study the steady state behaviour of different types of priority retrial queueing models with working breakdowns
- To determine the various queueing performance measures
- To demonstrate the particular application of queueing models in various fields

RESEARCH HIGHLIGHTS

Performance analysis of some retrial queueing system with working breakdown services

Queueing system is a powerful tool for modelling communication networks, transportation networks, production lines and operating systems. Providing excellent service quality and customersatisfaction is the important issue in a service industry. In the recent years, retrial queueing systems with different types of working vacations and working breakdowns are the fastest growing research areas in queueing models. Using the supplementary variable technique, the probability generating function of the number of customers in the system will be obtained. Solution obtained for mathematical formulations of all queueing models are numerically evaluated to analyze the impact of various parameters on the performance of server and results are suitably represented by means of graphs and tables. Various useful queueing and reliability measures, the mean busy period, cost optimizations are discussed. The proposed queueing models have potential practical applications in Simple Mail Transfer Protocol (SMTP) mail system to deliver the messages between mail servers, Wired Networks for selecting routes, in packet switched network, the telephone consultation, the manufacturing system, Storage Area Network (SAN) for high reliability and high speed network services. This type of retrial queueing models with working breakdown services discipline is a good approximation of such computer processing system.

Major Publications

1. Rajadurai P, Sensitivity analysis of an M/G/1 retrial queueing system with disaster under working vacations and working breakdowns, RAIRO- Operations Research, 2018; 54(1): 34-55. (IF – 0.55)
2. Rajadurai P, A study on M/G/1 retrial G-queue with unreliable server under variant working vacations policy and vacation interruption, Songklanakarin Journal of Science and Technology, 2018; 40(1): 231-242. (IF – 0.491)
4. Rajadurai P, A study on preemptive priority retrial queue with Bernoulli working vacation and vacation interruption, International Journal of Process Management and Benchmarking, 2018; Accepted for Publication. (IF - 0.454)
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Research Areas  
English Literature, Diaspora studies and Narratology  

OBJECTIVES  
• To identify possible narratological elements to be added to the existing theories.  
• To apply Labov’s model to study Diaspora Literature  
• To bring out new perspectives in the field of Narratology  

RESEARCH HIGHLIGHTS  
A Study of Jhumpa Lahiri’s Works through Narratology  
The present research uses a model of narrative structure to analyse Jhumpa Lahiri’s works. By using narrative structure it is very easy to interpret literature in dynamic perspective. There is scope to study the narrative technique embedded in writings such as novels, short stories and novellas. Such an approach will unfold the secret of a writer’s place in the cannon of Indian Writing in English mainly because of his/her artistry. Also, this analysis will bring out new perspectives in the field of Narratology.  

Major Publications  
OBJECTIVES

• To trace the cultural exchange that is present in Amitav Ghosh’s Ibis Trilogy
• To identify the effects of cultural exchange

RESEARCH HIGHLIGHTS

Amitav Ghosh is an Indian born English writer. He has written many books but Ibis Trilogy can be considered as his master piece. It includes three novels. They are, Sea of Poppies, River of Smoke and Flood of Fire. His major themes are nationalism, multiculturalism, migration and existential challenges. Cultural study is an interdisciplinary field which deals with the production, reception and significance of culture. Cultural exchange is an exchange process among ethnically different groups. Cultural exchange takes place mainly during migration and colonization. In the three novel of Amitav Ghosh, one could find people moving from one place to another and they are under the control of Britain. So there is a much for cultural exchange.

Major Publications

OBJECTIVES

- Analytical as well as computational approach on solutions of Tarry Escott Problem
- To study on Diophantine Equations
- To study on the various Application Problems in Number Theory

RESEARCH HIGHLIGHTS

Analytical Study on the solutions of Tarry Escott Problem
The present work focuses on the analytical way of approaching the solutions of “Prouhet Tarry Escott Problem” with the aid of analytical Number Theory. As a continuation of analytical approach, this work will extend to apply heuristic methods to the problem. Also the present work aims to obtain solutions of Tarry Escott Problem in terms of hyper geometry influenced by Srinivasan Ramanujan. As an application the work aims to extend to solve some conjectures in Number Theory.

Major Publications

1. Srikanth R, Subburam S. On the Diophantine Equation $y^2=[\prod_{i=1}^{8}x+k_i]$. Proceedings- Mathematical Sciences (Springer), 2018, Accepted, Published online. (IF: 0.371)
3. Srikanth R, Subburam S. On the Diophantine Equation $\prod_{i=1}^{m}d_i y+q_i=f(x)$. Afrika Matematika (Springer), 2018, 29, 1-5.
4. Srikanth R, Subburam S. On the Diophantine Equation $y^p=f(x_1,x_2,\ldots,x_r)$. Functiones et Approximatio, 2018; 58.1, 37-42. (IF: 0.517)
**V. Swaminathan**  
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**Research Areas**  
Theory of Modules, Anti-Homomorphisms, Computational Biology, Hypergraphs and Quantum Computing

**OBJECTIVES**
- To develop applicable pure mathematical concepts in hypergraph, module theory, lattice theory, triple system
- To hybridize hypergraph properties with intelligence techniques to reduce time complexity and design algorithms based on the theory developed in core mathematics

**RESEARCH HIGHLIGHTS**

Many algorithms employed for the computational biology includes NGS. Thus soft computing is inevitable. Many algorithms include Exhaustive search technique, greedy search, ACO, Genetic Algorithm (GA), PSO, Binary particle swarm optimisation, gravitational search, Tabu search, simulated annealing and in graphs, Hamiltonian, Eulerian and directed line are available for NGS. Each has its pros and cons. GA consumes more time and produces the accurate sequence. In the project, unimodular hypergraph hybridised with modified GA reduced the running time with the accuracy generated by GA. Besides anti-homomorphism constructs the reverse complement strand of DNA sequence obtained from HGGA.

Also, a computational framework for Geospatial Metadata by integrating TopicMaps and Hypergraphs (HXTM) based on the elements and their dependency relationships. Hypergraph-Helly property based weight assignment algorithm has been proposed for HXTM framework to calculate stable weights for metadata elements. Recursive use of hypergraph-Helly ensures the predominant element and rank order centroid computes standard weights. With the proposed algorithm, metadata editor, validator and visualization tool designed.
Major Publications


3. V. Swaminathan, Gangotri R, Abhisek V, B.S. Reddy, Kannan Krithivasan, A Hypergraph-Based Genetic Algorithm (HGGA) Built on Unimodular and anti-homomorphism properties for DNA sequencing by Hybridisation, Interdisciplinary Sciences Computational life sciences, 2018 (IF: 0.796)

4. R. Seetha Lakshmi, A. Sivakumar, Gangotri R, V. Swaminathan, Kannan Krithivasan, A novel Hypergraph based Feature Extraction Technique for Boiler Flue Gas components classification using PNN - A computational model for Boiler Flue Gas Analysis, Jr. of Industrial Information Integration, 2018, 9,

Research Areas
Graph theory (Domination Theory, Topological indices, Labelling)

OBJECTIVES
• Characterizing the extremal graphs for mixed domination parameters
• Designing a linear algorithm for enumerating the members in mixed dominating sets
• Apply Topological indices in Computational Chemistry

RESEARCH HIGHLIGHTS

Mixed Domination in Graphs
A set of vertices dominate another set of vertices and set of edges dominate another set of vertices. A set of vertices dominating the edges and set of edges dominating the vertices are studied little. The concept of mixed domination in graphs was introduced by K. Peters, in which a set of vertices dominating the edges called vertex-edge dominating set and set of edges dominating the vertices called edge-vertex dominating set. The concept of vertex-edge dominating set and edge-vertex dominating set is studied in detail.

Major Publications
1. Venkatakrishnan YB, Krishnakumari B. An improved upper bound of edge-vertex domination number of a tree. Information Processing Letters, 2018; 134: 14-17. (IF: 0.793)
2. Krishnakumari B, Venkatakrishnan YB, Ayyaswamy SK. Cactus graphs with equal domination and complementary tree domination numbers. ARS Combinatoria, 2018; 139: 229-235. (IF: 0.268)
3. Deng H, Venkatakrishnan YB, Balachandran S. Extremal properties of some topological indices of graphs. ARS Combinatoria, 2018; 139: 327-336. (IF: 0.268)
7. Li J, Balachandran S, Ayyaswamy SK, Venkatakrishnan Y B. The Randic indices of trees, unicyclic graphs and bicyclic graphs. ARS Combinatoria, 2016; 127: 409-419. (IF:0.268)
OBJECTIVES

- To solve the graceful tree conjecture by generating the graceful tree from the smaller graceful graphs
- To study various vertex valuations of known standard graphs

RESEARCH HIGHLIGHTS

Graph theory and Combinatorics

Graph theory is one of the fast growing branch of mathematics in recent days. The concept of graphs originates by the famous mathematician Euler by solving the famous Konigsberg bridge problem, Russia. In 1967, Rosa introduced $\alpha, \beta, \rho$ and $\sigma$- valuations as a tool to decompose the given complete graph on $2m+1$ into smaller sub graphs, which in turn to solve the Ringel – Kotzig conjecture “All trees are graceful”. Later Golomb termed this $\beta$-labeling as a graceful labeling and it is the notion which is widely used now. Many authors have defined different kind of labeling as a variation of graceful labeling and few of them are odd graceful labeling, cordial labeling, odd even graceful labeling etc and our area of research mainly focuses on those graphs that possess these vertex valuations.

Major Publications

7. P. Rajadurai, S. Venkatesh and K. Parameswari A study on two classes of customers in retrial queue with fluctuating modes of services, International Journal of Engineering and Technology(UAE), 2018, Volume.7, Issue.4. [IF: 0.085]
OBJECTIVES

- To explore the new niche research avenues in Human Resource Management
- To study and hone up skills in different HR research models
- To get insight into corporate HR practices and imparts it with academics

RESEARCH HIGHLIGHTS

Impact of Geographical Indication on Livelihood of Thanjavur Veena Makers in Thanjavur

An Indian Veena is the product of the different artisans including planter, the painter, and numerous other practitioners of art and craft. Conservation of elusive heritage is an urgent requisite in India, where the next generations of communities engaged in making veena leave their instinctive skill and forced to take up other opportunities simply because they have no alternatives in life. This study attempts to unfold impact of GI over the livelihood of veena makers and suggest remedies to improve their present condition of living. In addition, this study would communicate and create awareness of the Government support schemes to them and remedies for the challenges they have poised now. This study would also facilitate revival of arts and craft and link the music to modern life-style that could evoke mutual affection, harmony and peace in society.

Major Publications

OBJECTIVES

• To have an insight into the different dimensions in human behaviour at work.
• To analyse the quality gaps in service sectors.
• To study the consumer behaviour of various products and services in the market.

RESEARCH HIGHLIGHTS

Gauging service quality among management students in B Schools using MEQUAL

Evaluating management education becomes highly necessary and it is mandatory in developing the future decision makers. The proposed study is planned to be conducted in Standalone B-Schools present in Tier 1 and Tier 2 cities in Tamil Nadu and analysis will be done based on descriptive statistics & SERVQUAL Gap model. The major findings of this study will be highly useful for various institutions as these resulting factors can be used by the schools to improve their quality of service. This study would help them to rate themselves and to bridge the gap between the perceived quality and the expected quality of education. This will create a societal impact where the prospective managers are nurtured to meet the requirement of the corporates in the near future. This study can also be extended to other fields of education like engineering, medicine, paramedical and other professional programs.

Major Publications

OBJECTIVES

- Interested in taking up socio-economic research studies aimed at enhancing the livelihood, standard of living and eradication of poverty aimed at bringing positive solution to all the stakeholders concerned.
- Looking forward to research that promotes sustainable economic growth.

RESEARCH HIGHLIGHTS

**SHG groups and their utilization of Mahatma Gandhi NREGA (MGNREGA)**

The research study was commissioned to ensure an objective and scientific assessment of the implementation of MGNREGA in the States/UT and build a credible body of evidence that advocates the rights and entitlements of the most vulnerable and marginalized sections of the society. This project is funded by the Ministry of Rural Development and Panchayat Raj, Chennai to test the assumptions of the possible role of SHG groups in the implementation of the MGNREGA scheme. The primary objective of the study is to ascertain the convergence of TNSRLM-SHGs and MGNREGA scheme in the study area. The study area included Thanjavur, Trichy and Ariyalur districts. Based upon the input from pilot study and the input from the field staff, questionnaire for final survey was fine tuned. For the comprehensive study the team utilised primary and secondary data.

Survey has been conducted in Ariyalur, Perambalur, Thanjavur and Pudukottai districts. Delta blocks/villages from Thanjavur and Pudukottai districts and non delta blocks/villages from Ariyalur and Perambalur districts were included.
Major Publications
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Research Areas
Marketing / HR

OBJECTIVES

• To contribute new insights into the body of knowledge of management research
• To bring out socially and economically viable solutions to existing management problems and challenges through applied management research
• To develop workable models in the area of management by critically analysing the factors associated with contemporary management issues

RESEARCH HIGHLIGHTS

A Study on Availability, Acceptability and Accessibility of digital learning tools among Higher Education Institutions

ICT can be well integrated into higher education system since the progress made by the stakeholders of the education sector towards the use of such tools is considerable. The specific areas of this integration are content creation, delivery, learning and assessment. With increasing acceptance and use of digital media and information, the influence of ICT in higher education is becoming apparent which will further fuel its need and developments in the days to come.

Further, the advancement of Indian higher education system largely depends on digital technologies wherein the need for co-creating a distinct and exceptional learning environment is prominent. This study attempts to unfold the current status of digital education among higher education institutions and understand the views of its stakeholders so that the outcome of this study can offer useful inputs to the educational policy framework of the country which is the need of the hour.
Major Publications
OBJECTIVES

• To gather insight about customer experience in service sector like tourism, retailing, banking...
• To apply statistical tools like Structural Equation Modeling (AMOS), Cluster analysis, Conjoint analysis in research
• To study the behavior of the customer in the contemporary technological ecosystem

RESEARCH HIGHLIGHTS

Infrastructure significance and tourism amenities in Religious places of Tamilnadu-TEMPQUAL Scale development- A pragmatic study

In India, Tourism and Hospitality industry is rising as one of the key drivers of growth among various service sectors, according to India Brand Equity Foundation (IBEF). It is essential and relatively difficult to study the level of significance given to infrastructures and tourism amenities especially for the oldest form of tourism like a pilgrimage in the secularized and modern form of society with growing consumers demand and varying consumption habits. Infrastructural facilities required, basic amenities and good hospitality are important for any pilgrimage destination. To understand the pilgrimage tourists’ perspective on the various existing infrastructural facilities and another available form of services at the pilgrimage site, undertaking these kinds of studies are very much necessary. Satisfied tourists will act as an unpaid brand ambassador for pilgrimage destination. Management of the religious sites and local authorities are responsible for providing congenial ecosystem and pleasing traveling experience to domestic and inbound tourists.

Major Publications


OBJECTIVE

- To emerge as a strong thought vehicle in the chosen areas of research through evidence based analysis backed by empirical data and charter the course of public discourse on issues that are of national, regional & local interest.

RESEARCH HIGHLIGHTS

Sustainable livelihood mechanism for rural landless agriculture labourers
Developed an analytical framework to understand, measure & prescribe a livelihood model for rural landless agricultural labourers in and around Thanjavur district.

Comparative Analysis of Banking services
Developed a framework for comparative analysis between public & private sector banks in key attribute of customer service and the evolving role of Information Technology as an enabler

Rural financial literacy & role of women in investment decisions
To understand the level of financial literacy amongst rural households and the specific role of women in investment decisions. Special focus is on the literacy levels with regard to mutual fund industry and the extent of investment & role of women in mutual fund investment decisions (Funding Agency: Birla AMC)

Technology interventions in education
Understand the technology disruptions that alter the pedagogical practices in education with specific focus in school education. To also understand the broad comparative framework that governs adoption of technology in higher & school education

Rural empowerment through vocational education for entrepreneurship & employment generation
To understand the socio-economic dimensions amongst rural youth in their approach towards skill acquisition for entrepreneurship & employment generation (Tata Trusts)

Besides, these, actively contributed by writing in leading dailies frequently and published two books titled EXPRESS RIGHTINS – Volume 1 & 2, comprising more than 100 articles written in the last 5 years covering major issues like education, economics, public policy, etc.
Evaluating management education becomes highly necessary and it is mandatory in developing the future decision makers. The proposed study is planned to be conducted in Standalone B-Schools present in Tier 1 and Tier 2 cities in Tamil Nadu and analysis will be done based on descriptive statistics & SERVQUAL Gap model. The major findings of this study will be highly useful for various institutions as these resulting factors can be used by the schools to improve their quality of service. This study would help them to rate themselves and to bridge the gap between the perceived quality and the expected quality of education. This will create a societal impact where the prospective managers are nurtured to meet the requirement of the corporates in the near future. This study can also be extended to other fields of education like engineering, medicine, paramedical and other professional programs.

**Major Publications**

9. N. Vijayalakshmi, S. Vaidhyasubramaniam. Employee Training in Banking Sector:


OTHER PUBLICATIONS

1. Author of EXPRESS RIGHTings (2 volumes), a compilation of all articles on various issues of public policy written for various leading dailies and magazines

2. Regular columnist for New Indian Express and occasionally contribute for The Hindu, Dinamani, Thuglak, etc. on Public Policy issues (predominantly on Education.)
OBJECTIVES

• Make useful parallel manipulators like making Shake table and Driving simulators
• Develop mechanisms like portable RO plant and mobility of paralytic patients

RESEARCH HIGHLIGHTS

Design and development of a 6-DOF shake table based on parallel mechanism
In this project an alternative design of a 6-DOF shake table is proposed, developed and tested successfully with earthquake data. This shake table is much cheaper and easy to control compared to existing design of 6-DOF shake table. The design is patented and published in Patent office journal No.48/2016 dated November 18, 2016.

Fig 1: A novel 6-DOF shake table           Fig 2: Testing facility of the 6-DOF shake table

Development of an assistive device for paralytic patients
In this project, a novel single motor walking aid is developed for hemiplegic patients. For their balancing a tripod type balancing support is also provided. With the help of this walking aid, hemiplegic patients can have freedom for walking. This mechanism is patented and published in Patent office journal No 50/2016 dated December 02, 2016.
A hemiplegic patient walking the help of an assistant & Hemi-plegic patient with proposed walking aid

Tripod type balancing support for paralytic patients
Motorized contrivance for mobility of paralytic leg of the patient

A novel design and development of a drive simulator
All drive simulators have six legs and, normally, operated by 6 linear actuators. In this project, a novel design of a driving simulator is proposed. It has 3 legs and 6 rotary actuators which increases its workspace, and reduces the cost by 30 to 40 percent.

Solid model of the novel drive simulator with 3 legs and 6 rotary actuators
Developed prototype of the simulator
Bionic Arm

Bionic arm is an intelligent artificial arm for amputees. In this project, a bionic arm is designed and fabricated and controlled by brain waves of the amputee.

Brain controlled Bionic arm performing different tasks

Major Publications
1. B Bihari, D Kumar, C Jha, VS Rathore, AK Dash, “A geometric approach for the workspace analysis of two symmetric planar parallel manipulators”, Robotica 2016; 34(4), 738-763 IF: 0.9
2. M. Ganesh, D Kumar, C Kumar, AR Sree, KN Sowmya, AK Dash, “Determination of the closed-form workspace area expression and dimensional optimization of planar parallel manipulators” Robotica, 2017; 35(10):2056-2075 IF : 0.9
OBJECTIVE
To create a reliable database from the results harnessed from experiments besides benchmarking the same for future studies on flow over rough aerofoil surface

RESEARCH HIGHLIGHTS
Effect of bi-scaled surface roughness on the transition of a separated boundary layer over a semi-circular leading-edge flat plate: An experimental investigation

The problem of degradation of in-service gas turbines, owing to various operational and environmental factors like, airborne dust, combustion products, etc., should be properly addressed to ensure maximum availability for safe and efficient operation. As a consequence of these external degrading sources, surface erosion or deposition alters the profile by a few microns and the extent of surface degradation is purely a function of blade location and period that it has been under service. Also, separation of the boundary layer is evident near leading-edge of a highly cambered low-pressure turbine blade operating in the low Reynolds regime or with a thinner air operating at a higher altitude. Thus the separated boundary layer becomes highly unsteady when it interacts with surface imperfections, which might eventually bring down the aerodynamic efficiency with a significant change in flow path area apart from increasing the profile losses. Also, roughness influences the separation bubble dimensions to a greater extent with a change in Reynolds number, roughness size and its spatial distribution. Though several sources are responsible for dragging the performance of the engine at the design and in particular, at off-design conditions, the development of boundary layer from a rough leading-edge along with the curvature effect at the tail end will further make the problem more complex. The objective of this study is to bring a better understanding of these most intriguing problems such as wall-bounded flow, boundary layer separation, instability mechanism associated with transition etc. Predicting the location of transition for a separated boundary layer with various test matrices of surface imperfections is therefore necessary from the designer point of view.
**Schematic of boundary layer development over a model aerofoil**

**Flow visualisation of separated boundary layer past an inclined model aerofoil**

**PIV: Contours of instantaneous streamwise velocity superimposed with vectors**

**Major Publications**


**OBJECTIVES**

- To study and analyze various weld parameters
- To evaluate the structure-property relation in welded components

**RESEARCH HIGHLIGHTS**

**Thermal analysis of friction stir welded Aluminium alloys under varying weld environments**

This study is focussed on time temperature transformation of the friction stir welded (FSW) aluminium alloy plates at different environments. The effect of the environment on the mechanical properties shall be analyzed and optimized within the chosen window of weld parameters. Pilot simulation study followed by experimental comparison shall be used to confirm the effect of environment on the weld properties. This study shall bring out possibilities of using FSW at varying environments.

![Graphs showing thermal analysis](image)

**Studies on diffusion bonding issues on metal- metal matrix composite joint**

This work is focussed on the diffusion bonding of the aluminium based MMC with copper conducted to understand the effect of diffusion parameters and evaluate the mechanical properties. Structure – property evaluation of the joint with and without interlayer under varying conditions shall be done through optical, electron microscopy & mechanical testing. Optimal parameters for achieving maximum bond strength are the objectives of this work. Characterization of the interface of the diffusion bonded samples by varying bond temperature, pressure, time & composition of the interlayer under non- vacuum and vacuum conditions shall be evaluated.
Evaluation of flow stress and temperature distribution for friction stir welded metal matrix composites

Friction stir weld simulation was conducted to understand the effect of temperature and flow stress during welding a MMC composite joint. The effect of the stirring action on the advancing side & retreating side were studied with respect to the traverse speed & direction of tool rotation, using different tool geometries. The evaluation of the properties shall be duly supported with respective weld joints tested experimentally. The effect of the temperature during the plastic deformation of the plates and the induced flow stress during the process shall be mapped against various weld parameters.

Major Publications
OBJECTIVES

- To determine the optimum laser hardening parameters for spur gears
- To find the optimum laser texturing pattern and density to minimize wear
- To improve the cut quality of difficult to cut materials using AWJ and laser cutting

RESEARCH HIGHLIGHTS

Stress analysis of high contact ratio spur gears

The main objective of the project is to determine the improvement in the bending and contact load capacity of HCR spur gears compared with normal contact ratio (NCR) spur gears which is currently employed in aircraft applications. Finite element method is adopted to determine the load sharing based bending and contact stresses in the NCR and HCR spur gears. The results of high contact ratio spur gears are to be compared with the normal contact ratio spur gears to estimate the percentage of improvement in the load carrying capacity.

Major Publications

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Research Areas
Robotics, Rehabilitation and Mechanism design

OBJECTIVES
• To implement hybrid actuation in 6-DOF 3- RPRS manipulator for shake table application
• To verify hybrid actuation can reproduce earthquake data for the same payload as that of an existing shake table

RESEARCH HIGHLIGHTS
An alternative design of 6-DOF Seismic simulator based on 3-RPRS 6-DOF topology
Existing 6-DOF shake tables consist of 8 linear actuators-four in the vertical direction, two along the X-axis and two along the Y-axis. Being a redundant manipulator, it has some limitations—especially with regard to coupled control and high cost because of linear actuators. Proposed shake table can overcome the limitations without compromising other features of the existing design. The model was optimized for lighter mass in motion and higher force transmission. The mechanical model was designed using Pro-E and stress analysis was performed using ANSYS for 30 kg payload. Mobility of the mechanism was tested with 1940-El Centro earthquake data.

Major Publications
OBJECTIVES

• To examine plant fibre based composite materials for automotive/aerospace crash applications
• To develop an electric vehicle designs specific to Indian usage
• Explore usage of Internet of Things for sustainable Transportation framework

RESEARCH HIGHLIGHTS

Measurement of Impact energy absorption in composites

Natural fibre reinforced composites with plant fibre as reinforcement presents a much greener option compared to the synthetic fibre counterparts. Our aim is to examine the behaviour of Hemp, Flax and Jute based composites for impact and fatigue strengths in automotive and aerospace applications.

Electric Vehicle Design / Three-wheeler– sustainable transport system

In the Indian scenario of traffic, a composite mode of public transportation is pre-dominant. Three-wheelers (autorickshaws) remain one of the widely used mode of transport. We study the strong points of this vehicle and attempt to take forward a modified version suitable for electric power trains. We have know-how on power trains through our initial studies and tested it on student car projects. We also have in-house data on ride quality from a conventional auto-rickshaw with expertise in building simple data acquisition systems. Over the last couple of years, students from electrical and mechanical stream have worked on student electric vehicle design competition and the teams have won prizes last time in ESVC 2017. With our efforts and combined inter-disciplinary inputs in Internet of Things, we attempt to create next sustainable mode of public transport system.

Auto-rickshaw ride Analysis
Major Publications


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Research Areas
Natural and synthetic fibres reinforced polymer composites

OBJECTIVES
• To develop a Composite technology centre.
• To fabricate and characterise the mechanical properties of Natural and synthetic fibre reinforced polymer composites.
• To analyze and optimise the machinability behaviour of composites

RESEARCH HIGHLIGHTS
Analysis of Natural fibre reinforced polymer composites
Vibration analysis of aloevera fibre reinforced composite beam has been analyzed and it is inferred from this work that aloevera fibre is a very promising natural fibre and can definitely be used to reinforce composite structures. Ansys software is used in present analysis for calculating natural frequencies in various conditions. The present technique of employing natural fibres helps in a sustainable development following environmental policies. The results obtained are quite accurate and show the excellent performance of the present novel technique.

SEM analysis showed that the interfacial bonding adhesion between the fiber and polyester matrix as considerably good, when compare to epoxy matrix and also the curing time of the polyester resin is less than the epoxy resin. Fiber pullout is visible, which clearly indicate the improper fiber-matrix adhesion. This leads to a considerable reduction in the strength of the composites. Though matrix is responsible for the uniform stress transfer,
the air voids inside the resin is one of the main reasons for reduction in strength of the composite.

**Major Publications**


Experimental investigations on welding characteristics of sinter-forged pre-alloy Atomet 4601 steel

To study the mechanical and metallurgical changes in a sinter forged pre-alloy Atomet 4601 (Fe-0.54 % molybdenum (Mo)-1.8 % nickel (Ni)+0.3 %C) low alloy steel subjected to tungsten inert gas (TIG) welding.

Salient points on the research:
- With increasing density, the mechanical properties of the alloy steel are found to increase (ultimate tensile strength and hardness)
- Welded alloy steel has higher tensile strength than that of parent metal
- Higher hardness is found at the weld zone and then declining towards parent metal
- The formation of acicular ferrite in the weld zone is found to enhance the mechanical properties of the welded P/M alloy steel
Major Publications
7. Panneerselvam T, Kandavel T K, Arun K S, Dineshkumar V. Tribological Study on Hybrid Reinforced Aluminium Based Metal Matrix Composites. Int. J. Surface Science and Engineering, 2018; (IF: 0.507)
**OBJECTIVES**

- To study the effect of flow induced vibrations in vertical axis wind turbine due to the random excitation fatigue load induced by the wind.
- To investigate the role of vibrations in order to increase the life of the wind turbine structures.

**RESEARCH HIGHLIGHTS**

**Wind Induced Vibration on Vertical Axis Wind Turbine**

To identify the random excitation fatigue load induced by the across wind and along wind on a small scale vertical axis wind turbine.

**Major Publications**

**OBJECTIVES**
- Development of laboratory scale hybrid rocket engine setup for aerospace lab
- Regression rate enhancement studies for wax based fuels using hybrid rocket motor
- Internal ballistic studies on HTPB, BEE WAX and PARAFFIN WAX solid fuel grains

**RESEARCH HIGHLIGHTS**

**Development and performance analysis of hybrid rocket motor setup**

As a part of the research project, Development of Hybrid rocket motors with a thrust capacity of 3.5kg were developed. Paraffin wax and beewax combinations are used as a solid fuel along with GOX (Gaseous Oxidizer). Primary studies were focused on the reliability of the rocket as well as safety parameters of the hybrid rocket motor setup. Nearly 30 hot static firing tests are conducted without any malfunction.

**Major Publications**


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Research Areas
Machine Design, Gear Design and Finite Element Analysis

OBJECTIVES
• To determine the bending and contact load capacity of non-standard gears
• To evaluate the contact/sliding fatigue performance of asymmetric spur gears
• To design and develop high contact ratio spur gears for the light combat aircrafts

RESEARCH HIGHLIGHTS
Contact fatigue performance of asymmetric high contact ratio spur gears
The contact and bending fatigue performance characteristics of the direct design asymmetric high contact ratio (AHCR) spur gears are to be investigated through rolling contact fatigue test. The results for direct design asymmetric high contact ratio spur gears are to be compared with the conventional symmetric normal contact ratio spur gears to estimate the percentage of improvement in the load carrying capacity.

Finite element model and stress plot of the AHCR spur gear

a). 2D five teeth full rim FE model
b). Magnified view at A
c). Maximum bending stress
d). von Mises stress
Stress analysis of high contact ratio spur gears
The main objective of the project is to determine the improvement in the bending and contact load capacity of HCR spur gears compared with normal contact ratio (NCR) spur gears which is currently employed in aircraft applications. Finite element method is adopted to determine the load sharing based bending and contact stresses in the NCR and HCR spur gears. The results of high contact ratio spur gears are compared with the normal contact ratio spur gears to estimate the percentage of improvement in the load carrying capacity.

Major Publications
OBJECTIVES

• To analyse the real-time movement of Square, Triangular, Hexagonal, Octagonal and Square & Plus and “Y”-structured Omni Directional Mobile Robot.
• To design and develop the angle variable chassis (AVC), to find the optimum angle for the Omni Directional Mobile Robot.

RESEARCH HIGHLIGHTS

To determine Optimum Angle between the Two wheels for Triangular structured Omni directional Mobile Robot (TWOMR)- using newly Designed Angle Variable Chassis (AVC)

This research work focused only on the front and back movement, to analyse the square- and triangle-structured omnidirectional robot movements. An omnidirectional mobile robot shows different performances with the different number of wheels and the omnidirectional mobile robot’s chassis design. This research work presents a design of a unique device of Angle Variable Chassis (AVC) for linear movement analysis of a three-wheeled omnidirectional mobile robot (TWOMR), at various angles (\(\theta\)) between the wheels. Basic mobility algorithm is developed by varying the angles between the two selected omnidirectional wheels in TWOMR. The experiment was carried out by varying the angles (\(\theta = 30^\circ, 45^\circ, 60^\circ, 90^\circ\) and \(120^\circ\)) between the two selected Omni wheels and analysing the movement of TWOMR in forward direction and reverse direction on a smooth cement surface. Respectively, it was compared to itself for various angles (\(\theta\)), to get its advantages and weaknesses.

Figure 1a: Angle Variable Chassis Pro-E Design
Figure 1b. Angle Variable Chassis- Real-time prototype
Experimental Investigation and Path Deviation Analysis of Square Structured Omni Directional Mobile Robot

This research work describes a four wheeled, Square Structured Omni Directional Mobile Robot (SSODMR) movement analysis in different directions. The Omni Directional wheel consists of eight rollers in a single row, which has been arranged over the circumference of the wheel. This SSODMR can move in all eight directions without steering its wheel. In addition, it can also make clockwise and anti-clockwise rotations. A Square structured chassis holds the motors and they are manually controlled by DPDT switches. The motion analysis has been practically done on a cement floor. The deviation from the desired path has been measured and hence the mobility of SSODMR has been practically analysed.
Major Publications


RESEARCH HIGHLIGHTS

Super Critical Methanol Transesterification Reactor

Biodiesel can be produced from vegetable oils which are mono-alkyl-esters of long chain fatty acids derived by supercritical methanol transesterification process. The esterified cotton seed oil, pungam oil, rice bran oil and tamanu oil are to be selected as alternative fuels for this engine. These non edible oils are considered, because of their abundant availability in southern part of India particularly, in Tamil Nadu. The Multi cylinder diesel engine with CRDI & Turbo charger can be effectively run with biodiesel with same level of fuel consumption like that of diesel.

The supercritical methanol transesterification is usually carried out at 520–600 K and 16 MPa which is the optimum condition for maximum yield of biodiesel. The main advantage of supercritical methanol reactor is to produce biodiesel without catalyst. The supercritical methanol transesterification will give 90% of the yield from the seed and fats are fully removed from vegetable oil.

Major Publications


OBJECTIVES

- Optimization of aerodynamic bodies by topology transmogrification
- Investigating novel flow control techniques aiming in a wide range of turbulence
- Advancing aerodynamic bodies by influencing the underlying flow mechanism

RESEARCH HIGHLIGHTS

Influence of LEP on aerodynamic characteristics of tapered / swept wings

One of the most fascinating Biomimetic study utilizing the stall delaying tendency of the humpback whale flipper stands out in the recent years, spotlighting both the experimental and numerical studies. Researchers have attributed that the leading-edge undulations/ Tubercles generate a unique flow control mechanism offering the humpback whale an exceptional manoeuvrability. Recent research proves that wings with leading-edge protuberances have the ability to perform efficiently in post-stall region over the conventional straight wing. Moreover, the conventional straight wing outperforms the tubercled wing at a pre-stall region which is quintessential. Even though tubercled wing offers great performance enhancement because of the complexity of the flow the trough region of the tubercled wing is more prone to flow separation.

Aerodynamic characteristics of Re-entry Aerospace vehicles

Atmospheric re-entry is a challenge for manned interplanetary missions. Making a feasible re-entry is of utmost importance since the re-entry method and the trajectory determines the g-loads and the temperatures experienced by the crew. The re-entry into the earth’s atmosphere occurs at very high velocities corresponding to flight Mach numbers of 30 or even more. The highest was Mach 36 attained by the Apollo 6 return vehicle. These hypersonic flight conditions are associated with several difficult aerodynamic problems.
Subsequently, the successful manned entries of the Mercury, Gemini, and Apollo vehicles were striking testimonials to the success of the hypersonic research. The current computational study proposes an add-on, to the existing Orion-based re-entry vehicle; a duct circumventing the capsule from the shoulder to the base, to improve the aerocapture ability of the re-entry vehicle. Results show that the proposed design increases the drag for all the AARs considered in the subsonic regime. In the Supersonic regime, ducted models of higher AAR are more promising with the increase in Mach number. DRV's also exhibit lower ballistic coefficients than their baseline counterparts.

Aerodynamic characteristics of aerofoil at various turbulence intensities
A series of wind tunnel tests were performed to investigate the effect of turbulent inflows on the aerodynamic characteristics of unsymmetrical airfoil at various turbulence intensities and Reynolds number. To assess the aerodynamic characteristics, surface pressure measurements were made over the unsymmetrical airfoil surface by using a simultaneous pressure scanner MPS4264 of Scanivalve make. Furthermore, to understand the effect of turbulence intensity on aerodynamic characteristics, a self-generated passive grid made of parallel arrays of round bars were placed at four different locations to generate various turbulence intensities (TI) in the wind tunnel. The location of the passive grid has been normalized in terms of (z/L) considering the distance between the entry of the test section.
to the leading edge of the model. Based on the wind tunnel results, by comparing the baseline without grid low turbulence case $TI = 0.51\%$ with other turbulence generated cases like $TI = 4.68, 4.73, 6.04$ and $8.46\%$ at different Reynolds number it is found that the coefficient of lift (CL) increases with the increase in the turbulence intensity.

Major Publications
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Research Areas  
Powder metallurgy, 3D printing and CAD/CAM

OBJECTIVES

• To develop new hybrid powder metallurgy materials for industrial applications
• To characterise the hybrid P/M materials
• To perform various studies to study their behaviour

RESEARCH HIGHLIGHTS

Investigations on Mechanical, Tribological, fatigue, Corrosion and Deformation & densification Behaviour of Hybrid Powder Metallurgy alloys

• To develop the sinter hardenable hybrid powder metallurgy alloys
• To study the effect of conventional and microwave sintering on mechanical properties, tribological properties, fatigue, Corrosion properties, deformation and densification properties
• To study the influence of alloying elements such as graphite and Titanium on mechanical, tribological, fatigue, corrosion, deformation and densification properties of hybrid P/M alloys
• To predict of deformation and densification responses of Hybrid P/M alloys by using Regression mathematical models and ANN
• To study the microstructures using optical and SEM images of the test specimens of alloys and correlate with the mechanical, tribological, fatigue, corrosion, deformation and densification parameters
Major Publications

OBJECTIVE
To study the mechanical behaviour of fiber reinforced, natural fiber reinforced & hybrid composites, the tribological behaviour of composites, the machinability of composites/metals & alloys, and optimization of machining parameters.

RESEARCH HIGHLIGHTS
Investigation on mechanical behavior of Fiber Reinforced composites/Hybrid Composites and on delamination during drilling operations

Composite materials such as fibre reinforced composites and hybrid composites play a major role in engineering applications, automobile, aircraft industries and household appliances due to its light weight, good stiffness, high specific strength and flexible nature. Because of these properties, fibres are interbreeding with glass fibre in fabricating natural fibre reinforced hybrid composites. The research work is dealt with fabrication, testing of mechanical behaviour and delamination during drilling operation. Natural fibres such as sisal, coir fibres etc. along with glass fibre are commonly mixed with polymer (e.g.: vinyl ester, polyester etc.) with a volume fraction of 0.4 and 0.5 using hand lay-up process. Drilling the FRP composite materials is usually associated with a major problem known as delamination, a mode of failure in composite material which leads to poor dimensional stability, surface roughness and long term performance deterioration. Hence, the study focuses to minimise...
the delamination by the optimal set of drilling parameters such as drill bit material, drill bit diameter, spindle speed and feed rate during drilling the fibre reinforced composites. Taguchi’s orthogonal array experimental design, signal-to-noise ratio, analysis of variance and regression analysis are the methods applied to conduct and analyse the experiments in this research work.

**Major Publications**


RESEARCH HIGHLIGHTS

Design on Angle of Attack Tracking Controller in a Mini UAV

Current focus is on the design and simulation of a linear controller for tracking the commanded Angle of Attack (AOA/alpha) in a Mini Aerial Vehicle (MAV). The vehicle considered for this purpose uses inverse Zimmerman planform wing of aspect ratio 1.45. Controlling a Low Aspect Ratio (LAR) wing at low speeds is a highly challenging task. They do not stall sharply but produce nonlinear lift curves. Current works demonstrates the simulation of a tracking control task with a Proportional plus Integral plus Derivative (PID) controller using angle of attack as feedback signal. At present, the tracking problem is considered only in the linear range of angle of attack from -4º to 12º. As far as the feedback signal is concerned, initially it has been assumed that the measurement of angle of attack is directly available. A MATLAB program for Flight simulation and the tracking control problem is executed for a steady wing level flight. The true states generated through flight simulation are used and the angle of attack (which is one of the states) is taken as feedback. This method does not consider the real effects that sensors would exhibit, such as noise, drift and misalignment errors etc. Later, a simple method for estimation of angle of attack is presented considering sensor noise characteristics. Sensor data is primarily simulated by superimposing zero mean white noise with the true states. From these sensor data, angle of attack is estimated and is used as feedback signal for implementation of PID controller for the tracking control problem.

Major Publications

OBJECTIVE
To design and develop technological solutions for the benefit of differently abled persons

RESEARCH HIGHLIGHTS
Design and Development of Wheel Chair based Assistive Robotic System with Self-Transfer Facility to transfer of a wheel chair dependent person from one surface to another

• Wheelchair users face great difficulty in transferring themselves from one surface to another, for example from wheelchair to a toilet commode. In such cases, mostly a caregiver’s assistance may be required, but it affects one’s dignity.
• A robotic self-transfer device, aimed at offering privacy and independence to lower limb disabled in performing daily activities has been developed.
• The device, attached to a powered wheel chair is useful in transferring a user from a wheelchair to a toilet commode or any another surface following simple and natural transfer procedure without the need of any caregiver.
• The user can achieve transfer by operating joysticks.
• The device employs two linear actuators and a motor to accomplish the transfer.
• Trials were carried out to test the overall acceptability of the device by involving potential beneficiaries and device could successfully transfer the participants from a wheel chair to a chair with less effort in less than a minute.
• It was also found that the device is superior to the other existing transfer systems in terms of comfort and operation.
Design and Development of Mechatronic Training Kits for Teaching Psychomotor Skills to Children with Autism Spectrum Disorder

- Children with Autism Spectrum Disorder (ASD) have psychomotor skill deficits or show significant developmental delay in gross/fine motor skills in addition to challenges in verbal & nonverbal communication, social interaction and imagination collectively known as triads of impairments.
- Treating autism has become a global challenge with the drastic increase in the number of children affected by autism.
- An edutainment system with a focus on an all-round and expanded training for psychomotor skills for children with ASD to help them in their day to day activities has been developed.
- It is a gaming platform, with a training console involving two games viz. basketball and bowling that will transform the children to perform day to day activities effortlessly.
- The skills that could be imparted using the edutainment system are various grasps, depth perception, elbow movement, wrist rotation, rolling, pick & drop, hand eye coordination and various cognitive skills like focus, aim, concentration and selection.
- For the purpose of verifying the effectiveness of the system, trails were conducted involving children with ASD.
- The analysis of the data obtained from the trials proves that there is definite improvement in specific psychomotor skills when compared to the results of conventional training system.

Major Publications

OBJECTIVES

- To design and develop intelligent disease counselling system for arable crops, in order to prescribe protocols for disease management, to farmers.
- Assess the performance of crops using Unmanned Aerial Vehicles

RESEARCH HIGHLIGHTS

Disease Guidance System using Foldscope for (selected) Crop: A Pilot Study

Foldscope is attached with high resolution mobile phone to take magnified images of diseased crops. Then the images are processed using image processing algorithm to suggest suitable protocols for disease management. Hence, farmers can identify the disease at an early stage, thereby reducing the yield loss. Foldscope is a paper microscope with an affordable price invented by Manu Prakash and Jim Cybulski from Stanford University – USA, recently.

Performance of Crops using UAV

In 21st century, with all the latest technology, quest to remove hunger among the world population is a serious challenge for human society. In this context, assessing the health status of crops using various vegetative indices has been tried. The output of the system is to identify the areas where there is a water stress, lack in nutrients, etc., thereby corrective measures can be taken by the farmers, in those areas.
Major Publications

8. Szczepański C*, Wróblewski W, Raja P. Sensors of UAV used at agricultural and forestry applications. International Conference on Mechanics in Aviation, 16th May 2018, Poland
OBJECTIVES

- Power generation from low grade heat with use of renewable energy sources
- To develop cooling electronic equipment and thermal-energy conversion devices
- To develop heat pipes suitable to generate power from solar

RESEARCH HIGHLIGHTS

This research mainly focuses on mixed convection heat transfer in ducts with consideration of radiation effects. The analysis of results provides more physical insight and a deeper understanding of the effects of the interaction of surface radiation on convection heat transfer rates. An understanding of the multi-mode interactions provides new knowledge useful in the design of thermal energy conversion devices involving fluid flow and heat transfer. In this research, the mixed convection heat transfer in horizontal and vertical ducts, with two differentially heated isothermal hot and cold walls and two adiabatic walls were studied. The experimental work involved fabrication, assembly and instrumentation of test sections on horizontal and vertical ducts of suitable sizes. The major parameters considered in this work included wall emissivity, Reynolds number, thermal and geometric parameters and aspect ratios.

Flow visualization structure for the above experimental work.
Major Publications
RESEARCH HIGHLIGHTS

Atomization of Ethanol-Methyl Cellulose based green gel propellant

Detailed study on the combined effect of temperature and viscosity variation on atomization is required as an initial step for gel combustion. To fulfill this gap, a theoretical and experimental study is being carried out to understand the effect of temperature on atomization of Ethanol-Methylcellulose and Kerosene-silica based gel propellant. This investigation will additionally facilitate to apprehend the atomization behaviour of a green gel propellant in comparison with a conventional gel propellant. Required experiments (rheology and spray analysis) will be conducted for these gels and the data obtained from these experiments will form the building blocks for a comprehensive theoretical framework or suitable empirical correlation.

Numerical Study of boundary layer bleed control in scramjet intakes

In this investigation, the separation control performance of a single bleed slot for a supersonic intake is studied based on the boundary layer characteristics both numerically and theoretically. Numerical simulation has been carried out in both 2D and 3D flow domain using commercially available software ANSYS. Shock induced flow separation is induced by a 5° half-wedge placed along the opposite wall of the slot. From the simulated flowfield, shock position and shock angle are identified and compared with 1D theoretical analysis. From the results, data analysis was done which showed that the boundary layer adjacent to the shock wave separates which was identified by the value of the boundary layer shape factor. Addition of the bleed slot reduced the boundary layer shape factor value from 2.53 to 1.76 thereby reducing chances of separation. Some small region of separation
Gas Dynamics of extra shock wave

Flow over a half wedge with 11.3° angle in a supersonic flow of $M=2.0$ is simulated using commercial CFD software ANSYS Fluent. Both viscous and inviscid flow models are used for the analysis. From time averaged numerical simulation results, oblique shock formation was observed to occur for the viscous flow model below the half wedge at the leading edge without the presence of any possible physical obstruction to the oncoming supersonic flow. This is referred to as pseudo-shock or extra shock wave in available literature. Formation of the boundary layer over the bottom surface of the half wedge may provide obstruction to the supersonic flow thereby generating the shock wave. During the course of this investigation, occurrence of this extra shock wave is investigated further by employing time resolved simulation of the flow domain. Results obtained from the unsteady analysis showed that the development of the boundary layer and the shock wave are independent of each other, thereby nullifying the boundary layer induced shock generation assumption. The pressure jump across the extra shock wave at discrete times. Fluid dynamic phenomena of formation of this extra shock wave still needs to be further investigated.
Major Publications

Validation of Angle of Attack Estimation Algorithms in Mini Aerial Vehicles

The current work focuses on the validation of four different schemes of estimation of Angle of Attack (AOA) that are developed for Mini-UAVs. As a first step, one of these estimation schemes is validated using wind tunnel measurements. For this purpose, a 1.61 meter wingspan vehicle is considered. A scale reduced model of the same is used in a wind tunnel and the necessary measurements are recorded for estimation of AOA. The wind tunnel measurements are used to write down the CL and CD equations of the flight vehicle. Further, this paper discusses the instrumentation of the flight vehicle, flight testing and recording of sensor data on the chosen flight vehicle. All the necessary measurements for estimation of AOA are recorded along with the actual measurements (of AOA). Using the post flight data in a MATLAB program, the estimation algorithms are validated by comparing the estimated and the actual measurements of alpha and the performances of the estimation schemes are evaluated.

The validation of Angle of Attack (AOA) Estimation algorithms has been addressed in this work. Estimation of AOA is a great challenge in mini flyers. This is mainly due to two factors. First factor being the weight constraint the second is the availability of the aerodynamic data. Knowledge about complete aerodynamic data is not available easily, thus imposing more stringent difficulty in estimation of AOA. Considering these challenges, few AOA estimation algorithms have been developed which produce reasonably good estimates of AOA in terms of accuracy. These algorithms are tested using computational experimentations in a flight simulation environment.

Though the performance of these estimators is tested computationally, the current works focus on the experimental validation of the same. To achieve this, a Mini-UAV developed at CSIR-National Aerospace Laboratories (NAL), Bangalore is considered as the flight vehicle.
vehicle. Initially, a scale reduced model of the vehicle was used in the wind tunnel and
with the help of wind tunnel measurements – three axes forces and the flow angles – one
of the AOA estimation schemes, the ES1 has been validated. Subsequently, flight recorded
data is fed into a post flight computational program using MATLAB for validation of
Alpha Estimators. All the required data are measured in-flight along with the direct AOA
measurements using Swiss Air-Data’s Smart Miniature Vane probe. The Flight vehicle
is a Mini-UAV developed by CSIR-NAL which has a wingspan of 1.61m and a Mean
chord of 0.278m. The Smart Miniature Vane SMV-1 shown in the figure below is a fully
integrated wind-vane probe to measure angle of attack (AoA), angle of side-slip (AoS) and
other airflow angles. The SMV-1 is the optimal solution if precise airflow information is
needed on unmanned aircraft (UAV), remotely piloted aircraft (RPA) and other flight
vehicles. The probe provides calibrated absolute angular data on the RS 485 data interface.
The vane probe is installed in SUCHAN and a wind tunnel calibration has been done. The
vane is calibrated at different airspeeds such as 10m/s, 13 m/s and 20m/s. The maximum
angle of incidence considered was 20º. Beyond this limits, the model is closer to the wall.
Figure 5 depicts the calibration setup of SMV-1 vane in the MART facility of the NAL
Bangalore.
Major Publications
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Research Areas
Composites, Nano-structures, Aerodynamics and Thermal Engineering

OBJECTIVES
Experimental study on behaviour of Natural fibre reinforced composites under cyclic loads and to provide optimised structural design for potential application in aerospace and automobile industry.

RESEARCH HIGHLIGHTS
Numerical and experimental study on Enhancement of Structural Responses of Damaged Composite Laminates
The objective of the present investigation is to employ piezoelectric patches for enhancing the performance and thereby reducing the effects of internal flaws in Carbon fibre Composites.

• The study at first aims to analyse the bending, buckling, and free vibration behaviour of laminated composite structures using FEM
• The effects in response of composite plates due to a region of damage are to be introduced
• Effects of piezoelectric patches on the bending, buckling, and free vibration characteristics of the damaged Composite plates are to be analyzed

Major Publications
OBJECTIVES

• To determine and compare the performance of the cutting insert made with microtextures in the flank and rake faces
• To optimize various machining parameters using different optimization techniques

RESEARCH HIGHLIGHTS

Multi-objective optimization of machining parameters using different optimization techniques
Machining parameters like cutting speed, feed rate, depth of cut and coolant flow rate for machining AISI H13 die steel, and PTFE polymer was carried out by considering the metal removal rate, surface roughness, cutting tool temperature, cutting forces and power consumption. RSM based design experiments were carried out and optimized using grey relational analysis and TOPSIS algorithm. The genetic algorithm is also used to compare with results with the conventional algorithm for achieving the multi-objectives.

Effect of textured and coated cutting tools for machining hard materials
Cermet cutting insert made with parallel, perpendicular and cross textured pattern were used to check the performance while machining hard steels. The textured tool was coated with different coating materials, and their performance was compared with the simulation results.

Formation of GFRP composites and characterization for the machining operations
Glass fibre reinforced polymer (GFRP) composites are finding its application in various areas. In this project, GFRP composites prepared with natural fibres were characterised for its distribution and various orientation of glass and natural fibre machining parameters of milling and drilling operations were optimized using different optimization techniques.

Major Publication
RESEARCH HIGHLIGHTS
Enhancement of Structural and Aeroelastic Responses of Damaged Composite Laminates

Mathematical modeling of damaged composite plate will be done and enhancement of structural and aeroelastic responses will be analyzed for damaged composite plates after placing piezoelectric material over the composite substrate in this work. The study at first aims to analyse the effect of various damage parameters on the buckling, free vibration, and flutter behaviour of a damaged laminated composite structures using FEM. Effects of different voltages on the piezoelectric material (which is bonded over the laminated composite substrate with internal flaws) on the buckling, free vibration, and flutter characteristics are to be analyzed. In broad sense, the present investigation on structural and aeroelastic characteristics of new structural materials such as composites and smart composites will help addressing some vital issues concerning structures where weight is a prime design factor as in aerospace applications.

Major Publications
RESEARCH HIGHLIGHTS

Development of metal matrix composites through powder metallurgy route

The usage of powder metallurgy route for processing the metal powders results in superior mechanical and thermal properties where the near net shape components are formed by blending, mixing, compacting and sintering of metal powders. Metal matrix composites have an excellent potential to become one of the most important materials in power, aerospace, automotive and manufacturing sectors since the higher strength to weight ratio is possible to achieve even for low density. As these materials exhibit poor ductility during operation even at room temperature, research is needed to carry out on powder metallurgy products to improve the ductility through different approaches and to facilitate rapid commercial usage of consolidated powder products. In the proposed investigation, the powder metallurgy process required for consolidation will be developed. The powders will be mixed together in required ratio and then the mixed powders will be consolidated through spark plasma sintering under highly controlled pressure and temperature to obtain the desired compaction. The consolidated samples will be analyzed for porosity, density, phase distribution, hardness and strength.

Major Publications

OBJECTIVES

- To develop a void fraction/liquid film thickness measurement system that can be effectively used for characterization of multiphase flows online
- To enhance heat and mass transfer in mini/micro reactors using passive techniques

RESEARCH HIGHLIGHTS

Measurement of Liquid film thickness using Fluorescence Tracking and Laser Image processing in Taylor bubbles

The present work is focused on the effect irradiation behavior of infrared rays (IR) during gas liquid two phase flow consisting of thin liquid films inside a mini channel. The influence of size and shape of the slug regime and liquid film thickness on IR rays is analyzed with COMSOL Multi physics package. Experiments are carried out in a mini/micro channels made of borosilicate glass tube. The refraction and transmittance behavior of IR rays on slug and bubbly flow is studied by analyzing the Current-time output of an IR photodiode kept at different angles with the test section. The results are found to be in good agreement with experimental image processing technique and COMSOL results. The results obtained will be useful for designing of IR sensor arrays sensitive to multiphase flows. It can also be used for measurement of liquid film thickness with proper calibration.

3D Model developed in Comsol
IR rays transmitted at (a) front; (b) centre; (c) rear - slug length 3.21mm and diameter 2.44mm

Major Publications
1. Mithran N, Venkatesan M. IR transceiver irradiation characteristics on bubble/slug flow regimes in conventional and mini channels. IEEE Transactions on Instrumentation and Measurement, 2018; DOI - 10.1109/TIM.2018.2843078. (IF: 2.45)
COLLABORATIONS

SASTRA has emerged as a front runner in higher education and this has led to the establishment of synergetic relationships with multinational giants, international universities and research centres worldwide. The national and international collaborations with various universities / academic organizations are listed below:

- Central Electrical & Electronics Research Institute, Chennai
- Central Council for Research in Ayurveda & Siddha, New Delhi
- Cornell University, USA
- Deakin University, Australia
- Drexel University, USA
- EPN, Ecuador
- Georgetown University, USA
- Georgia Tech, USA
- Harvard-MIT Division of Health Sciences & Technology, USA
- Indian Space Research Organization
- Indira Gandhi Centre for Atomic Research
- Institute of Genomics & Integrated Biology
- Institute of Acoustics, China
- Jawaharlal Nehru Centre for Advanced Scientific Research
- Karlsruher Institute for Technology, Germany
- Michigan State University, USA
- Nanyang University of Singapore
- National Centre for Biological Sciences,
- National Institute of Nutrition (NIN)
- National Institute of Oceanography (NIO)
- National University of Singapore
- NIMS, Japan
- Orebro University, Sweden
- Plymouth University, UK
- Staffordshire University, UK
- Tokai University, Japan
- Tokyo City University, Japan
- University of Bologna, Italy
- University of California (Berk.), USA
- University of Connecticut, USA
- University West, Sweden
- Universite Montpellier, Paris
- University of Pittsburgh, USA
- University of Tennessee, USA
- University of Wisconsin, Madison, USA
- University of Wisconsin, Milwaukee, USA
- UPC, Barcelona
- UAB, Barcelona
- UB, Barcelona
- University of Texas at Austin, USA
- University of Windsor, Canada
- Osaka Prefecture University, Japan
- Vikram Sarabhai Space Centre
- Virginia Tech, USA

Besides these, extensive collaboration exists with various industry houses. The partial list is given below:

- Accenture
- Altera
- Brakes India Ltd.
- City Union Bank
- Cognizant Technology Solutions
- IBM
- JIPMER, Pondicherry
- Lucas TVS Ltd.
- Microsoft
- Novozymes
- Orchid Chemicals & Pharmaceuticals
- Sankara Nethralaya
- Madras Diabetics Research Foundation
- Seshasayee Paper Boards Ltd.
- Shree Baidyanath Ayurved Bhawan
- TATA TRUSTS
- Tata Power
- Tata Consultancy Services Ltd.
- TATA Communications Ltd.
- TATA Power SED
The Global SAstraite

“SASTRA’s forward-looking collaborations with renowned foreign universities have been instrumental in adding a global recognition to our academic pursuits. The Desh-Videsh scholarship scheme provides financial support that encourages and supports students to embark on a global career option.

- Desh-Videsh Scholars

Semester Abroad Partners
PUBLICATIONS & PATENTS
The encouragement given for research has resulted in 6,836 SCOPUS indexed publications. During the calendar year 2017, 875 papers were published and 691 papers have been published so far in 2018. In addition, about 100 manuscripts have been accepted and another 100 manuscripts are in different stages of review. The h-index of the institution is 58. The faculty and students of SASTRA file six patents during the year 2017–18 taking the total number of patents to 42.

The snapshot from SCOPUS database shows the percentage of publications in different areas:
RESEARCH INITIATIVES & INCENTIVES
SASTRA has been providing various incentives to promote research and development.

1. SASTRA Research & Modernization Corpus Fund has so far funded 39 research projects with an outlay of about Rs 460.84 lakh. During this year, two new facilities in the School of Civil Engineering and School of Chemical & Biotechnology have been sanctioned at a total cost of Rs 50 lakh.

2. SASTRA provides 10% of the project value as incentive to any number of faculty members who secure a research grant. In the year 2017–18, Rs 60.45 lakh was given as incentive to 62 faculty members.

3. Thirteen faculty members were presented a cash incentive of Rs 1 lakh each for completing their Ph. D. without compromising their teaching commitment.

4. To encourage on-campus research, Faculty Research and Development Scheme was launched in April 2010 during the Silver Jubilee Celebrations. During the period June 2010– May 2016, eighteen faculty members received Rs 6 lakh each for publishing a minimum of three SCI / SSCI papers as corresponding author and / or for successfully guiding two full-time Ph. D. scholars or publishing a book through a reputed publisher.

5. Prof. R. John Bosco Balaguru, Dr. R. Chandramouli and Dr. S. Philip Anthony have won the SAPHIRE award for the year 2017–18 in recognition of their contribution towards research activities. The award carries a citation and round trip vacation package with family to a foreign location.
SUPPORT FOR RESEARCH

Prof. T. R. Rajagopalan R&D Cell – Seed Grant
The Institution provides seed grants through Prof. T. R. Rajagopalan R&D Cell. The award carries a grant of Rs 2,00,000 for research work to be completed within a year. However, depending on the nature of the problem, both the financial support and duration are relaxed.

Research and Modernization Fund
Research and Modernization Fund has been created with a corpus of Rs 5 crore to conduct research and modernize the laboratory. Every year, proposals are invited from faculty members of all Schools and selected proposals are funded. During this year, two new facilities in the School of Civil Engineering and School of Chemical & Biotechnology have been sanctioned at a total cost of Rs 50 lakh. So far, 39 research projects have been funded with an outlay of about Rs 460.84 lakh.

Teaching Assistantship Fund
To encourage research and attract young scholars to pursue their Ph.D., SASTRA has launched the Teaching Assistantship Scheme with a corpus fund of Rs 2.50 crore, wherein candidates will be admitted to the Ph. D. programme at SASTRA with a monthly stipend of Rs 12,000 up to a maximum of Rs 16,000 irrespective of external funding. Every semester, examinations and interviews are conducted to select about 20 research scholars who are provided with teaching assistantship. The scheme also enables us to identify prospective project staff, who could be recruited as JRF in funded research projects thereby avoiding delay in recruitment.

335 full–time Ph. D. students are currently enrolled for full–time Ph. D. and every student is provided stipend through research projects, CSIR fellowship, DST-INSPIRE fellowship and other fellowships. 95 Ph.D. students are supported through the Teaching Assistantship Fund to enable them pursue their full-time Ph. D. Programmes.

In addition, the Institution provides financial support to the creation of research facilities as and when required including contributions to the DST–FIST and other research projects.

Students Innovation Fund
SASTRA has created a “Student Innovation Fund” with a corpus of Rs 2 crore. The aim of this fund is to encourage creativity and innovation amongst the student community of SASTRA. Under this scheme, top 10 innovative student research projects are funded to a tune of about Rs 2 lakh each. In addition, consumables and other requirements for students’ research projects are supported through the provisions available for the laboratories.
STUDENTS’ ACHIEVEMENTS IN RESEARCH

The achievements of SASTRA students are a direct reflection of the Institution’s transparent and merit-based admission policy, coupled with SASTRA’s drive to make its students soar high. The success of SASTRA students in various fields has been manifold and a few of the notable achievements in the past year are highlighted below:

1. Dr. K. Lakshmi Varaha Iyer, a SASTRA alumnus received the Governor General’s Gold Medal in Canada. Established in 1873, this Gold Medal is one of the most prestigious awards that can be received by a student in a Canadian educational institution for exceptional academic achievement. A 2009 batch B.Tech. in Electronics and Communications Engineering at SASTRA, Dr. Iyer is currently working as Technical Specialist Engineer in Corporate R&D and Engineering, Magna International Inc. Aurora, Ontario. He did his M.A.Sc., degree and Ph.D. at the University of Windsor, Canada and thus received the prestigious Governor General’s Academic Medal for 2016-17 from the University on behalf of the Governor General of Canada.

2. Chi. Kannan Veeraraghavan, a final B. Tech. Mechanical Engineering student of SASTRA Deemed University has been awarded the Cambridge India Ramanujan Scholarship for pursuing Ph.D. programme at Cambridge University. The bilateral scholarship supported by Department of Science and Technology, and Cambridge Trust provides composite tuition fee waiver and an annual allowance of UK £16,800. The scholarship programme is given for pursuing research in the fields of astronomy, cancer research, chemical engineering, chemistry, computer science, engineering, materials science and metallurgy, mathematics, pharmacology, plant sciences and physics. Kannan will be pursuing his Ph.D. in Engineering at Robinson College at Prof. N. Swaminathan’s Hopkinson Lab on cyclone intensity modelling. Kannan is one among the 20 students from India to be selected for the annual scholarship.

3. It is matter of pride that in the recently held CSIR-SRF interview, 18 of our students have been selected at the National level accross various disciplines.

4. Khorana Award

Kum. Rachita K. Kumar, III year, B. Tech. Bioinformatics student has been selected for the prestigious Khorana Program for Scholars 2018. As a part of this program, Rachita will join as an intern in Prof. Roger D. Kornberg’s laboratory in Stanford University School of Medicine, USA. Prof. Kornberg is a renowned Structural Biologist, who received the Nobel Prize in 2006.
5. Students from various departments have done exceedingly well in GATE 2018. The following students have scored within Top 100 All India Rank in GATE 2018:
  i. Harini (2017 batch) – AIR 38 – Biotechnology  
  ii. K. Adithi – AIR 41 – Biotechnology  
  iii. V. Gopikaa – AIR 56 – Biotechnology  
  iv. Vallala Sai Nivedh – AIR 63 – Aerospace Engineering  
  v. Dhanam Koilraj – AIR 87 – Aerospace Engineering

6. Under the SASTRA FOSSEE Centre, undergraduate Chemical Engineering students have developed a process flowsheet using a free and open source chemical process simulator DWSIM. The developed process flowsheets are hosted at the FOSSEE portal maintained by FOSSEE, IIT-B. Students are given honorarium and certificate of appreciation under this flowsheeting project. The SASTRA FOSSEE Centre is coordinated by Dr. P. R. Naren, Chemical Engineering Department.

7. About 171 students from the 2019 Batch are doing their IAS / Non-IAS summer fellowship with various Premier Institutions in India and abroad, like IIT, IISc., IIISER, Indian Institute of Space Science and Technology, Tata Centre for Interdisciplinary Sciences, Indian Institute of Information Technology, Design & Manufacturing, FOSSEE, IIT – B, Bhabha Atomic Research Institute, Mumbai, IGCAR, Kalpakkam, HAL, Bangalore and Industries like Sundaram Clayton, TVS Motors, ZoomRx, TCS, Encore Theme, etc. This summer Internship took place during May to July 2018.

8. IAS Fellowship
   Ten students were selected by Indian Academy of Sciences for their Summer Fellowship during May–July 2017. One hundred and seventy six students did their summer fellowship in Premier Institutions like DRDO, NIOT, IISc, NCBS, IITs, IMSC, TCS, Wipro, Renault Nissan, TVS Motors, etc.

9. Semester Abroad Programme
   Eighty eight students of 2018 batch are undergoing Research Internship and Course Work under the Desh–Videsh programme of SASTRA, at 27 prestigious foreign universities like MIT–Harvard, Albert Einstein College of Medicine, New York, Georgia Tech, USA, Plymouth University, UK, University of Texas, USA, UPC–Barcelona, Tokyo City University, Japan, University West, Sweden and NUS, Singapore. They are paid a monthly stipend of USD 200 and round trip airfare by SASTRA Deemed University. Last year 61 students under the Desh–Videsh scheme were supported to a tune of Rs 61.10 lakh.
Ph. D. DEGREES AWARDED
Sixty three candidates were awarded Ph.D. degrees during 2017–18 for their research work and the following table provides information:

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CONCLUSIONS & FUTURE PLANS
The targets set for last year have been achieved substantially and the Institution aims to further its research activities. The research at SASTRA have been globally recognized, which has resulted in featuring SASTRA in the Times Higher Education Ranking and QS Asia & BRICS ranking. The research progress has also shown satisfactory growth as ensured by publication outcome, patents filed, increasing collaborations, funding opportunities, international conference, etc. This year also saw the establishment of a Technology Business Incubator in the area of 3D printing and Internet of Things (IoT). However, the hallmark of a research University lies in its capacity to sustain the momentum and also expand the research scope with coherent synergy.

To achieve excellence in research and strengthen collaborations, SASTRA follows the Vision 2025 document, which provides strategic guidance. Our future goal is to establish Centres of Excellence in niche areas and a Centre for Innovation.

Our action plan to establish Centres of Excellence are:
1. Enhance competencies in emerging areas of research
2. Strengthen our intellectual resources enabling trans-disciplinary and innovative research pursuits
3. Actively participate in national and international research missions
4. Integrate theoretical and experimental research expertise to achieve deeper insights
5. Introduce research-intensive programmes in thematic areas

Our action plans to establish Centre for Innovation is:
1. Encourage entrepreneurship in emerging areas
2. Conduct frequent joint workshops with Industry to identify high-priority challenges
3. Maintain a database of patents generated and widely publicize them to identify potential beneficiaries
4. Facilitate filing and transferring of patents to Industry / Government bodies
5. Invite & peer-review research proposals from faculty based on specific requirements
6. Institute a corpus to promote and award technology development initiatives and innovations
7. Host industry R&D units / office to promote Industry-Academia collaborations
8. Conduct national level innovation contests to recognize and encourage innovators