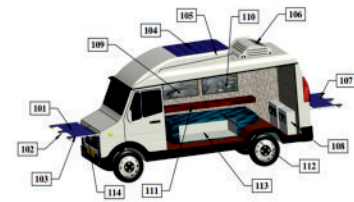
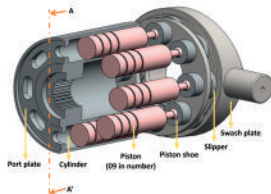




A Handbook of
Ideas,
Innovations &
Technologies of
IIT Indore



IIT INDORE



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Directors' Message

I am very happy to present this edition of compilation of technologies developed by the professors of IIT Indore and their students. They have evolved from the years of scientific research undertaken by the professors and students. The technologies are at various levels of readiness. Some of them are already transferred to the market but several of them requires specialized support to enhance their technology Readiness level (TRL). To this end, the institute has conceptualized centre for translational research (CTR). The institute offers the translational research fellowships to Ph.D/ M.Tech/ B.Tech students to stay back into the institute after completing their course work to focus on the converting them into useful prototypes and products that can be commercialised. Already five such translational fellows are working in the CTR in the institute.

I am sure this compilation will give the most comprehensive view of the contributions of the institute in the domain of technology development to the industries, innovation and building entrepreneur.

My heartiest congratulation to the all the faculty members and students of the institute who have contributed to this edition of technology compilation. I also wish them all success in taking their technologies forward to prototype or product development.

Best Wishes

Prof. Suhas Joshi
Ph.D., FNAE, FNASc
Director, IIT Indore



Dean (R&D)'s Message

Research and development are one of the key fortes of IIT Indore since its inception. The journey of research at IIT Indore started with sponsored project from DST including DST Inspire, young faculty, startup research grant from DST etc. More number of projects started flowing with slow and steady pace. Till date, we have closed to around 600 sponsored projects sanctioned to IIT Indore and a strong publication record of 7500 in the internationally reputed journals.

Patent and Product development was one of the key focus since the inception of IIT Indore. Near to around 140 patents has been filed and close to around 63 patents has been granted till date. To encourage the faculties and students to file more patents, a **Scheme on Intellectual Property Protection and Translation (SIPPT)** was proposed and approved by the Director and Board of Governance, IIT Indore which supports the considerable number of patent through this scheme. In addition, through **Young Faculty Research Grant Scheme (YFRGS)**, funding supports are provided to the newly joined faculties to involve undergraduate students in their research projects, execute external project, and provide exposure to collaborate and work in reputed abroad universities.

To strengthen the technology translation and commercialization process, the R&D Office is closely

working with the Techno commercial experts to assess the TRLs of the technology towards commercialization. Till date 3 technologies has been transferred to Industries and some more are in the pipeline. However, to create a robust methodology to establish Lab to Land ecosystem a **Centre for Translational Research (CTR)** has been initiated. The main focus of centre is to align the technologies based on the market demand and provide the necessary hand holding techno-commercial support to the students and faculties. As an initial start, the Centre has come up with the Translational Research Fellowship through students and researchers involved in the technology having commercialization potential in their academic projects. These projects are supported with fellowship to maintain the continuity in leveraging the Technology Readiness Level (TRL) of the technologies. In order to showcase the technologies to the community, The technologies at different levels are compiled in the form of book. The technologies are classified under differ domains including AI/ML, Health Care, sustainability, Manufacturing, Robotics etc. This consolidation of the technologies will help the industries to reach out to the faculties of different domain. We aim for translating more technologies from IIT Indore to reach market through this initiative.

Prof. Palani Iyamperumal Anand
*Dean Research and Development,
IIT Indore*

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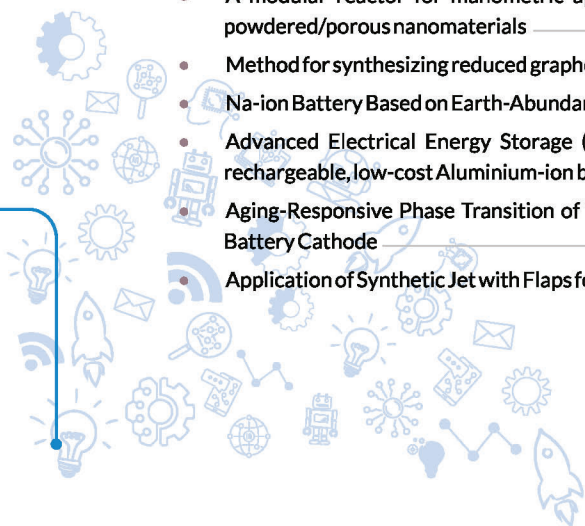
Dr. Sidharth Sharma (Department of Computer Science & Engineering)

AI/ML/Blockchain Technologies (including Quantum Computing)

• Road Surface Quality Assessment and Monitoring	02
• A Semi-Automated Target-oriented Linguistic Bias Detection and Classification Tool For 1947 Partition Texts	03
• AI Based Soyabean-Seed Viability Sensor for Assessment of Seed-Quality	04
• Ground Water Management App and Ground Water Level Measuring Device	05
• Development of Mobile App For Farmers to Help Them in Agricultural Activities: Krishi Sewa	06
• A Smart Road Asset Management System and Method There of	07
• Anomaly-Based Incident Detection on Highways	08
• Crop Doctor : An Extensive Soybean Information App	09

Clean Energy & Renewable (including Hydrogen & EV)

• Catalytic Process for Hydrogen Production from Polymeric Polyethylene Terephthalate (PET) Waste	11
• Catalysts for Low-temperature Hydrogen Production	12
• A Method for Estimating the Gas Adsorption Capacity of a Solid Adsorbent	13
• A modular reactor for manometric apparatus operable in a hydrogen environment at high pressures and capable of handling powdered/porous nanomaterials	14
• Method for synthesizing reduced graphene oxide aerogels	15
• Na-ion Battery Based on Earth-Abundant Materials	16
• Advanced Electrical Energy Storage (beyond Li-ion battery): Light-weight, binder-free thin-film cathode for high performance rechargeable, low-cost Aluminium-ion battery	17
• Aging-Responsive Phase Transition of VOOH to V10O24·nH2O vs Zn2+ Storage Performance as a Rechargeable Aqueous Zn-Ion Battery Cathode	18
• Application of Synthetic Jet with Flaps for Thermal Management and Energy Harvesting	19



Defense & Aerospace

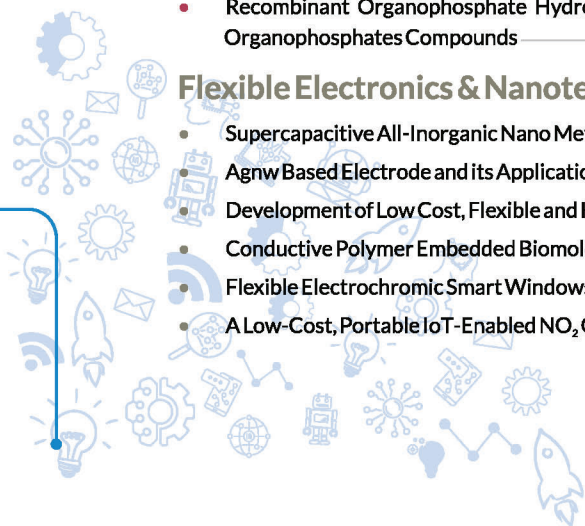
• Large Antenna Characterization System	21
• A Method of Maintenance For High-Performance Machineries Employing Axial Piston Pumps and Multiple Cylinders	22
• A Method and System for Detection and Determination of Failure of A Fluid-Power System	23
• High-Performance Lightweight Curved Composites	24
• Triboelectric based shoe sole for energy harvesting for powering microdevices for army personnels	25
• Multilayer hybrid composite panels under impact loading	26

Environment & Sustainability (Including Air, Water, Rivers)

• Passive Radio Source Localisation System	28
• Compressed Colored Bi-layered Bricks	29
• Controlling of Surface Seismic Wave using META Surfaces	30
• Data-driven solution to enhance Climate Resilience and Mitigate the impacts of Hazards	31
• Spatio-temporal Distribution, Detection, and Prediction of Aerosol Atmospheric Rivers (AARs) on a Global Scale	32
• A Novel Process on Quantification of Hydrologic Resilience Potential and its Attributions	33
• Recombinant Organophosphate Hydrolyzing Enzyme Immobilized Composites for The Detection and Degradation of Organophosphates Compounds	34

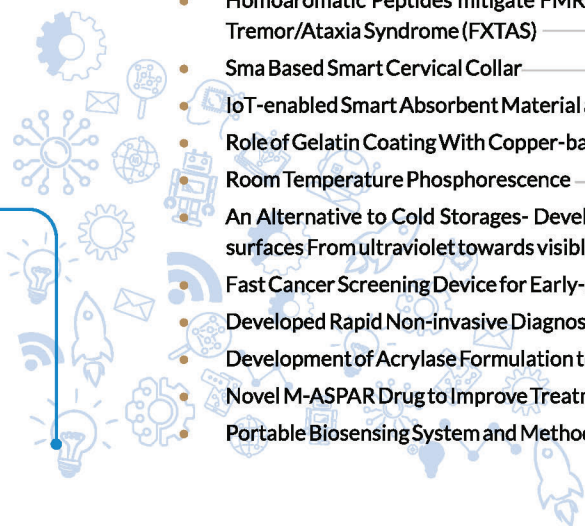
Flexible Electronics & Nanotechnology

• Supercapacitive All-Inorganic Nano Metal-Oxides' Complex: A 1800 Super-Bendable Asymmetric Energy Storage Device	36
• AgNW Based Electrode and its Application in Photodetector	37
• Development of Low Cost, Flexible and High Responsivity UV Dosimeter	38
• Conductive Polymer Embedded Biomolecular Hydrogels (CPBHS) and Method There of	39
• Flexible Electrochromic Smart Windows	40
• A Low-Cost, Portable IoT-Enabled NO ₂ Gas Sensor System with Enhanced User Safety	41



Healthcare (Including Devices and Digital Health)

• Ultrasonic Atomizer Based Method for Development of Biodegradable Anticancer Nanoparticles, Microspheres and Hybrid Micro-particles	43
• Robust Remote Photoplethysmography Estimation By Denoising Eulerian and Lagrangian Pulse Signals Using Contrastive Learning	44
• System, Apparatus and Method for Heart Rate Determination of Individuals Wearing Face	45
• Automated Parkinson's Disease Detection System using EEG Signals	46
• Novel 3D-printing Biomatrix Ink: A Double Cross-linked Self-healable Hydrogel for Cell Culture Applications	47
• A Standalone, Portable Apparatus for Automatically Measuring Blood Pressure with Remote Monitoring	48
• A Vaccine and Biological Material Carrier Box	49
• Epstein-Barr virus glycoprotein M peptide plausibly instigates Alzheimer disease-like symptoms	50
• A Sanitization Device for a Protective Article	51
• Small Molecule Drugs for Treatment of Tuberculosis	52
• Early Diagnosis and Treatment of Prostate Cancer	53
• New Small Molecule Peptides for Treatment of Cancer	54
• A Composition for Sepsis and Method Thereof	55
• Homoaromatic Peptides mitigate FMR Poly-G-protein-mediated toxicity and alternative splicing defects in Fragile X-Associated Tremor/Ataxia Syndrome (FXTAS)	56
• Sma Based Smart Cervical Collar	57
• IoT-enabled Smart Absorbent Material and Sanitary Device	58
• Role of Gelatin Coating With Copper-based Metal-organic Framework For Controlled Insulin Delivery	59
• Room Temperature Phosphorescence	60
• An Alternative to Cold Storages- Development of a Portable kit for visible light Photo dynamic inactivation of microbes on food surfaces From ultraviolet towards visible light: a sustainable future	61
• Fast Cancer Screening Device for Early-stage Cancer Diagnosis, using a Quantitative Photoacoustic Spectral Response Technique	62
• Developed Rapid Non-invasive Diagnostic Kits (TB-RAP) for Tuberculosis	63
• Development of Acrylase Formulation to Reduce Acrylamide Carcinogen Formation in Processed Food Products	64
• Novel M-ASPAR Drug to Improve Treatment of Primary and Relapse Blood Cancer	65
• Portable Biosensing System and Method for Milk Spoilage and Adulteration Detection	66

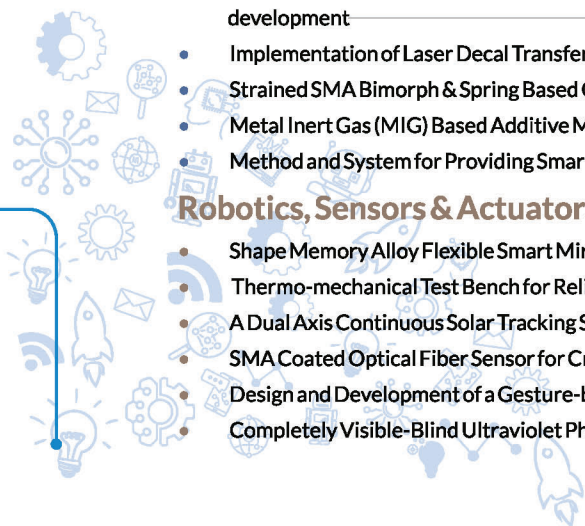


Manufacturing (Including Smart, Advance and Industry 4.0)

• System and Method for Direct Ink Writing	68
• Design of Industrial Illumination Drone with Obstacle Avoidance	69
• Non-Contact Technology for High Quality Finishing of Bevel Gears	70
• Abrasive Flow Finishing Machine for High Quality Finishing of Cylindrical and Conical Gears	71
• Micro-Controlled 3-Axis Machine for Abrasive Jet Machining (AJM) Process	72
• Single Flank Roll Tester for Functional Performance of Cylindrical Gears	73
• Double Flank Roll Tester for Functional Performance of Cylindrical Gears	74
• Noise and Vibrations Test Rig for Cylindrical and Conical Gears	75
• Non-Contact Flank Modification Technology for Spur Gears	76
• μ -Plasma based Additive Manufacturing Technology for Metallic Materials	77
• A method and apparatus for transferring heat from stationary/moving surfaces using impingement jet	78
• In-Situ Temperature Monitoring and Feedback Control in the Wire Arc Additive Manufacturing Process	79
• Wide Area-Monitoring of the Indian Electricity Grid for Enhanced Visibility	80
• Portable Integrated Stand for Constant and Falling Head Permeability Apparatus	81
• Design and development of Triboelectric nanogenerator-Based Machine Skin integrated with smart actuator for Digital Twin development	82
• Implementation of Laser Decal Transfer Towards Laser μ -3D Printing	83
• Strained SMA Bimorph & Spring Based Condition Monitoring System for Fluid Leak Detection in Hydraulic Hoses SMA	84
• Metal Inert Gas (MIG) Based Additive Manufacturing Technique For Fabricating Shape Memory Alloy Ring	85
• Method and System for Providing Smart Communications for Distributed Operations Planning in an Industrial Network	86

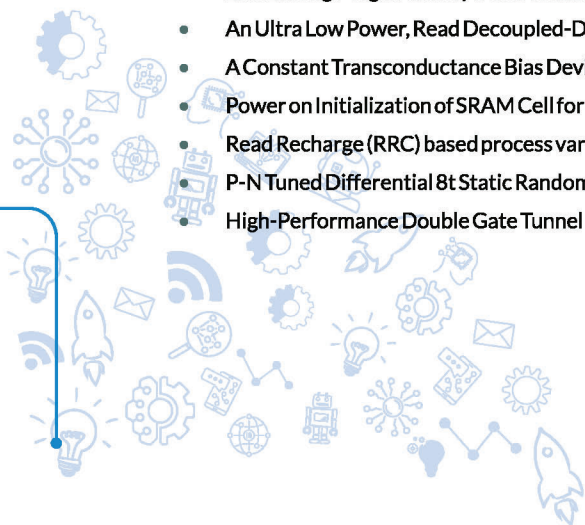
Robotics, Sensors & Actuators

• Shape Memory Alloy Flexible Smart Mirrors for Opto-Mechatronics Applications	88
• Thermo-mechanical Test Bench for Reliability Estimation of Shape Memory Alloy (SMA) Springs	89
• A Dual Axis Continuous Solar Tracking System Using shape Memory Alloy Bimorph Based Solar Panel	90
• SMA Coated Optical Fiber Sensor for Cryo Temperature Sensing	91
• Design and Development of a Gesture-based SMA-actuated robotic hand for human-machine interface	92
• Completely Visible-Blind Ultraviolet Photodetectors	93



• Drone-AI Technology for Wide-Area Crowd-Counting in Surveillance and Security Applications	95
• GridProtect: Protecting the Electrical Grid Networks from Resource Depletion Cyber Attacks	96
• GOBAIR - A novel cow dung based foaming agent for developing low cost sustainable light weight construction materials	97
• Monitoring infrastructure faults with YOLOv5, assisting safety inspectors (Smart City)	98

• Multiple Gate Tunneling Field Effect Transistor Device For Capacitorless Dynamic Memory	100
• Multiple Gate Junctionless MOSFET (Metal Oxide Semiconductor Field Effect Transistor)	101
• Semiconductor Heterojunction Technology for Chip-scale Photonic Devices	102
• Mass production of >99% Ti ₃ AlC ₂ MAX phase for high quality 2D layered MXene	103
• Photoconductive Device for THz Emission and Detection with Metal-semiconductor and Metal-insulator-semiconductor Contact Electrodes	104
• Design and Development of High Temperature Setup For Temperature Dependent Energy Band Gap Measurements for Semiconductors	105
• Low Leakage-high Stability Differential Positive Feedback Controlled 10T (DPFC10T) SRAM Cell	106
• An Ultra Low Power, Read Decoupled-Differential Write, 10T SRAM Cell with Higher Read/Write Noise Margin	107
• A Constant Transconductance Bias Device	108
• Power on Initialization of SRAM Cell for FPGA	109
• Read Recharge (RRC) based process variation tolerant 10T SRAM cell	110
• P-N Tuned Differential 8t Static Random Access Memory (SRAM) Cell	111
• High-Performance Double Gate Tunnel Field Effect Transistor For Low Power Applications	112



VLSI, Hardware Security

• SOFTDEEP: an HLS based IP Protection tool for Secure Optimal Fault Tolerant Designs with Embedded Encrypted Proteinsignature	114
• Faciometric Hardware Security Tool	115
• Crypto-Steganography Tool	116
• KHC-Stego Tool: Key-Triggered Hash-Chaining Driven Steganography Tool	117
• KSO-PW tool -: Key-driven structural obfuscation and physical level watermarking	118
• POM-SO tool -: Pseudo Operation Mixing Based Structural Obfuscation Tool	119
• Secure Hardware of Girt Cascade Using Color Interval Graph Based Embedded Fingerprint for ECG Detector	120
• A Hardware Security Method to Design Secure Hardware Accelerators for Cardiac Pacemaker	121
• Offset Compensated Data Sensing Technique For Low Energy Embedded SRAM	122
• Improved Schedule Delay Estimation Process For Datapath During High Level Synthesis of Application Specific Processors	123
• Design Space Exploration of Optimal KC-Cycle Transient Fault Secured Datapath System with Intelligent Cut Insertion	124
• Design Space Exploration of Optimal K-cycle Transient Fault Tolerant Datapath Based on Multi-Objective Power-Performance Tradeoff	125
• Design Space Exploration of an Optimized Hardware Trojan Detectable/Secured Datapath During High Level Synthesis	126
• Method and System for Automatic Fault Recovery and True Output Extraction During High Level Synthesis	127
• Design Space Exploration System and Method There of Using A Bacterial Foraging Optimization Mechanism	128
• System and Methodology for Development of a System Architecture Using Optimization Parameters	129
• System and Method For Development of System Architecture	130
• System and Methodology For Development of A System Architecture Using Optimization Parameters	131
• System and Method for Development of System Architecture	132
• Embedding Watermark Based on Multi-Variable Signature Encoding at Behaviour Level for Reusable IP Core Protection	133

List of Patents of IIT Indore

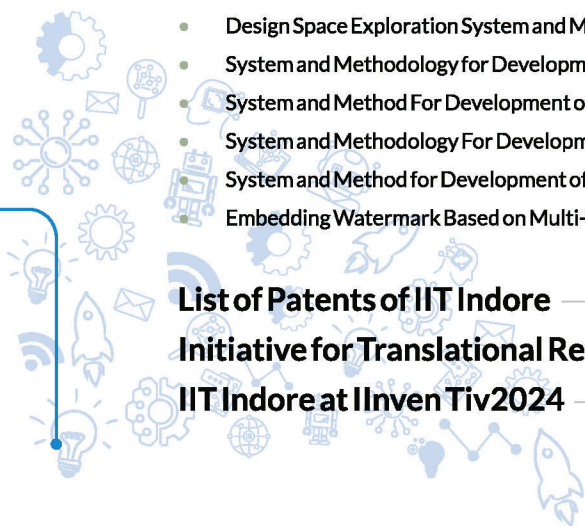
135

Initiative for Translational Research at IIT Indore

146

IIT Indore at Inven Tiv2024

147



AI/ML/Blockchain Technologies (Including Quantum Computing)

Road Surface Quality Assessment and Monitoring

India has the second largest road network in the world, its maintenance is a big task.

We can capture many defects, potholes, road furniture and others. This system brings in the transparency and ensures the delivery of good governance through visualization and reports. Exact ground reality on condition of roads available at click of a button to administrators and policy makers. Accurate estimation of material, better rectification as well as budget planning, and prediction of time and quality of repairs are made easy through this system.

Patent: Under Process

Proposed Relevant Industries: Infrastructure Companies, NHAI, State Road Departments, Smart City, Contractors, and System Integrators

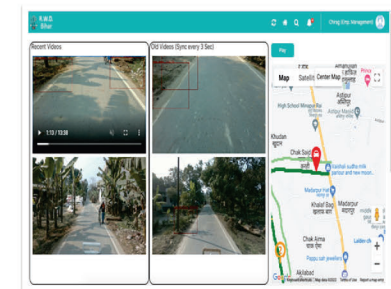
Inventor: Prof. Vimal Bhatia (vbhatia@iiti.ac.in), Department of Electrical Engineering

There are either a very high precision imported product about 50-80 times the cost, or a cheap solution using smartphones which is not robust and give very few details with very low precision, and is not standards compliant. We are currently at TRL 5-6.

Improved roads save lives, increase GDP and other development factors. Better quality roads are utmost important for the common people, the maintenance of roads through this system proved to make this possible and cost effective, which benefits and supports Government's schemes. Improved connectivity ushers in economic growth, saves precious human lives.



Mounting and Testing of PoC

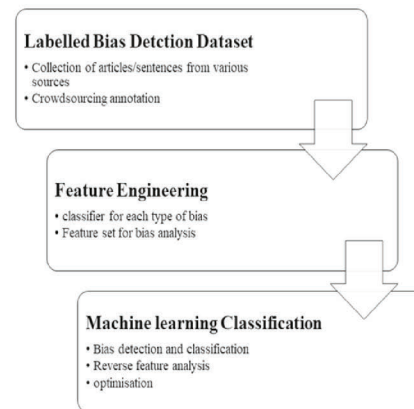


UI showing comparison video of Before and after, with map

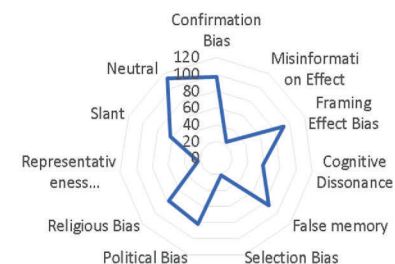
A Semi-Automated Target-oriented Linguistic Bias Detection and Classification Tool For 1947 Partition Texts

Bias analysis is an overarching term applied to methods that estimate the rationale, direction, and magnitude of systematic errors and their sources that influence measures of associations in a text (Lash et al, 2016; Frampton et al, 2022). Understanding biases is of high societal and policy relevance as it allows readers to critically and independently review and reason information. This tool identifies, categorizes, and suggests the manifestation across ten linguistic bias categories in 1947 Partition texts. The dataset used to develop the model consists of 6,850 sentences from select partition texts and Wikipedia articles on partition under the NPOV dispute category. For the detection module, this

study adapts the methods from the metrics of Chen et.al (Chen,2020; Chen,2020; Chen,2018) and Pryzant et.al (Pryzant, 2020). RNN classifiers were employed for the classification tasks, where each cell is a Gated Recurrent Unit (GRU) of a recurrent rate size of 32. The pre-trained word embedding model GloVe with a word embedding dimension of 50, the optimizer Adam, and a learning rate of 0.001 are employed. Based on the estimation of bias strength at the word level and sentence level experiments were designed. The study also captures useful collective information and features from the context.



Architecture and workflow of the model



Bias Analysis Results of Urvasi Butalia's *The Other Side of Silence*

Patent: Nil

Proposed Relevant Industries: Social Media Analytics/ Media/ Scholarly Publishing

Inventors: Justy Joseph, Prof. Nirmala Menon (nmenon@iiti.ac.in), School of Humanities and Social Sciences

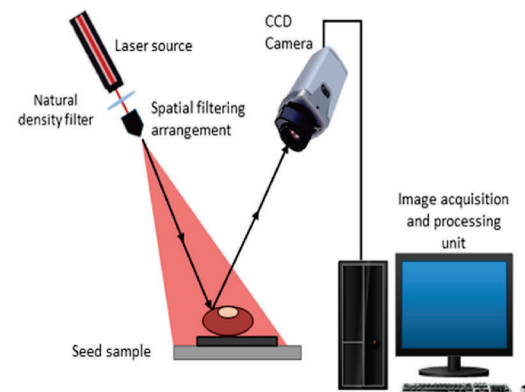
AI Based Soyabean-Seed Viability Sensor for Assessment of Seed-Quality

Agriculture plays an important role in the economic and human factor development of India. This is an interdisciplinary area and work is done in collaboration to develop technology based on laser biospeckle in conjunction based deep learning. This is used for as a solution to overcome to automate and improve estimation of real-time parameters that are of importance in seed quality estimation. We have developed and are currently enhancing the deep learning based processing framework for extraction of both spatial as well as temporal features associated with the speckle images. To this end several deep learning based processing frameworks (including convolution

neural networks (CNN), deep neural network (DNN), recurrent neural network (RNN), and artificial neural network (ANN)) are developed efficient characterization of data.

The current TRL of the Technology is 3-4. there is no currently available product. C-DAC's Aanadarpan comes closer to this however it is only based on 2D visual imaging and does not come closer to the proposed idea.

The idea can be to provide seed testing services to the farmers in rural and urban areas. These services can also be beneficial for the industries working on product and solutions used for enhancing seed productivity. Moreover,



automatic seed-testing procedure will help farmers to choose high-quality seeds even in remote areas. The developed product can be used for training in academic institutes too.

Patent: Granted, Indian Patent No. 389627

Proposed Relevant Industries: Farming, Agriculture and Seed Industry.

Inventor: Prof. Vimal Bhatia (vbhatia@iiti.ac.in), Department of Electrical Engineering

Ground Water Management App and Ground Water Level Measuring Device

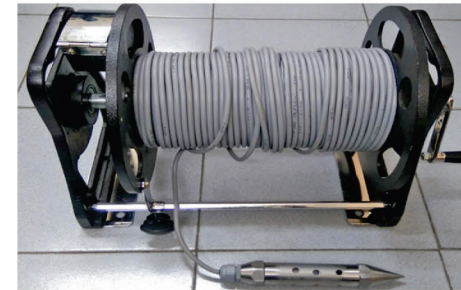
The aim of the given technology is to develop an integrated app and advanced measuring device for effective monitoring and conservation of ground water.

The ground water level measuring device an electric switch-type device, with electrodes having open ends attached to a wire, which is further connected to a battery beeper and LED and the associated ground water management app have geolocator, water level visualization, water level comparison and multilingual facility.

Copyrighted and transferred to an NGO and Four African countries.

The integration of a Groundwater Management App and a sophisticated

Groundwater Level Measuring Device yields profound societal benefits. This comprehensive unit facilitates real-time monitoring, enabling informed decision-making to address water scarcity. Its implementation ensures sustainable water resource management, thereby safeguarding agricultural productivity and enhancing resilience to climate change. Beyond technological advancements, the unit promotes community engagement and awareness, fostering a shared commitment to water conservation. This formalized approach cultivates environmental stewardship, contributing to long-term socio-economic well-being and responsible resource utilization.



Patent: The Ground Water Management App developed by IIT Indore under the supervision of Prof. Aruna Tiwari in collaboration with RuTAG IIT Delhi has been copyrighted jointly with IIT Delhi. **Proposed Relevant Industries:** The app is given to an NGO, Ramkrishna Jaidayal Dalmia Seva Sansthan, Block-Chirawa, Dist-Jhunjhunu, Rajasthan (Bhupendra Paliwal, Project Manager) on Sept. 28, 2022, The complete unit (Groundwater level measuring device and Groundwater Management app) is presented to African Asian Rural Development Organization (AARDO) member countries (Sudan, Namibia, Zambia, and Ghana) in a technology awareness and outreach event, a joint initiative of AARDO & office of PSA to the Government of India. **Inventors:** Anjali Gupta, Deepali Sukhija, Deepika Sukhija, Subir Kumar Saha, Dr. Davinder Pal, Prof. Aruna Tiwari (artiwari@iiti.ac.in), Department of Computer Science and Engineering

Development of Mobile App For Farmers to Help Them in Agricultural Activities: Krishi Sewa

To develop an app which can provide assistance regarding potato crop to the farmers and stake-holders.

The Krishi Sewa has 17 major diseases and insect identification for potato crop, confidence score mechanism, Threshold mechanism. Additionally, it also has data collection facility (Database Creation). In this app we have questions related to symptoms to confirm the disease. And based on the questions, the disease is confirmed. In the later course of the project, we plan the implementation of Machine Learning models to predict the diseases and the pest that affected the plant based on weather and other known parameters with the help of

precision agriculture, image processing and AI/ML technologies.

This App is in its final stage, and it will be used by ICAR-CIAE Bhopal.

The development of the mobile app "Krishi Sewa" for farmers holds immense social impact. By providing importation about diseases and pests, the app empowers farmers to make informed decisions, enhancing crop yields and economic outcomes. Accessible technology bridges the information gap, promoting inclusivity in rural areas. Improved agricultural practices contribute to food security and economic sustainability. "Krishi Sewa" fosters community collaboration,



creating a network for knowledge sharing among farmers. Overall, the app strengthens the social fabric by elevating the livelihoods of farmers, fostering self-reliance, and fostering a sense of community empowerment in the agricultural sector.

This app is developed under Center for Rural development and technology (CRDT), IIT Indore.

Patent: Upon completion of the app, it will be copyrighted and given to ICAR-CIAE for future use.

Proposed Relevant Industries: ICAR-CIAE Bhopal, NGOs, Farmers

Inventors: Prof. Aruna Tiwari (CSE), Krish Agarwal, Divya Agarwal, Yash Vasistha, Shashi Rawat, Prof. Aruna Tiwari (artiwari@iiti.ac.in), Department of Computer Science and Engineering

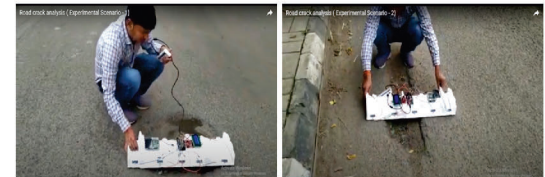
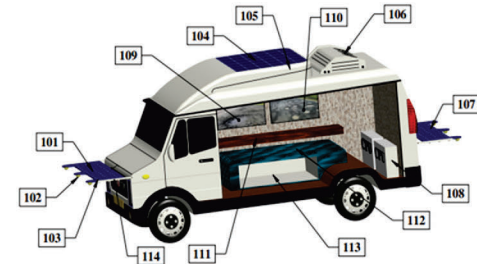
A Smart Road Asset Management System and Method There of

To develop a smart road asset management system. Generally, estimation of the dimensions of the potholes, Bleeding, Block cracks, Edge cracks, Longitudinal cracks, Ravelling, Transverse cracks, and other types of cracks are carried out manually, which requires more workforce, equipment, time, and cost.

1. To calculate the total area with a location for maintenance of the road (Ruler / Urban/Highway).
2. To calculate the total budget as per the current rate of material for the maintenance of the road (Ruler / Urban/Highway).
3. Product can help with road maintenance tenders.
4. To reduce the

main power for identifying cracks in roads. The technology has been developed and delivered.

In the Indian context, implementing a Smart Road Asset Management System can have transformative societal impacts. This technology ensures efficient maintenance of road infrastructure, reducing accidents and travel time. Improved road conditions enhance public safety and contribute to a more sustainable environment. In a country where transportation is vital, the system facilitates smoother traffic flow, reducing congestion and fuel consumption. Economic benefits arise from minimized vehicle wear and tear, lowering repair costs. Moreover, by



incorporating advanced technologies, the system creates job opportunities in the tech sector. Overall, the Smart Road Asset Management System stands to elevate road safety, environmental sustainability, and economic development, aligning with India's aspirations for smart and efficient infrastructure.

Patent: Granted, Indian Patent No. 440090

Proposed Relevant Industries: Transportation

Inventors: Ashish Verma, Neetesh Kumar, Sanjay Patidar, Upendra Singh, Prof. Aruna Tiwari (artiwari@iiti.ac.in),
Department of Computer Science and Engineering

Anomaly-Based Incident Detection on Highways

Surveillance cameras often face challenges in accurately detecting and categorizing unusual events on highways. These systems may struggle to differentiate genuine issues from false alarms, and their effectiveness diminishes when handling many cameras. Additionally, there is a delay in recognizing anomalies, making it more challenging for these systems to promptly ensure highway safety. Our proposed solution is based on the Reconstruction and prediction of normal events using Deep Learning Methods.

By using real-time image processing, we can accurately tell the difference between regular and unusual happenings.

The solution's adaptability and scalability make it uniquely suited to address the limitations of current highway surveillance systems.

Patent: NIL

Proposed Relevant Industries: Transportation

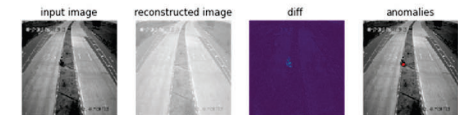
Inventors: Anikeit Sethi, Rituraj, Sanjay Singh, Prof. Aruna Tiwari (artiwari@iiti.ac.in), Department of Computer Science and Engineering

Our technology has reached Technology Readiness Level - 3. Trained and Tested in a laboratory setting using highway toll videos, focusing on scenarios like bikes crossing dividers and cattle on roads, showing promising results. The initial testing revealed better anomaly detection rates, and we're continuously fine-tuning the system to enhance its performance across various real-world situations.

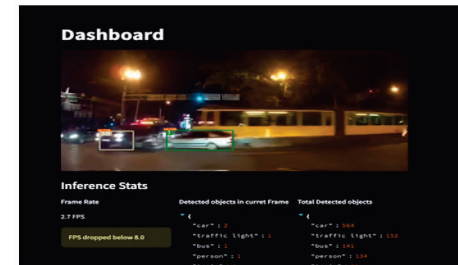
Implementing this technology in highway surveillance will significantly enhance public safety by enabling quicker and more accurate detection of anomalies, reducing response times to emergencies, traffic incidents, and security breaches. This innovation contributes to a safer and more efficient highway infrastructure, positively impacting society at large.



Cart in Pedestrian side is consider abnormal



Real Life Highway dataset where anomaly or violation is bike going over divider to cross road



Real-time anomaly detection dashboard

Crop Doctor : An Extensive Soybean Information App

The aim of this technology is to develop an app a Mobile App for Disease & Insect Identification in Soybean Plants Crop Doctor.

The Crop Doctor app has information related to major diseases and insect identification for Soybean crop, general information regarding soil, information regarding weather addition it is available in two languages, i.e., English and Hindi.

The app development has been completed and currently it is in copyright process.

Soyabean is one of the most consumed oilseed crops in India. It is a rain-fed crop exposed to vagaries of nature and is attacked by several insects and pests in a sequential or complex mode during the entire crop growth period leading to yield

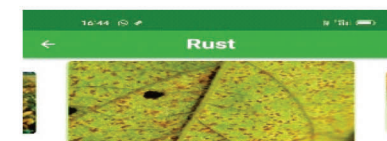
losses. There is a need to enhance soil health by using biological control agents that may control root diseases and nematodes, as well as proper systematic identification and awareness about these diseases and pests through which we aim to provide the tools for the farmer to choose the best combination of locally available pest management tools and thrive in an economically sustainable manner. To deal with this we build an app that allows farmers to upload a picture of the crop, whereafter the app will correctly identify the cause of the problem and provide suggestions on how to treat the ailment.

This app is developed under Rural Technology action group (RuTAG) initiative.

Patent: Currently this App is in Copyright Process.

Proposed Relevant Industries: ICAR-IISR Indore, Agricultural NGO 'Samarth Society', Bhopal

Inventors: Rajesh Dwivedi, Pranjal Gadge, Parul Mogre, Dr. Milind Ratnaparkhe, Prof. Aruna Tiwari (artiwari@iiti.ac.in), Department of Computer Science and Engineering



यह कवक मूल की एक बीमारी है जिसके कारण होता है Phakopsora pachyrhizi बहुत बार, यह मनाया जाता है फुलों की अवस्था के दौरान। इन अवधियों (जुलाई-सितंबर) के दौरान कार्बन के परिणामस्वरूप कम तापमान (22-27 डिग्री सेल्सियस) होता है और उच्च आर्द्रता (80-90%) सप्ती की सतह को लगातार 3-4 घंटे तक नम / गीला रखता है जो जंग की घटनाओं की संभावना को और बढ़ाता है। रात/सुबह कोहरे से जंग के संक्रमण की संभावना भी बढ़ जाती है। रोगजनक मुख्य रूप से संघर्षात्मक क्षेत्रों में जीवित रहता है। प्रारंभ में, क्लोरोटिक गै-ब्राउन स्पॉट पर दिखाई देने हैं। पत्तियों, कम सतह पर प्रचुर मात्रा में, धीरे-धीरे बड़े pustules बनाने के लिए आकार में बढ़ते, आच्छिन्न, पत्तियों कोड़े समय के भीतर भूरे रंग की हो जाती हैं जिससे जल्दी डिफोलिएशन होता है और पत्ती, बीज और बीज के खलन की संख्या में कमी आती है। pustules के टूटने के कारण होने वाले भूरे रंग के पाउडर की उपस्थिति एक विशेषता लक्षण है।

रीकपम और इलाज

Clean Energy & Renewable (Including Hydrogen & EV)

Catalytic Process for Hydrogen Production from Polymeric Polyethylene Terephthalate (PET) Waste

This technology reports One-pot upcycling of PET-based plastic waste for hydrogen production.

The uniqueness of the solution is to generate high-purity hydrogen gas from PET-based plastic waste at low temperature.

This technology has been developed at a laboratory scale and the current TRL level is 4. It was granted a patent by the India Patent Office (IPO). This work has also been published in the Wiley-VCH journal (ChemCatChem, 2023, 15, e202300574).

Upcycling PET-based plastic waste to produce hydrogen gas and valuable chemicals has multiple benefits: it cuts landfill use, decreases plastic pollution, and drives innovation in recycling and renewable energy. It also creates jobs in research and waste management, fostering expertise in sustainable technology. This approach addresses waste problems and might offer cleaner energy options for social communities.

Patent: Granted, Indian Patent No. 422056

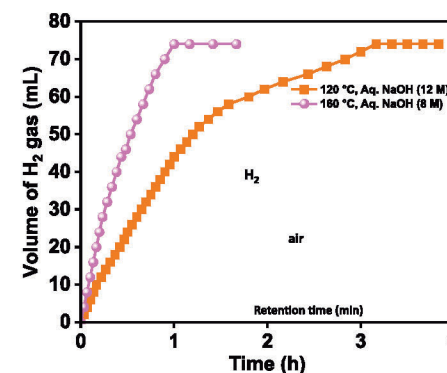
Proposed Relevant Industries: Energy, Fuel etc.

Inventor: Prof. Sanjay Kumar Singh (sksingh@iiti.ac.in), Department of Chemistry



H₂

- One-pot upcycling of PET into H₂ gas
- Complete selectivity for H₂
- High yield of H₂ (~38 L H₂/100 g PET/GRU)
- Works for different types of PET



Catalytic hydrogen production from PET-based plastic waste over ruthenium catalyst (inset: GC-TCD analysis of produced gas).

Catalysts for Low-temperature Hydrogen Production

This technology reports Low-temperature hydrogen production from methanol.

The uniqueness of the solutions is to generate high-purity hydrogen gas from methanol at low temperature.

This technology has been developed at a laboratory scale and the current TRL level is 4. It was granted a patent by the India Patent Office (IPO). This work has also been published in the RSC journal (Catal.Sci. Technol, 2021, 11, 136-142).

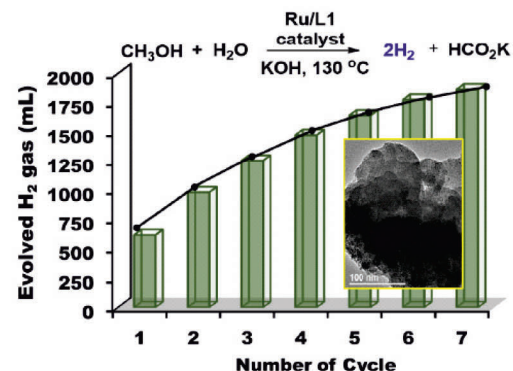
Utilizing methanol for hydrogen production holds great potential for positive social impact, contributing to a cleaner and more sustainable energy

future. This approach enhances energy security, reduces greenhouse gas emissions, and supports the transition to a low-carbon economy. The use of biomass-derived bagasse for methanol production offers an environmentally friendly alternative to traditional fossil fuels. This not only promotes sustainable energy but also addresses agricultural residue management. The shift towards renewable methanol aligns with global efforts to combat climate change, improve resource efficiency, and foster sustainable development, contributing to a resilient and diversified energy portfolio.

Patent: Granted, India Patent No.386686

Proposed Relevant Industries: Energy, Fuel etc.

Inventor: Prof. Sanjay Kumar Singh, Professor (sksingh@iiti.ac.in), Department of Chemistry

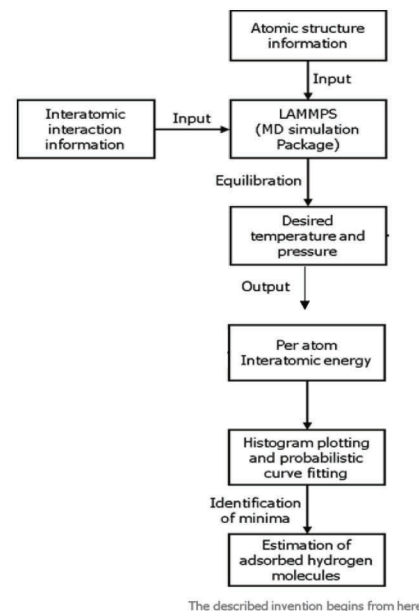


Catalytic conversion of methanol to hydrogen gas and formate in water over the ruthenium catalyst.

A Method for Estimating the Gas Adsorption Capacity of a Solid Adsorbent

The conceptual and computational design of solid nanomaterials for gas adsorption/storage applications requires the use of molecular dynamics simulations. While performing the molecular dynamics simulations of an adsorbent and adsorbate at the nanoscale, the estimation of the amount of adsorbate adsorbed using the previous method is crucial for defining the extent of adsorption. The process for calculating the amount of adsorbent is not well defined for structures with complex geometry, ill-defined pores, and warps during their formation (like 2D materials and organic frameworks). We have invented a method for

estimating the gas adsorption capacity of a solid substrate using molecular dynamics simulations. The gas adsorption capacity of nanoparticles can be estimated using computational techniques like DFT, DFT-molecular dynamics, semi-empirical methods, and classical molecular dynamics. Classical molecular dynamics is a preferred choice for adsorption as it is computationally economical and faster compared to other methods. During the molecular dynamics adsorption simulations at specified temperatures and pressure, the calculation of gravimetric density of adsorbed quantity requires the knowledge of the



number of hydrogen molecules adsorbed. This can be identified using the process described in the below section a(c). To summarize, it is a process for calculating the extent of gas adsorption on an adsorbent during molecular dynamics simulations.

Patent: Filed, Indian Patent Application No. 202221024912

Proposed Relevant Industries: Gas Adsorption/Storage, Materials Studio etc.

Inventor: Nitin Luhadiya, Dr. Shailesh Kundalwal (kundalwal@iiti.ac.in),

Prof. Santosh Kumar Sahu (sksahu@iiti.ac.in), Department of Mechanical Engineering

A Modular Reactor for Manometric Apparatus Operable in a Hydrogen Environment at High Pressures and Capable of Handling Powdered/porous Nanomaterials

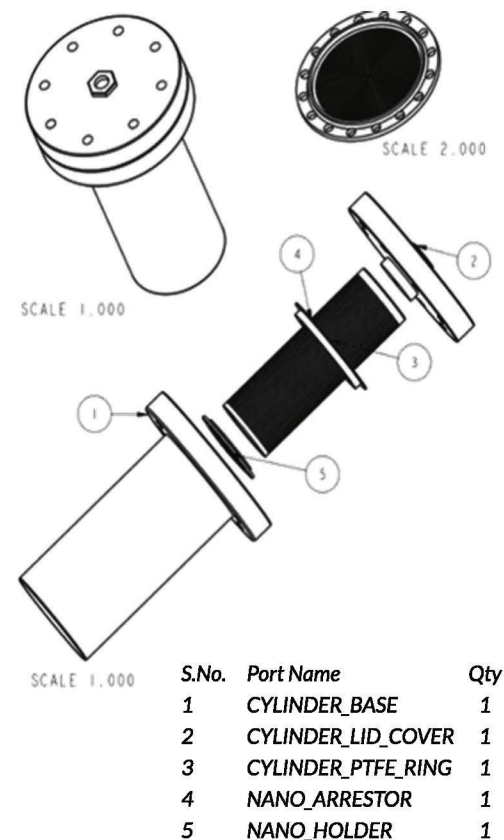
The estimation of hydrogen gas adsorption/desorption capacities of powdered/porous nanomaterials in small quantities via manometric apparatus is a difficult task and requires a highly reliable and safe setup. This is because of the high chances of gas diffusion at high pressures, leading to hydrogen embrittlement of metallic parts of set-up. Furthermore, the modular reactor containing the samples goes through multiple cycles of gassing/degassing operations. Due to this, powdered/porous nanomaterials can adhere to the sensors and valves in the main assembly and may cause them to malfunction. The invented modular reactor designed with a calibrated volumetric capacity allows the measurement of the

adsorption on the nanomaterial surfaces with high accuracy. In addition, the invention is equipped with mesh at the top and bottom, which isolates the sample from the reactor walls and also limits the permeation of the sample into the main assembly. The added circular mesh allows the gas to reach the bulk of the powdered/porous sample from all directions without any resistance, increasing the permeability and promoting fast reversibility of adsorption/desorption. The invented modular reactor will be useful in industries endorsing the hydrogen economy and automobile sectors working on hydrogen fuel cell vehicles.

Patent: Filed, Indian Patent Application No. 202221069960

Proposed Relevant Industries: Green Energy, (The companies involved in hydrogen economy).

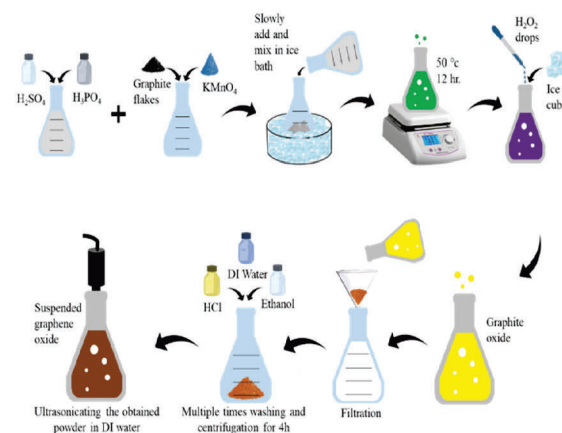
Inventor: Nitin Luhadiya, Saurabh Mishra, Dr. Shailesh Kundalwal (kundalwal@iiti.ac.in), Prof. Santosh Kumar Sahu (sksahu@iiti.ac.in, Department of Mechanical Engineering



Method for Synthesizing Reduced Graphene Oxide Aerogels

A structurally stable, low density, highly sorbent material with desired functionalization's is difficult to synthesize. The invented process defines a technique for synthesizing the low density reduced graphene oxide (r-GO) aerogels functionalized with titanium nanoparticles. The Ti-aerogels are produced with facile synthesis technique using the graphite and titanium(III) chloride (TiCl_3) as a precursor. The graphite is firstly converted into graphite oxide layers that are separated with high frequency mechanical vibrations which results in graphene oxide (GO) solution. The TiCl_3

solution is oxidized using a colloidal technique that produces TiO_2 nanoparticles (NPs). The GO solution and the TiO_2 NPs are added together and further processed to obtain the Ti-rGO aerogels. The existing methods of synthesizing the Ti-rGO aerogels involves a lot of steps and multiple chemical and equipment requirements as opposed to the method described in this invented process. The process is economic and also could be scaled up with very simplistic equipment setup. The Ti-rGO aerogel could be used for adsorption of gases, pollutant removal, photocatalytic applications. TiO_2 in



anatase form is highly porous and when added to r-GO aerogels, they could help in achieving a high hydrogen adsorption capacity.

Patent: Filed, Indian Patent Application No. 202321016125

Proposed Relevant Industries: Automobile Industries, Insulation lining Industries etc.

Inventors: Nitin Luhadiya, Dr. Shailesh Kundalwal (kundalwal@iiti.ac.in), Prof. Santosh Kumar Sahu (sksahu@iiti.ac.in, Department of Mechanical Engineering

Na-ion Battery Based on Earth-Abundant Materials

To achieve 'Net Zero Emissions', a substantial increase in renewable energy production is imperative. While lithium-ion batteries (LIBs) have been widely adopted, their ever-increasing demand, coupled with limited lithium reserves and recycling challenges, is raising sustainability concerns. Sodium-ion batteries (NIBs) are emerging as a promising alternative, especially for stationary storage and mid-range electric vehicles, leveraging abundant sodium reserves and similarities with LIBs in components and manufacturing. Layered oxides are promising for commercial Na-ion batteries due to their high specific capacity, cyclability, and facile synthesis. However, issues like poor C-rate performance and capacity fading

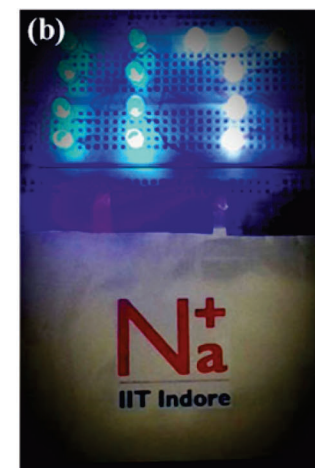
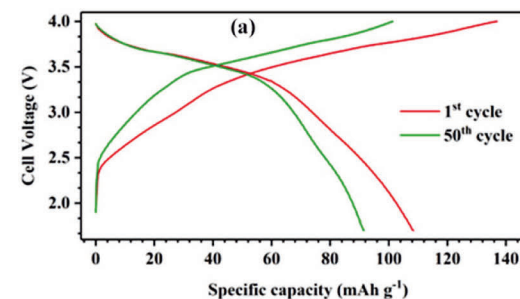
necessitate the development of novel cathodes for faster Na^+ diffusion in sustainable high-performance Na-ion batteries.

We have developed a biphasic P2/O3 $\text{NaMn}_{0.60}\text{Ni}_{0.30}\text{Cu}_{0.10}\text{O}_2$ cathode based on earth-abundant materials in our lab and have fabricated a pouch-type Na-ion cell with hard carbon as the anode (developed cathode capacity = 188 mAh/g, average cell voltage = 3.4 V, cell capacity = 108 mAh/g, specific energy at active materials level = 367 Wh/kg, and TRL = 4). The excellent performance parameters of this cell are attributed to the tailored biphasic nature of the cathode. The suppressed strain at P2/O3 interfaces during the charge-discharge process resulted in structural integrity.

Patent: Under Process

Proposed Relevant Industries: Electric Vehicles, Renewable Energy Sector etc.

Inventor: Dr. Sunil Kumar (sunil@iiti.ac.in), Department of Metallurgical Engineering and Materials Science



(a) Charge-discharge curve of 1st and 50th cycle.

(b) Developed Na-ion pouch cell.

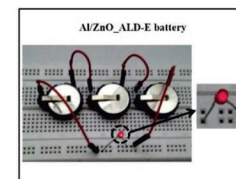
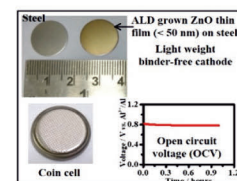
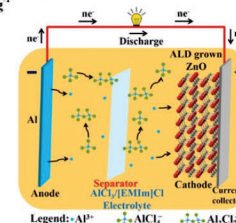
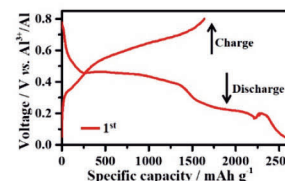
Advanced Electrical Energy Storage (beyond Li-ion battery): Light-weight, binder-free thin-film cathode for high performance rechargeable, low-cost Aluminium-ion battery

Considering ever increasing global power requirement and the limitations of present-day lithium-ion batteries, e.g., the high cost, limited lithium resources in the earth's crust, reliability and safety issues, sodium-ion, magnesium-ion and aluminum-ion batteries, as alternative energy storage systems have attracted significant attention as the post-lithium systems. Subsequently, due to the low cost, higher safety, low-flammability, lower reactivity, environmental friendliness and natural abundance of aluminium (Al), the Al-ion battery, as a new efficient electrical energy storage, has displayed excellent prospects. In this context the present work of Prof. Sudeshna Chattopadhyay's research group is focused on Aluminium ion

batteries, addressing the important aspects including light weight, safety, high performance, low cost of the batteries.

The uniqueness of the solution is its Ultra-thin (< 50 nm), light-weight electrode for safe, low-cost, high performance Al-ion battery.

The findings (part of the work) have been published in international reputed journal: ChemistrySelect, 3, 12512–12523 (2018), title: "Binder-Free ZnO Cathode synthesized via ALD by Direct Growth of Hierarchical ZnO Nanostructure on Current Collector for High-Performance Rechargeable Aluminium-Ion Batteries". We are working for the Patent applications on this overall work, and on other thin-film batteries.



Ultra-thin (< 50 nm), light-weight electrode for safe, low-cost, high performance Al-ion battery.

Patent: Nil

Proposed Relevant Industries: Battery Industries

Inventor: Prof. Sudeshna Chattopadhyay (sudeshna@iiti.ac.in), Department of Physics

Aging-Responsive Phase Transition of VOOH to V10O24·nH₂O vs Zn²⁺ Storage Performance as a Rechargeable Aqueous Zn-Ion Battery Cathode

Vanadium oxyhydroxide has been recently investigated as a starting material to synthesize different phases of vanadium oxides by electrochemical or thermal conversion and has been used as an aqueous zinc-ion battery (AZIB) cathode. So far, there is no study on understanding the phase evolution of such low-valent vanadium oxides and their effect on the electrochemical performance toward hosting the Zn²⁺ ions. The primary goal of the work is to develop a high-performance AZIB cathode, and the highlight of the current work is the insight into the auto-oxidation-induced phase transition of VOOH to V10O24·nH₂O under ambient conditions and Zn²⁺ intercalation behavior thereon as an aqueous zinc-ion battery cathode.

Patent: Nil

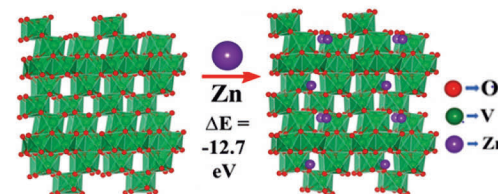
Proposed Relevant Industries: Battery Industries

Inventor: Dr. Srimanta Pakhira (spakhira@iiti.ac.in),

Department of Physics and Centre for Advanced Electronics (CAE)

At a comparable specific power of ~64–66 W/kg, the fresh VOOH and aged VOOH after 60, 120, and 150 days of aging showed the respective energy densities of 208.3, 281.2, 269.2, and 240.6 Wh/kg. Among all the VOOH materials, the 150 day-aged VOOH cathode exhibited the highest energy density at a power density beyond 1000 W/kg. Thanks to the improved kinetics, the 150 day-aged VOOH cathode delivered a considerable energy density of 39.7 Wh/kg with a high specific power of 4466 W/kg. Also, it showed excellent cycling performance with only 0.002% capacity loss per cycle over 20300 cycles at 10 A/g.

The high energy density of 126.2 Wh/kg and power density of 1033.2 W/kg demonstrated by the Zn//VOOH-150 cell suggest a breakthrough in energy storage



*Pristine V10O24 and
Zn-intercalated V10O24*

technology. Such advancements are critical in addressing global energy challenges, offering the potential to enhance the efficiency and reliability of renewable energy sources. The ability of the VOOH-150 cathode to maintain a high energy density of 39.7 Wh/kg with a specific power of 4466 W/kg is crucial for the integration of clean energy solutions. This contributes to the development of more efficient and sustainable energy storage systems, facilitating the transition towards a cleaner and greener energy landscape.

Application of Synthetic Jet with Flaps for Thermal Management and Energy Harvesting

Thermal management of the heat-emitting component is essential for efficient and safe operation. Synthetic jets are one of the methodologies used for removing heat from the components. Conventional synthetic jets are less effective when the distance between the jet exit and the heating surface is low, thus not effectively used in compact devices.

The proposed new methodology uses piezoelectric flaps in the streamwise direction of a synthetic jet generated from an acoustic speaker. The addition of the flaps alters the recirculation patterns of the air impinging on the heated surface, positively changing the heat transfer performance. These flaps start vibrating with the incoming synthetic jet flow, which is excited at a specified frequency. The heat transfer rates are measured with and without piezoelectric flaps over the heated surface. The system with piezoelectric flaps

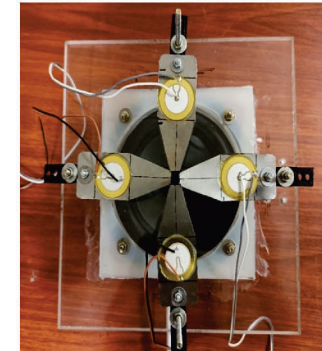
provided up to 55% improvement in the area averaged Nusselt number. The energy generated in the piezoelectric flaps due to vibrations is measured, which additionally conserves the energy input up to 106 mW per strip. Thus, the proposed device enhances the heat transfer rates and thus can be effectively used in thermal management systems required in a large number of applications. Thermal management applications include electronic components, electric vehicle battery packs, solar photovoltaics, etc. The experimental prototype is fabricated, and the obtained results are validated.

Efficient thermal management systems lead to efficient and safe working of the components along with a prolonged life cycle. Thus, the proposed system would help in developing sustainable systems for various applications including EVs and electronics.

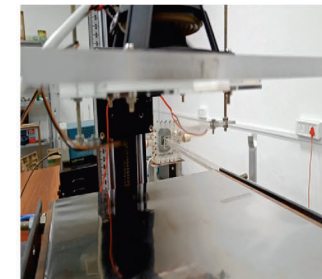
Patent: Under Process

Proposed Relevant Industries: Electric vehicle/motor/battery pack manufacturing companies including

Inventors: Dnyanesh Mirikar, Rajat Kumar, Dinesh, Dr. Harekrishna Yadav (krishnpme@iiti.ac.in); Dr. Satyanarayan Patel (spatel@iiti.ac.in), Department of Mechanical Engineering



The prototype developed for an acoustically actuated synthetic jet with piezoelectric flaps



Working of the piezoelectric flaps when the synthetic jet is actuated using an acoustic speaker

Large Antenna Characterization System

Characterizing large antennas, crucial for applications like radio astronomy and deep-space communication, presents significant challenges stemming from their immense size. The sheer physical dimensions create difficulties in both accessing and manipulating these antennas for accurate measurements. Additionally, achieving precision in measurements for gain, polarization, and radiation pattern demands highly accurate instruments, with potential compromises arising from environmental factors and the need for specialized equipment capable of filling the beam of such large antenna aperture.

In order to tackle this we proposed a drone based antenna characterization system

Patent: Nil

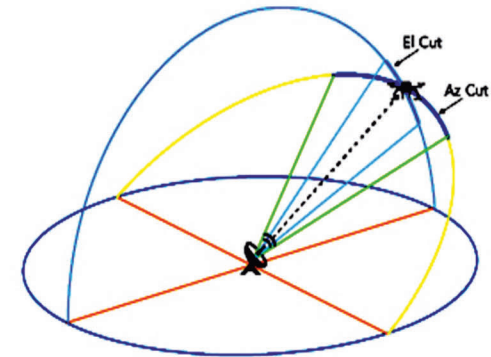
Proposed Relevant Industries: Communication, Space and Defence Industries

Inventors: Harsha Avinash Tanti, Prof. Abhirup Datta (abhirup.datta@iiti.ac.in),
Department of Astronomy, Astrophysics and Space Engineering

which can autonomously revolve around the large antenna with a Radio Frequency (RF) transmitting (Tx) payload with a well characterized omni-directional Tx antenna. The large antenna will act as a receiver (Rx) and will be connected to the ground station. The ground station will take data from the drone RF Tx payload along with its positional information and Rx data thereby, mapping it to characterize the antenna.

The RF Tx payload has been designed and tested, the payload's integration with the drone is currently under testing.

Accurate characterization of large antennas promises societal benefits in communication reliability, scientific research, space exploration, navigation

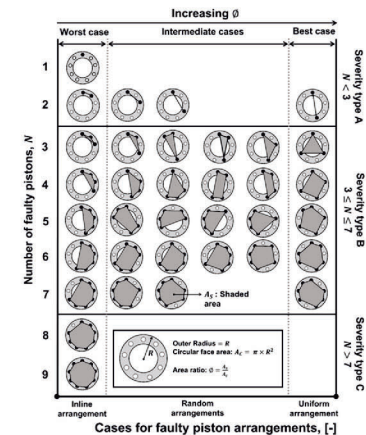
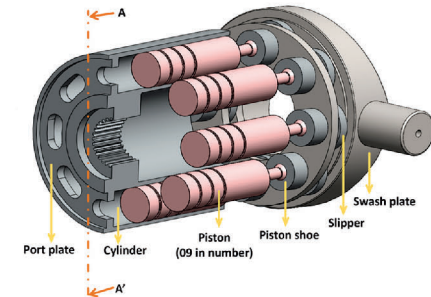


systems, technological innovation, education, and environmental monitoring. The impact spans across global connectivity, emergency communication, groundbreaking discoveries, improved technologies, educational opportunities, and enhanced environmental understanding, highlighting the broad-reaching implications of this advancement.

A Method of Maintenance for High-Performance Machineries Employing Axial Piston Pumps and Multiple Cylinders

The present disclosure relates to a method of maintenance and operation for high-performance machineries, employing axial pumps and multiple cylinders, which are omnipresent in earth moving equipment, mobile hydraulics, and steering systems of aircraft and sea-going vessels. The method comprises identifying the position of healthy pistons and faulty pistons inside the axial piston pump. The alternative configuration is determined for faulty piston positions in such a

manner to generate the least amount of peak-to-peak pressure fluctuations. The faulty pistons are repositioned for uniform pressure distribution for an optimized performance of the axial piston pump under faulty conditions. The proposed method reduces the maintenance downtime significantly and results in substantial cost savings through the reuse of the damaged parts and increases the working life or the utilization of an otherwise faulty pump.



Patent: Granted, Indian Patent No. 412148

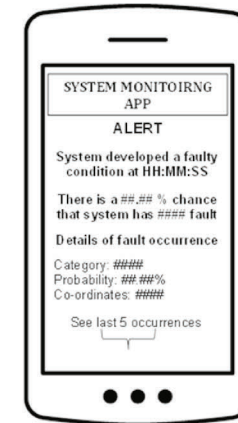
Proposed Relevant Industries: Defense and Aerospace

Inventors: Dr. Ankur Miglani (amiglani@iiti.ac.in), Prof. Pavan Kumar Kankar (pkankar@iiti.ac.in),
Department of Mechanical Engineering

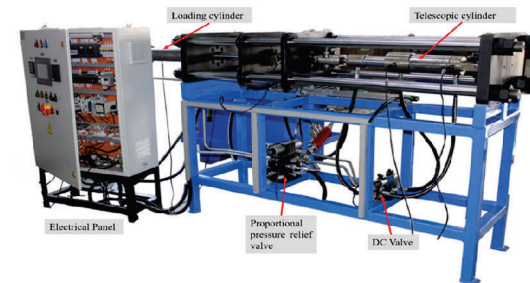
A Method and System for Detection and Determination of Failure of A Fluid-Power System

The present invention is to provide system for monitoring the anomalies in a hydraulic system, the system acquires the sensor signals (preferably but not limited to the flow and/or pressure sensors mounted on the hydraulic cylinder) and a microprocessor programmed to convert these time domain signals into a time-frequency spectrum, which is a 2-D representation of the acquired signals. The represented spectrum is continuously monitored using a vision sensor attached to a

microprocessor that localizes and identifies the operating condition of the system. This invention will provide a system for logging the anomaly identification on a device and a microprocessor programmed to convert it to a defined format (preferably but not limited to .txt or .csv) and transmit it to a central server which triggers the alarm and notification to users when anomaly is detected in the system or components for which the monitoring is being carried out.



User interface for warning and alert about system fault



Experimental test-rig for demonstrating the fault prognosis and diagnosis in a high-pressure hydraulic system

Patent: Filed, Indian Patent Application No. 202321059456

Proposed Relevant Industries: Defense and Aerospace

Inventors: Dr. Ankur Miglani (amiglani@iiti.ac.in), Prof. Pavan Kumar Kankar (pkankar@iiti.ac.in), Department of Mechanical Engineering

High-Performance Lightweight Curved Composites

Lightweight curved structures built using fiber reinforced plastics, functionally graded sandwiched composites, and CNT reinforced composites for weight sensitive engineering applications generally found in aircraft hangers, ship hulls, submarines, aircraft panels, cowling of jet engines, furnaces, missiles, and bulletproof armours.

The following are the novelties:

- The hygrothermal performances.
- Progressive failure and crack propagation predictions.
- Stiffened composites for greater load carrying capacities within a fixed material consumption.
- instability issues for thin panels.

Patent: Nil

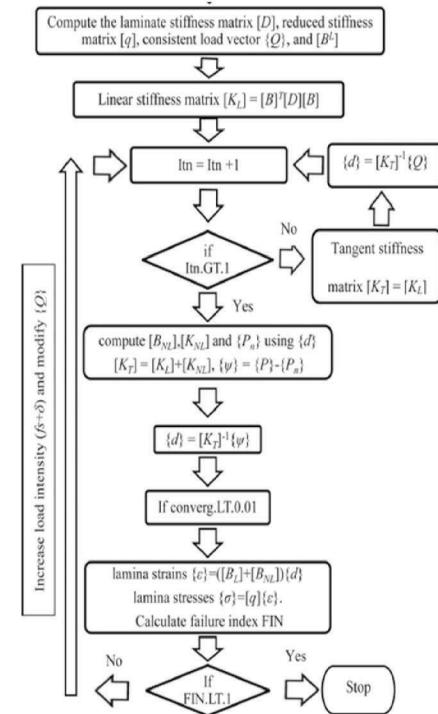
Proposed Relevant Industries: Civil Engineering Construction, Aircraft Manufacturing and Maintenance, Marine Structures Manufacturing and Maintenance, Defense Structure Manufacturing, Space Research Organizations, Sports Car Manufacturing

Inventor: Dr. Kaustav Bakshi (Kaustav.bakshi@iiti.ac.in), Department of Civil Engineering

A computer code is developed using geometric nonlinearity and shear deformation theories to simulate curved composites. The code can simulate the following types of composites:

- Fiber reinforced composites
- Functionally graded composites
- Flat, cylindrical, conoidal, spherical, hyperbolic paraboloidal, and elliptic paraboloidal.

The lightweight structures are easier to handle and operate than the conventional metallic ones. Naturally, the mass induced forces like centrifugal forces, seismic and foundation forces are lesser. Additionally, there is excellent heat and moisture resistance, excellent durability and overall less operational and maintenance cost.



The Flow Chart Describing Solution Technique

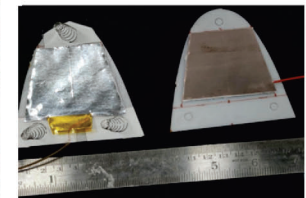
Triboelectric Based Shoe Sole for Energy Harvesting for Powering Microdevices for Army Personnels

To powerup the wearable electronics, batteries are the main source of power to make it functional. As a result, these gadgets need to be recharged frequently, which reduces their overall efficacy of the microdevices. To overcome this problem, a new solution should be needed which has longer life and does not required charging for the longer period of time. A shoe is integrated with triboelectric nanogenerator and electronic components within the shoe sole to powerup the microdevices with the human-motion. Triboelectric nanogenerators (TENGs) are devices

that convert mechanical energy into electrical energy. The triboelectric nanogenerator work on the principle of electrostatic-induction between two surfaces i.e. tribo-positive and tribo-negative surfaces. The triboelectric nanogenerator and electronics components are installed inside the shoe sole so that the when the person walks, the flow of charge start getting stored in the storage device. The stored energy can be used for the for powering the small micro devices in remote location. The current technolgy is closed to TRL-6



Position of TENG inside the sole



Tribomaterials attached with 3D Printed Structure

Working Principle of Triboelectric Nanogenerator



Patent: Under Process in collobrtiaon with ARDE Pune

Proposed Relevant Industries: Defense, Sports Shoe Manufactures, Biomedical Industries

Inventors: Prof. Vipul Singh, Department of Electrical Engineering,
Prof. Palani I A (palaniia@iiti.ac.in), Department of Mechanical Engineering

Multilayer Hybrid Composite Panels Under Impact Loading

Performance assessment of any material/structure against impact and blast loading has become important and challenging task for researchers and scientists as it causes extreme deformation and involves severe complications while analysing different phenomena. There have been considerable efforts towards improving the impact resistance of different materials, but the problem is far from getting solved in a robust manner. In this project, we aim at providing multilayer hybrid composite armor to improve the state-of-the-art in protective design of structures. Unlike traditional ceramic-based composite armor, in this project,

the performance of carbon fibers in multilayer hybrid composite armors are assessed under high strain rates. The concept of using carbon fiber in hybrid composite armors is an attempt to replace ceramics in add-on multilayer composite armor thereby achieving light weight armor. The developed product can be used in different fields as an alternative to various composite materials and traditional ceramic based composite armor and also offers the advantage of reduced weight and cost effectiveness. The study involves experimental as well as numerical analysis of the penetration resistance exhibited by a multilayer hybrid

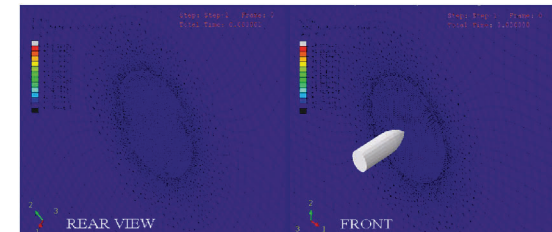


Plate of 2 mm thickness impacted with bullet of CRH 2 getting stuck in the plate

composite armor system. This study would impart a huge contribution to the protection of law enforcement officers, military personnel, and guards. The outcomes from the proposed work will lead to the betterment of the traditional composite armor system with respect to performance, safety, and economy.

Patent: Nil

Proposed Relevant Industries: Defense

Inventors: Gyanesh Patnaik, Dr. Abhishek Rajput (abhishekrjput@iiti.ac.in),
Department of Civil Engineering

Environment & Sustainability (Including Air, Water, Rivers)

Passive Radio Source Localisation System

Determining the direction of arrival of electromagnetic signals at a radio antenna sensor is a crucial task, particularly when confronted with the challenges posed by multiple signals, interference, and noise. In scenarios where multiple signals converge on the antenna sensor, they amalgamate into a superposed combination, creating a complex scenario that complicates the identification of individual signals of interest. The presence of interference and noise further exacerbates the difficulty in isolating and accurately discerning the specific direction from which each electromagnetic signal originates. This becomes especially challenging when there are a limited number of sensors (Antennas) and resources.

Patent: Nil

Proposed Relevant Industries: Communication, Space and Defence Industries

Inventors: Harsha Avinash Tanti, Prof. Abhirup Datta (abhirup.datta@iiti.ac.in),
Department of Astronomy, Astrophysics and Space Engineering

We propose a Snapshot Averaged Matrix pencil method Direction of Arrival (SAM-DoA) algorithm as well as ML-based DoA (ML-DoA) algorithm for passive radio source localization using tri-axial orthogonally co-located antennas. These developed algorithms were tested in simulations as well as in practical scenarios. (DOA: 10.1007/s10686-023-09897-6)

Algorithms are tested and verified, the hardware design and prototyping are under progress

Accurate solutions to the passive Direction of Arrival (DoA) problem bring significant societal benefits by optimizing wireless communication for 5G and IoT applications, improving satellite

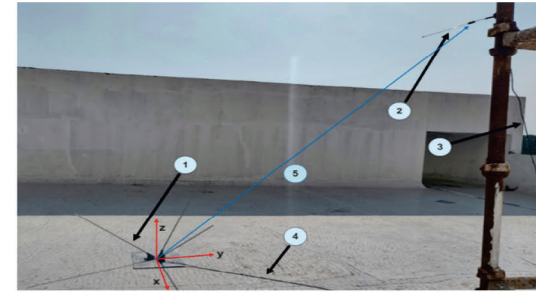


Figure 9: An image describing the experimental arrangement where, (1) is the Fabricated tri-axial antenna, the red arrows denotes the reference axis (x, y, z) and (2) is the synthetic source constitutes of a monopole and a RF generator (Keysight NS173B) set at frequency of 72 MHz and power of 10 dBm. (3) shows the RF line which connects monopole and RF generator. The data from the tri-axial at (1) is carried by RF line shown by (4) and is received using a DSO (Keysight Infinium DSO9254A). (5) indicates line of sight of the source which is located at Az/EI $\sim 41^\circ/51^\circ$ from the reference axis displayed in the image.

(Image of practical verification from our published article DOI: 10.1007/s10686-023-09897-6)

communication reliability, enhancing radar systems for defense, and ensuring reliable communication in emergency services. Additionally, these technologies play a role in reducing electromagnetic pollution in urban environments. The overall impact extends to technological innovation and scientific research, contributing to societal well-being and advancement.

Compressed Colored Bi-layered Bricks

Although the fired bricks are of auspicious red color, their manufacturing adversely affects the environment and many Indian states have already banned its manufacturing. On the other side, eco-friendly gray colored fly ash brick needs to be aesthetically improved. This can be easily done using the synthetic colors, but then, it would not be cost effective. As a solution, the researchers of IIT Indore developed an aesthetically improved low-cost alternative masonry product i.e. "Compressed Colored Bi-layered Bricks" using inherently colored dimensional stone waste. These stone wastes are available in million tons quantity in dumping areas. Initially, stone wastes

from western India such as from Dholpur, Jaisalmer, Kota and Makrana have been used which can easily be replicated using the other local stone wastes. Researchers have blended the colored stone waste with steel industry's slag using chemical binders to develop a novel colored composite of M-10 grade suitable for brick manufacturing. To keep the bi-layered bricks low cost, the colored composite is used in a limited thickness over which plaster, and paint is not required as such and therefore results in approximately 35% savings in cost. These specially designed bi-layered bricks can be manufactured at industrial scale in the cost less than five rupees per brick for low-cost building infrastructure.



Patent: Nil

Proposed Relevant Industries: Brick Manufacturing, Paver Block and Precast Product Manufacturing Industry

Inventors: Vivek Gupta, Prof. Sandeep Chaudhary (schaudhary@iiti.ac.in), Department of Civil Engineering

Controlling of Surface Seismic Wave using META Surfaces

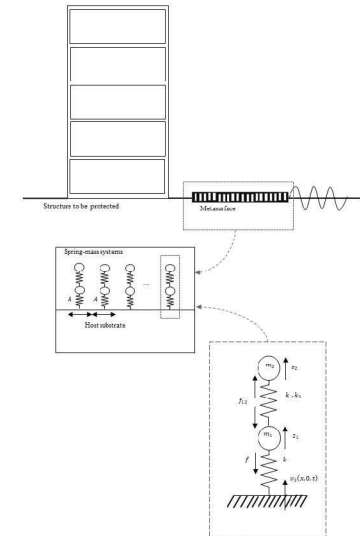
Metasurfaces are the devices employed to manipulate seismic waves and thereby mitigate the destructive impact of earthquakes. A novel design for the metasurface consisting of an array of nonlinear two-degree-of freedom spring-mass systems is mounted on the freesurface of a nonlocal elastic substrate. The research focuses on the combination of the concepts of nonlinearity, double mass system, and nonlocal elasticity to unveil the dispersive properties of Rayleigh waves.

A dual spring-mass system in the metasurface produces two frequency band gaps. A cut-off frequency is then determined that sheds light on the frequency at which the wave transformation takes place. Dispersion curves are plotted to demonstrate how

surface waves transform into shear waves upon crossing these cut-off frequencies. On comparing the nonlinearities in springs, it is found that a metasurface with hardening nonlinearity confines higher-frequency Rayleigh waves, while softening nonlinearity produces broader bandgap compared to a linear metasurface.

To achieve optimal bandgaps, we intend to develop several designs of metasurfaces using springs, beams, plates, and their combinations.

The primary purpose of these artificially engineered structures is to offer solutions to mitigate the disastrous impact of earthquakes. These structures absorb or redirect energy by transforming seismic waves and could be used as an effective energy harvesters in certain earthquake



hotspot areas. The various designs to devise this metasurface could be advantageous in protecting several infrastructures, including bridges, tunnels, buildings, archaeological monuments, etc. The optimization of the effectiveness of metasurfaces, along with minimizing the building cost, may contribute to having a positive impact on the economy of society.

Patent: Nil

Proposed Relevant Industries: Gas & Oil Industry, Nuclear Power Plants, Mining Companies & Civil.

Inventors: Manasa Bhat, Dr. Santanu Manna (santanu@iiti.ac.in), Department of Mathematics

Data-driven Solution to Enhance Climate Resilience and Mitigate The Impacts of Hazards

The main objective of the developed technology is to predict atmospheric rivers (ARs) using Deep Learning Models to mitigate the impacts of ARs. The increasing frequency and intensity of global extreme weather events due to climate change pose unprecedented threats to sectors like agriculture and energy, necessitating urgent measures for climate risk assessment and management in decision-making processes.

The study introduces a pioneering comprehensive framework, seamlessly integrating climate risk assessment, addressing multi-sectoral impacts. Leveraging advanced AI-driven early warning systems, the research focuses on atmospheric rivers (ARs), predicting and mitigating impacts like floods, thereby

transforming disaster preparedness strategies.

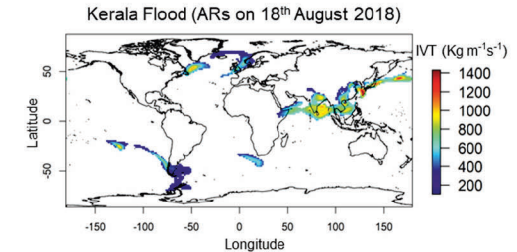
Categorized at Technological Readiness Level (TRL) 4, the work showcases significant progress in AR characterization, impact validation, modeling & prediction, and statistical validation, placing the technology at an advanced stage of development with potential practical applications.

The study's societal impact lies in its potential to revolutionize disaster preparedness, particularly predicting and mitigating extreme precipitation events. Offering a proactive approach to climate risk assessments, the research contributes to the climate resilience of various sectors, ensuring better preparedness against escalating climate threats.

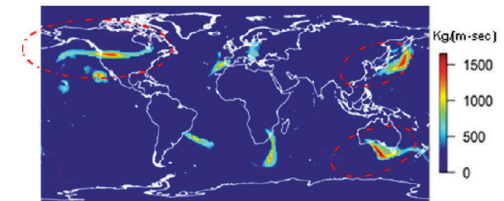
Patent: Under Process

Proposed Relevant Industries: Since ARs lead to extreme floods, a better understanding of AR impacts and prediction could be beneficial for the farming industry, regional and national water resources managing bodies, Disaster management bodies, etc.

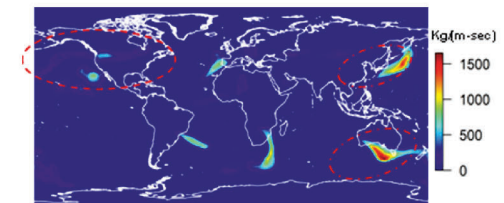
Inventors: Shivam Singh, Prof. Manish Kumar Goyal (mkgoyal@iiti.ac.in), Department of Civil Engineering



(b) ARs observed at a time



(c) ARs Predicted through Convolutional Autoencoder



(a) Kerala flood (b) ARs observed at a time © ARs Predicted through Convolutional Autoencoder

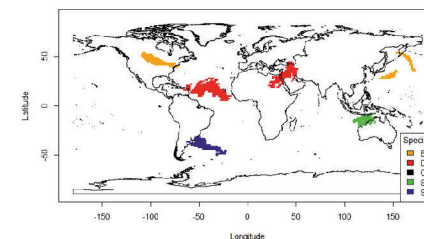
Spatio-temporal Distribution, Detection, and Prediction of Aerosol Atmospheric Rivers (AARs) on a Global Scale

The main objective of the developed technology is the Detection & Prediction of AARs of key aerosol species with their associated seasonal climatology using AI&ML. Rapid urbanization, civilization, and industrialization contribute to severe air pollution, causing 6.7 million premature deaths and economic costs of \$2.9 trillion annually. The global challenge of aerosol pollution, capable of transboundary movement, affects air quality across regions, impacting health, environment, and multiple Sustainable Development Goals (SDGs).

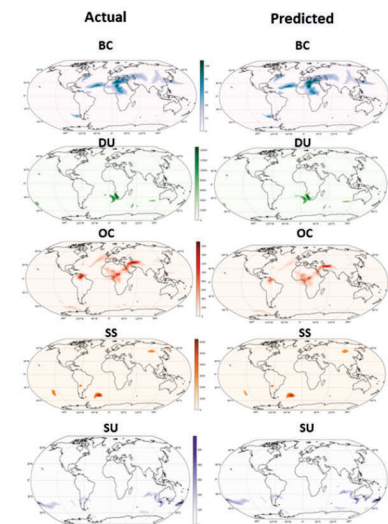
Introducing the concept of AARs, the study employs advanced AI&ML models for detection, characterization, and prediction of AARs globally. The

innovative use of integrated aerosol transport (IAT) based AAR detection algorithm and convolutional auto-encoder-based deep learning models provides a unique approach, enhancing predictive accuracy and enabling real-time predictions.

At Technological Readiness Level (TRL) 4, the research marks a significant advancement in addressing aerosol pollution through AI&ML-based models and AAR detection algorithms. The study analyzes seasonal climatology and underscores the potential of AI&ML models in predicting AARs, contributing to advanced forecasting and resilience enhancement.



Detected AARs of key species



Predicted AARs of key species at an arbitrary time step

Patent: Under Process

Proposed Relevant Industries: Metropolitan City Authorities, Public Health Officials, Forestry Management Authorities, Pollution Control Boards.

Inventors: Kuldeep Singh Rautela, Shivam Singh, Prof. Manish Kumar Goyal (mkgoyal@iiti.ac.in), Department of Civil Engineering

A Novel Process on Quantification of Hydrologic Resilience Potential and its Attributions

The main objective of the developed technology is to assess the influence of anthropogenic stress and climatic variability on catchment hydrology and hydrological resilience of catchments to warming periods using the proposed adjusted elasticity index. The global concern over climate change, particularly global warming, has led to challenges in water resources management. The study addresses the pivotal problem faced by water managers in maintaining sustainable watershed management practices given the dynamic nature of hydrology under climatic disturbances.

The proposed invention introduces a novel approach for evaluating hydrological resilience across river basin scales. It incorporates anthropogenic and natural

stresses, offering a comprehensive tool to quantify hydrological resilience. The model's spatiotemporal independency, simplicity, robustness, and percentile-based approach distinguish it from existing methods. The innovation provides a nuanced understanding of mean annual water balance dynamics under various environments.

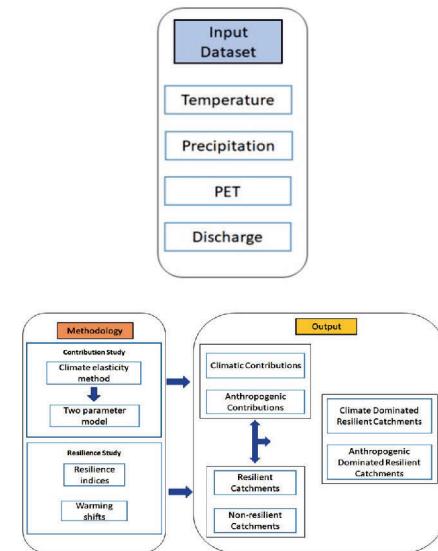
The proposed methodology is at TRL 4 and all relevant results are generated, validated and ready to implement. The technology is positioned for academic applications, serving hydrology research communities, stakeholders, and government officials. Its versatility allows application anywhere and anytime. The percentile-based approach enhances its capability to capture a broader range of climatic variabilities compared to previous studies.

Patent: Filed, Indian Patent Application No. 201921037336

Proposed Relevant Industries: Risk Management, Disaster Management

Inventors: Jhilam Sinha, Dr. Jew Das, Prof. Manish Kumar Goyal (mkgoyal@iiti.ac.in), Department of Civil Engineering

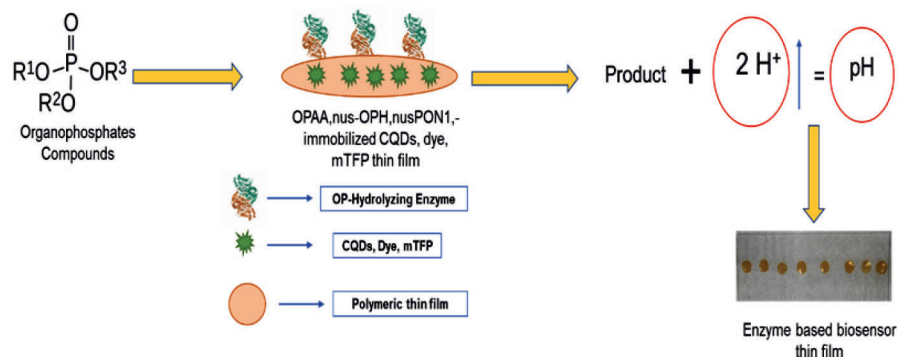
A method for measuring hydrological resilience of a region in response to anthropogenic activities and climatic changes



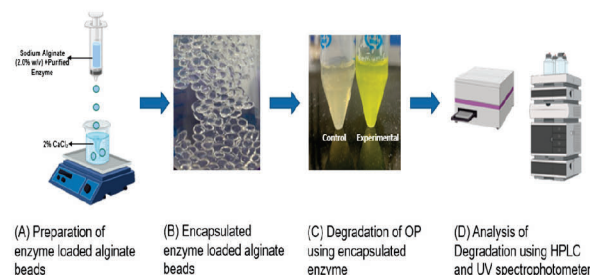
By enabling the quantification of hydrological resilience and attributing the impacts of anthropogenic stress and climatic variability, the invention aids in predicting hydrologic responses under climatic disturbances.

Recombinant Organophosphate Hydrolyzing Enzyme Immobilized Composites for The Detection and Degradation of Organophosphates Compounds

This invention deals with developing and using recombinant OP hydrolyzing enzymes for detection and degradation. OP hydrolyzing enzymes used in this invention are and their immobilized matrices which will aid the process of detection and degradation of Organophosphate compounds. The enzymes are immobilized on the polymer based thin films/nano-micron size carriers having pH responsive properties.



Schematic representation of detection of OP compounds through OP hydrolyzing enzyme immobilized pH sensitive fluorophores based biosensors



Schematic workflow of immobilization of recombinant enzyme and degradation of EP using immobilized beads

Patent: Filed, Indian Patent Application No. 202321038508

Proposed Relevant Industries: Agriculture Sector

Inventors: Tanmay Vyas, Surbhi Jaiswal, Prof. Prashant Kodgire

(pkogire@iiti.ac.in), Dr. Abhijeet Joshi (abhijeet.joshi@iiti.ac.in)

Department of Bioscience & Bioengineering

Flexible Electronics & Nanotechnology

Supercapacitive All-Inorganic Nano Metal-Oxides' Complex: A 180° Super-Bendable Asymmetric Energy Storage Device

Flexible supercapacitors with great specific capacitance retention with maximum possible bending angles and high specific capacitance, make flexible supercapacitor device more suitable for real life applications

Electrode materials with complementary redox activity increase the supercapacitive device performance by increasing the mobility of electrolyte ions to the electrode-electrolyte interface. Other highlights of the solution is as below:-

A prototype 180° super bendable supercapacitor ($\text{Co}_3\text{O}_4/\text{WO}_3$) device, demonstrating a high specific capacitance, power density and energy density.

Fabricated super bendable

supercapacitive device displays flexible supercapacitive performance by sustaining 100% capacitance retention with bending angles.

The detailed electrochemical analysis of device confirms the enhanced charged storage performance is due to the complementary redox active nature of the electrodes.

Due to its importance the work got published in:-

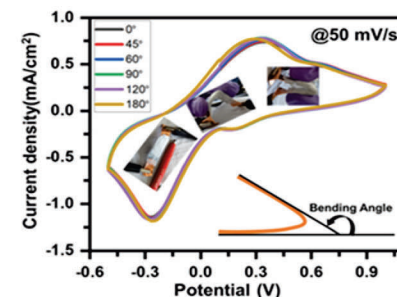
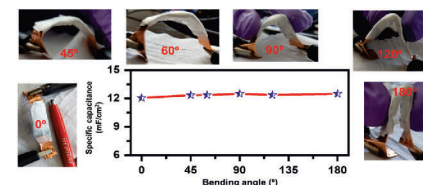
L. Bansal, S. Kandpal, T. Ghosh, C. Rani, B. Sahu, D. Kumar Rath and R. Kumar, J. Mater.Chem.C, 2023, 11, 16000–16009.

Supercapacitors with extreme flexibility and high electrochemical performance will help in flexible and wearable electronics in the energy storage industry.

Patent: Nil

Proposed Relevant Industries: Wearable Electronics, Electric Vehicles, Electronic Textiles. etc.

Inventors: Love Bansal, Dr. Rajesh Kumar (rajeshkumar@iiti.ac.in), Department of Physics



AgNW Based Electrode and its Application in Photodetector

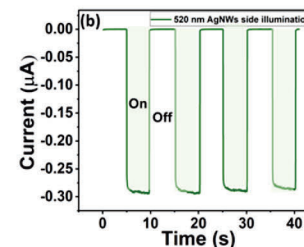
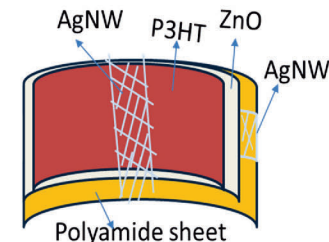
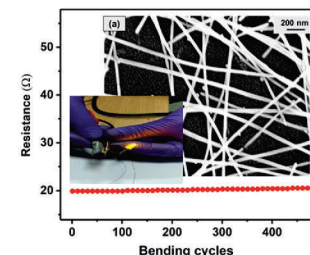
The increasing demand for flexible optoelectronic devices necessitates flexible transparent conducting electrodes (FTEs). While indium tin oxide (ITO) is widely used for its high conductivity and transparency, its high cost and brittleness limit its suitability for flexible substrates. Therefore, alternative materials for FTEs are sought.

This AgNW based Flexible electrode gives highly flexibility, solution processable, transparency and conductivity, SPR effect and has application in wearable electronics.

Flexible self bias hybrid Photodetector is self bias UV-Vis detection, high photosensitivity $\sim 10^5$ in self bias mode.

The current TRL of the Technology is 3.

Flexible photodiodes have a positive impact on society by enhancing healthcare monitoring through wearable technology, promoting inclusivity in accessible devices, contributing to environmental sustainability in electronics.



Patent: Under process

Proposed Relevant Industries: Flexible Electronics, UV-Vis Photodetector

Inventor: Prof. Vipul Singh (vipul@iiti.ac.in), Department of Electrical Engineering

Development of Low Cost, Flexible and High Responsivity UV Dosimeter

Exposure to UV rays can cause premature aging of the skin and signs of sun damage such as Premature aging and other skin damage. UV rays can also cause skin cancer, Immune system suppression, Cataracts and other eye damage.

The uniqueness of the Solution lies in:

Flexible Al substrate:

1. Application in wearable Sensors
2. Piezoelectric effect

Growth of ZnO nanowalls : Highly sensitivity to UV radiation

Patent: Nil

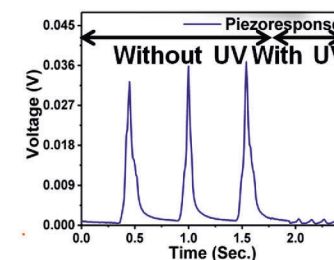
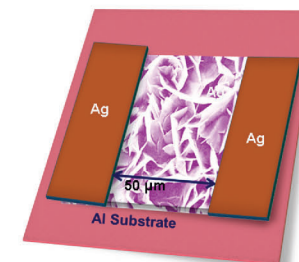
Proposed Relevant Industries: Flexible Electronics, UV Photodetector

Inventor: Prof. Vipul Singh (vipul@iiti.ac.in), Department of Electrical Engineering

High photosensitivity and Responsivity of 349 and 265 mA/W @ 0.1 V applied bias.

The current TRL of the Technology is 3.

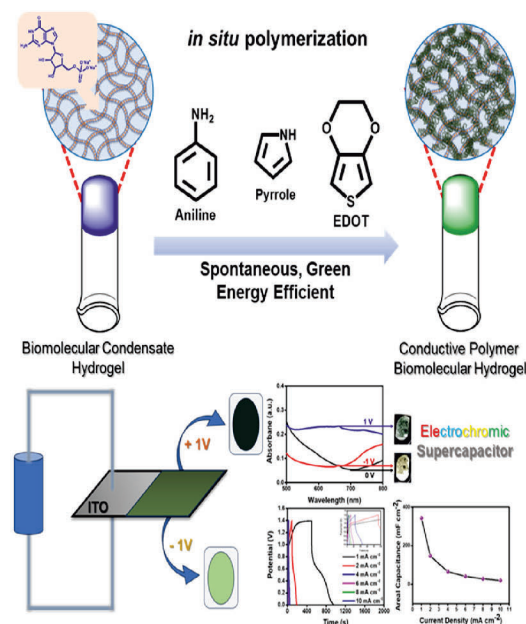
UV dosimeters are used in industries where workers are exposed to UV radiation, such as welding, healthcare (UV sterilization), and laboratory settings. They help ensure that exposure levels comply with safety regulations.



Conductive Polymer Embedded Biomolecular Hydrogels (CPBHS) and Method There of

Conductive Polymer Hydrogels (CPHs) have garnered significant research interest due to their ability to mimic key features of soft tissue mechanics, water-rich 3D scaffolds, and tunable electrical properties. A method employing a nucleotide condensate matrix-assisted in situ polymerization for crafting organic CPHs through the in situ polymerization of small monomers (aniline, pyrrole, and ethylenedioxythiophene) has been developed. Unlike using prefabricated petroleum or inorganic matrices, the biomolecular matrix enhances biocompatibility, making it suitable for diverse biomedical applications. The in situ biomolecular condensate matrix-assisted polymerization process is energy-

efficient, scalable, and allows the synthesis of multiple conductive polymers within a single biomolecular matrix. The process's versatility permits the use of any water-soluble organic acids with various functionalities, enabling the polymerization of three conductive polymers (polyaniline, polypyrrole, and PEDOT) within a single Guanosine monophosphate biomolecular condensate matrix. The polyaniline hydrogels show excellent electrochromic supercapacitor behavior with areal capacitance of 236 mFcm⁻². All the fabricated hydrogels can serve as smart, printable materials for biosensors, health monitoring devices, bio-printable scaffolds, tissue engineering devices, and more.



Patent: Filed, Indian Patent Application No. 202321083824

Proposed Relevant Industries: Numerous Global Companies, Including Indian Startups, are Actively Developing Conductive Hydrogels for Electrophysiological Applications

Inventors: Suryakamal Sarma, Nishita Jain, Dr. Tridib Kumar Sarma (tridib@iiti.ac.in), Department of Chemistry

Flexible Electrochromic Smart Windows

The developed heat shielding electrochromic device filter heat when in transparent (optically) state, unlike available device which filters IR but becomes opaque to the visible spectrum.

b. Compatible for making flexible device on PET/Plastic substrates as well.

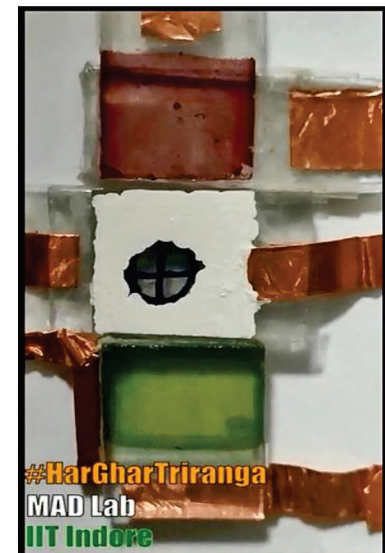
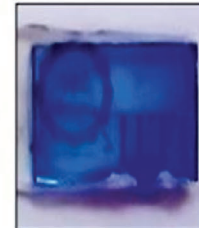
The device saves energy required to maintain the heat in a building/car

The current TRL of the technology is 3.

Such windows will be of immense use for the Smart City projects.



Oxidation
↔
Reduction



Patent: Nil

Proposed Relevant Industries: Automobile and Infrastructure

Inventors: Anjali Chaudhary, Prof. Rajesh Kumar (rajeshkumar@iiti.ac.in), Department of Physics

A Low-Cost, Portable IoT-Enabled NO₂ Gas Sensor System with Enhanced User Safety

Poor selectivity towards target gas in the presence of other inferring gases. Unavailability of real-time monitoring facility of toxic gas concentration. Unavailability of remote-alert facility via call and SMS if the gas concentration exceeded in the hazardous range. Costly and poor sensitivity towards target gas

Large scale synthesis of advance quantum 2D materials which operate at room temperature. Synthesis of advance material which are highly selective and sensitive towards target gas. Development of android/iOS application for real-time monitoring. Integration of resistance readout circuit with GSM module for remote-alert facility. The current TRL of the technology is 7.

Major incidents caused by gas leaks can result in both human injuries and financial losses. In the past, we have also witnessed two major gas tragedies such as Bhopal and Visakhapatnam. These incidents happened solely due to lack of real-time monitoring and alert facility of the gas sensing system. As we looked into the time of the incidents of gas tragedies, we discovered that they mostly occurred late at night or in the wee hours of the morning, when there is unavailability of man-made monitoring facility of the system. To avoid and overcome such catastrophe in the future, we are desperately in need of a system that can alert the user via various means such as visual, sound, SMS and phone call if a toxic gas leakage occurs in the pipeline or system somewhere.



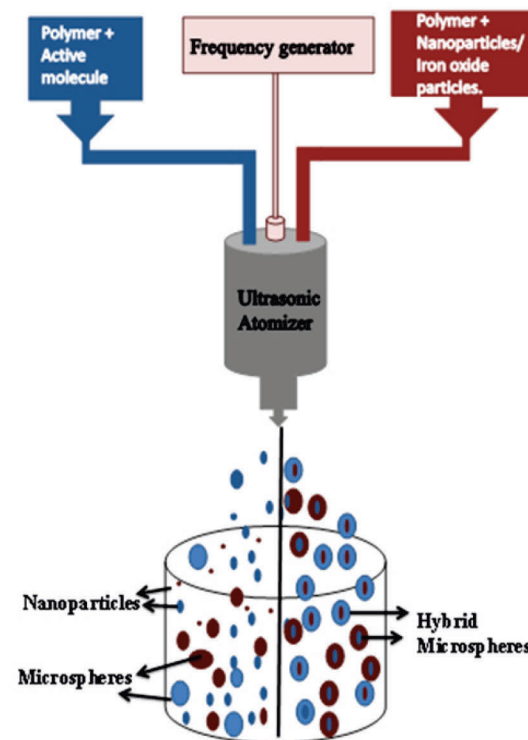
Patent(s): Granted, Indian Patent No. 435803; Filed, Indian Patent Application No. 202321052277

Proposed Relevant Industries: Steel Manufacturing, Toxic Gas Sensor Manufacturing Unit, Environmental Monitoring

Inventors: Chandrabhan Patel, Prof. Shaibal Mukherjee (shaibal@iiti.ac.in), Department of Electrical Engineering

Ultrasonic Atomizer Based Method for Development of Biodegradable Anticancer Nanoparticles, Microspheres and Hybrid Micro-particles

The present invention relates to a method for synthesizing anticancer nanoparticles, and more particularly relates to a method of synthesizing nanoparticles, microspheres and hybrid micro particles loaded with anticancer drug using an ultrasonic atomizer for theranostic applications. The particles produced using this method have great potential in cancer chemotherapy.



Patent: Granted, Indian Patent Application No. 201921015731

Proposed Relevant Industries: Pharmaceuticals

Inventors: Ms. Bhavana Joshi, Mr. Gaurav Pandey, Dr. Abhijeet Joshi (abhijeet.joshi@iiti.ac.in)

Department of Bioscience & Bioengineering

Robust Remote Photoplethysmography Estimation By Denoising Eulerian and Lagrangian Pulse Signals Using Contrastive Learning

The primary challenge addressed by the discussed technology is the accurate, non-contact estimation of heart rate (HR) from facial videos. Traditional contact-based HR measurement methods, such as pulse oximeters, are not suitable for continuous monitoring, can cause discomfort in sensitive individuals (like neonates and burn victims), and carry an increased risk of viral transmission. The existing methods provide substandard results under variable lighting, camera focus and motion artifacts.

The unique solution proposed combines both Lagrangian and Eulerian methods with contrastive learning to enhance the accuracy of non-contact HR estimation. While Lagrangian methods analyse head motions and Eulerian methods focus on facial colour changes due to blood flow,

neither is sufficient in isolation under all circumstances. The novel approach uses contrastive learning to refine the model's ability to discern true pulse signals from noise, thus improving the robustness and reliability of HR estimation from video data.

Currently the technology reaches the TRL level 5. The functionality of the technology has been verified and validated through testing in a controlled laboratory environment.

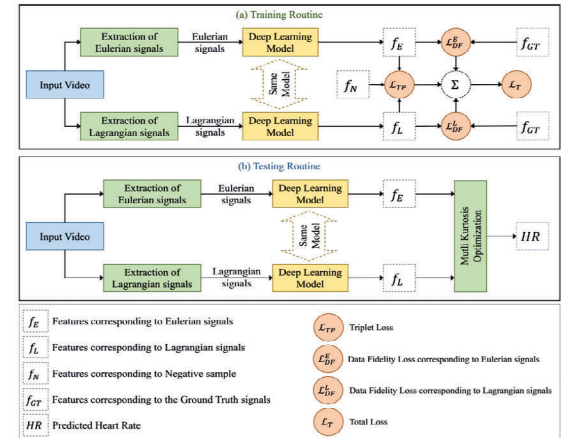
This technology offers a safer, more comfortable alternative to traditional methods, making it ideal for monitoring patients with infectious diseases, vulnerable populations like infants and burn victims, and individuals during sleep or physical activity.

Patent: Filed, Indian Patent Application No. 202221043505

Proposed Relevant Industries: Healthcare, Forensics, Security Monitoring

Inventors: Anup Kumar Gupta, Lokendra Birla, Dr. Puneet Gupta (puneet@iiti.ac.in),

Department of Computer Science and Engineering



By providing a means to monitor vital signs without physical contact, the technology could vastly improve patient care, reduce the risk of disease transmission in medical and public health settings, and enable continuous health monitoring in everyday settings, potentially leading to better health outcomes and more personalized healthcare.

Additionally, this technology can be useful in other applications such as face anti-spoofing, deep-fake detection, mental health where face video analysis plays an important role.

System, Apparatus and Method for Heart Rate Determination of Individuals Wearing Face

The widespread use of face masks, particularly in response to global health challenges such as pandemics, has posed a significant impediment to traditional methods of heart rate monitoring that rely on facial video analysis. Existing methods face limitations in accurately estimating heart rates from individuals wearing masks since most of the skin portion of the face is now covered by mask.

This technology can estimate heart rate remotely by analysing the face video of a person even if the person is wearing face mask.

The solution enables the extraction of relevant pulse information not only from the non-occluded face region but also from the mask region. It consolidates both the

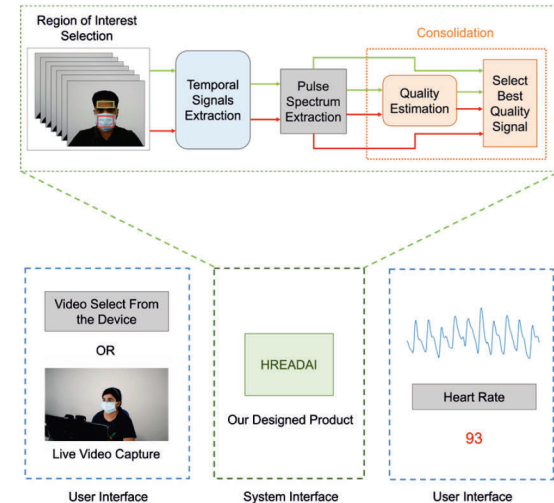
information extracted from mask and non-occluded face region in order to enhance the efficacy of the heart rate estimation.

Currently the technology reaches the TRL level 5. The functionality of the technology has been verified and validated through testing in a controlled laboratory environment.

This technology could be particularly useful in healthcare settings, crowded public places, or during outbreaks where continuous health monitoring is essential even with subjects wearing face masks.

The technology's remote capabilities may enhance healthcare accessibility, especially in remote areas.

The technology's non-invasive approach, relying on facial videos, could provide a



more comfortable and acceptable means of monitoring heart rates for individuals, reducing discomfort and potential health risks.

Additionally, this technology can be useful in other applications such as face anti-spoofing, deep-fake detection, mental health where face video analysis plays an important role.

Patent: Filed, Indian Patent Application No. 202321071568

Proposed Relevant Industries: Healthcare, Forensics, Security Monitoring

Inventors: Trishna Saikia, Anup Kumar Gupta, Dr. Puneet Gupta (puneet@iiti.ac.in),
Department of Computer Science and Engineering

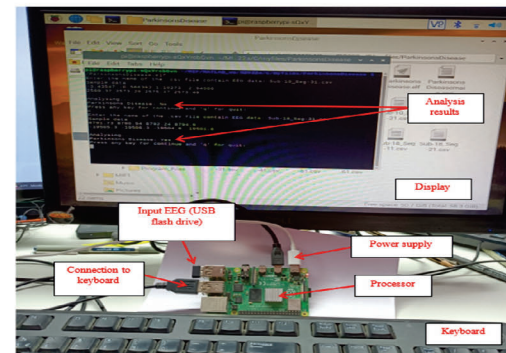
Automated Parkinson's Disease Detection System using EEG Signals

Ten million people are affected by Parkinson's disease worldwide, and more than one million cases per year are reported in India. Only four percent (estimated) of people are diagnosed with Parkinson's disease before age 50. At present, there are no definitive imaging or biological markers for detecting Parkinson's disease. Early detection of Parkinson's disease is crucial to start appropriate treatment and care in the early stages.

A system or method for predicting Parkinson's disease comprises input receiving multichannel EEG data is proposed. Data are decomposed into several narrowband signals based on the data-adaptive decomposition technique, namely multivariate iterative filtering

(MIF). These narrowband modes are then represented in higher dimensions using phase-space representation (PSR). A set of features from these bands are obtained and pre-trained classifier is used to classify the EEG segment based on the extracted features. A graphical user interface (GUI) application is developed, which can be installed on any desktop. The algorithm has been developed on a Raspberry Pi board connected with a display, and input device (keyboard and mouse), input flash drive for standalone system for Parkinson's disease detection. In Figure, the system has been shown where different sub-systems are marked.

The developed system has been tested using a real-time EEG data. The technology readiness level (TRL) is 8 out of 9. This can



be a lucrative solution to several problems like shortage of doctors, poor healthcare infrastructure, etc. Also, it provides a cost-effective and reliable solution. The developed system can be used as a part of tele-medicine system, where remotely send EEG data can be analysed and report can be sent back. This kind of system will be helpful for rural area where healthcare resources are limited. Also, the efforts, cost, and time for travelling to urban area for diagnosis can be minimized.

Patent: Filed, Indian Patent Application No. 202221027358

Proposed Relevant Industries: Smart Healthcare Industries

Inventors: Kritiprasanna Das, Prof. Ram Bilas Pachori (pachori@iiti.ac.in), Department of Electrical Engineering

Novel 3D-printing Biomatrix Ink: A Double Cross-linked Self-healable Hydrogel for Cell Culture Applications

BioMatrix Ink is composed of non-animal derived synthetically cross-linked components and can be used in the fields of 2D and 3D cell culture applications. The novel proprietary **BioMatrix Ink** forms a nanofibrous network, mimicking the extracellular matrix, which can support cell growth, signaling, and proliferation. Additionally, it has been developed to offer optimal rheological properties for bioprinting by extrusion-based printing methods ensuring both cell viability and printability.

BioMatrix Ink can be tailored to specific applications, and it has potential as 3D models, in 3D bioprinting, 3D cell cultures, and to entrap and sustain release of different bioactive drugs/cargos.

Patent: Filed, UK Patent Application No. 2210605.8

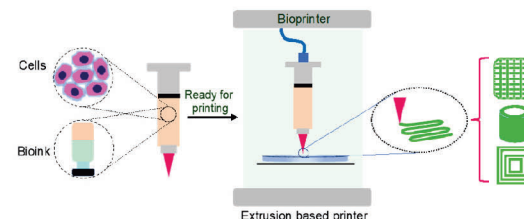
Proposed Relevant Industries: Healthcare Sector, Additive Manufacturing

Inventors: Prof. Deepak M. Kalaskar, Prof. Apurba K. Das (apurba.das@iiti.ac.in), Department of Chemistry

BioMatrix Ink exhibits a self-healing property due to the presence of higher order cross-linking; it can be supplied as a powder, to be rehydrated with the most suitable aqueous based solution including commercial cell culture media.

Advantages

- **Reproducibility:** BioMatrix Ink is non-animal derived and produced synthetically. This ensures batch-to-batch reproducibility, which in turn guarantees consistent prints.
- **Easy handling:** the addition of buffer/water/cell culture media triggers quick gelation. No requirement for extreme temperatures, pH adjustment, UV curing, or addition of reactive crosslinking reagents, which can be detrimental to cells' health.



- **Tunability:** BioMatrix Ink has been optimized for extrusion-based printing methods only; however, it is also possible to prepare lower/higher viscosity formulations upon varying the concentration of hydrogelator for alternative printing techniques.
- **Printability:** BioMatrix Ink is printable at room temperature to provide a self-supporting structure. The ink is shear-thinning and thixotropic, which can reduce the shear stress experienced by cells during the printing process.
- **Biocompatibility:** proven biocompatibility with various cell types (including human dermal fibroblast, mesenchymal stem cells, osteoblasts).

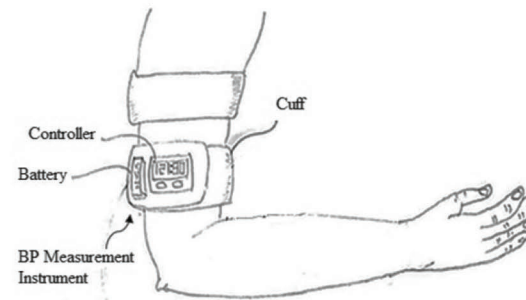
A Standalone, Portable Apparatus for Automatically Measuring Blood Pressure with Remote Monitoring

Self-measurement of blood pressure at home has been shown to be useful in predicting target organ damage, cardiovascular events and mortality. Korotkoff (auscultatory) method and the oscillometric method are two commonly used cuff-based approaches for non-invasive BP measurement. While the mercury sphygmomanometer is considered the gold standard for auscultatory measurement, it poses environmental concerns and requires trained personnel, limiting its practicality. The limitations of the auscultatory method include observer bias and difficulties in judgment, while the oscillometric method lacks precision due to arbitrary ratio application.

There is a need for an accurate, user-friendly, standalone, and portable reliable BP measurement instrument, operable by non-medical individuals. The potential advantages of having patients take their own blood pressure accurately are twofold: the distortion produced by the white coat effect is eliminated, and multiple readings can be taken over prolonged periods.

The main objective of this invention is to develop a portable device to automatically measure an individual's blood pressure using the Korotkoff (auscultatory) method of blood pressure assessment.

Unique Features of the Solution are : Patient-Centric Approach, Enables Self-



Automatic Blood Pressure Measurement

Measurement of Blood Pressure at Any Time, Compact, Lightweight, and Portable Design.

The prototype has been meticulously developed and subjected to rigorous testing across diverse conditions, with a direct comparison to measurements conducted under standard conditions. Ongoing experiments are focused on optimizing its user interface for simplicity and ensuring comfort in operation, targeting widespread usability within the general

Patent: Filed, Indian Patent Application No. 202021032245

Proposed Relevant Industries: Healthcare Industry, General Population

Inventors: Arjun Singhal, Mayank Maroliya, Adarsh Singh, Prof. Devendra Deshmukh (dldeshmukh@iiti.ac.in), Department of Mechanical Engineering, Dr. Shilpa Raut (shilparaut@iiti.ac.in), Health Centre, IIT

A Vaccine and Biological Material Carrier Box

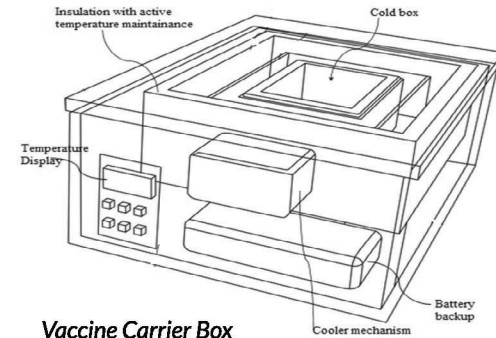
Immunization stands as a crucial element in disease prevention, significantly reducing the mortality and morbidity associated with vaccine-preventable diseases. Effective immunization requires a reliable vaccine transportation system. Traditional insulated containers, reliant on passive methods and vulnerable to temperature fluctuations, often disrupt vaccination schedules, leading to incomplete coverage in target populations.

This innovation presents a self-contained, compact, and portable vaccine carrier system. The box incorporates an anti-freeze mechanism, eliminating the reliance on ice packs and ensuring temperature stability during transportation. The uniqueness of this solution lies in its ability to maintain the required temperature

conditions without interruptions, even in diverse environmental conditions. By addressing the limitations of existing vaccine transportation methods, this portable carrier box represents a significant advancement in the field. Its potential to enhance the efficiency of immunization programs by providing a reliable and temperature-controlled environment for vaccines and biological specimens makes it a promising solution for the global health community.

Rigorous testing of a prototype vaccine carrier box, incorporating experiments conducted under diverse conditions. Future plans involve field experiments and certification as per World Health Organization (WHO) guidelines.

The developed technology is poised to



Vaccine Carrier Box

address the critical need for precise temperature control in the storage of immunological products, vaccines, and other biological materials. The impact of this innovation extends to healthcare workers engaged in vaccination services, particularly in subcenters and during door-to-door campaigns in villages. The active vaccine carrier box, capable of maintaining temperatures between 2 to 8 degrees Celsius for over 40 hours in varying ambient conditions, represents a significant advancement over existing solutions.

Patent: Granted, Indian Patent No. 416164

Proposed Relevant Industries: Health Care Industry, Bioscience and Biomedical Research Industry

Inventors: Dr. Abhay Gaidhane, Sawangi Meghe, Dr. Shilpa Raut (shilparaut@iiti.ac.in), Health Centre, IIT Indore, Prof. Devendra Deshmukh (dldeshmukh@iiti.ac.in), Department of Mechanical Engineering

Epstein-barr Virus Glycoprotein M Peptide Plausibly Instigates Alzheimer Disease-like Symptoms

Epstein-Barr virus glycoprotein M peptide plausibly instigates Alzheimer disease-like symptoms

Neurodegenerative diseases are characterized by the progressive loss of structure or function of neurons and are increasingly recognised as major causes of death and disability worldwide. Brain ailments i.e., Alzheimer's disease (AD) cause the worsening of many bodily functions, including balance, movement, talking, and breathing. According to global burden of diseases report from 1990 to 2019 showed elevation in AD and other dementia prevalence from 7,236.38 to 51,624.19. Several pathogens i.e., Epstein-Barr virus (EBV) trigger profound contribution in the aforementioned diseases. Numerous

studies have reported that EBV proteins like EBNA1, EBNA3A, LMP1, LMP2A, BZLF1, gp350 and BNLF-2a are associated with AD and Multiple sclerosis (MS). The present invention comprise a 12 amino acid long peptide derived from glycoprotein-M (gM) of the EBV that is involved in initiating the amyloid beta-42 ($A\beta_{42}$) cascade resulting in AD. Upon evaluation, we observed that gM peptide exhibits aggregation property comparable to $A\beta_{42}$ and also accelerate the aggregation of $A\beta_{42}$ in co-incubation experimental conditions. Likewise, changes on neuronal cells as well as in mice suggested effective role of gM in elevation of AD-associated markers. Therefore, this viral peptide can be used for generation of virus-mediated model system for AD and eventually to test the therapeutics.

Patent: Published, Indian Patent Application No. 202121032715

Proposed Relevant Industries: Pharmaceuticals

Inventor: Dr. Hem Chandra Jha (hemcjha@iiti.ac.in), Department of Biosciences and Biomedical Engineering

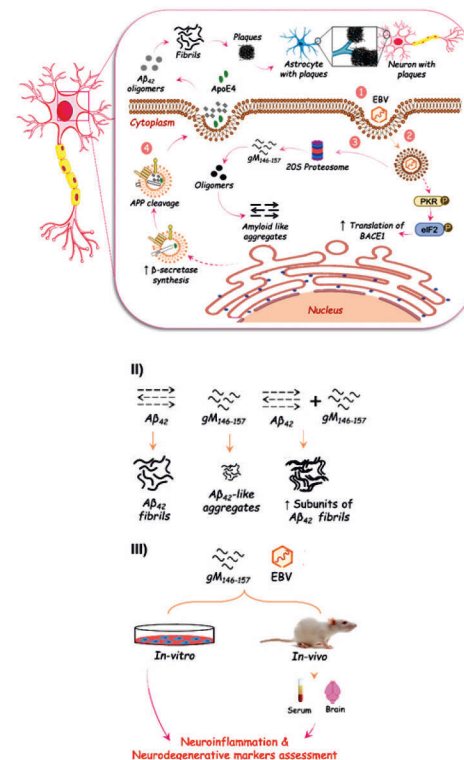
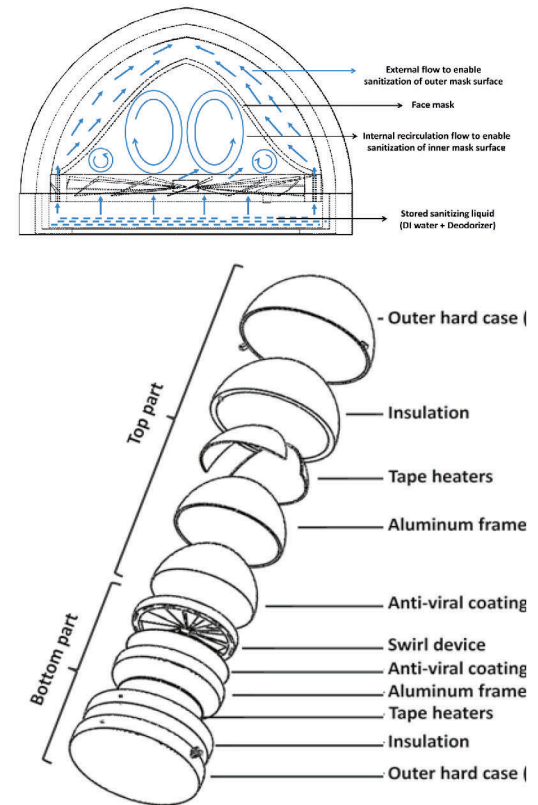


Illustration of possible details of technology for EBV-mediated Alzheimer's disease.

A Sanitization Device for a Protective Article

The presented device relates to a sanitization device, for storing and sanitizing any protective article such as a filtering face piece respirator or face mask. The sanitization device stores and sanitizes the mask in-situ using heat and moisture. In particular, it can store the face mask therein and is also capable of heating the mask to a temperature of 60-65°C while achieving a relative humidity of at least 80 – 85 % for sanitization. The device is structured in

the form of a portable storage unit that prevents masks from external environment and reduces the propensity of transmission of the contagion. The device is compact and easy to handle, and therefore, it is highly portable for being carried around by the user and performs in-situ sanitizing of the masks. It provides an environmental friendly solution by reducing the carbon footprint through reusability of masks.



Patent: Granted, Indian Patent No. 440833

Design Registration: Indian Patent Provisional Application No. 202221041778

Proposed Relevant Industries: Healthcare Industry

Inventors: Dr. Ankur Miglani (amiglani@iiti.ac.in), Prof. Pavan Kumar Kankar (pkankar@iiti.ac.in),

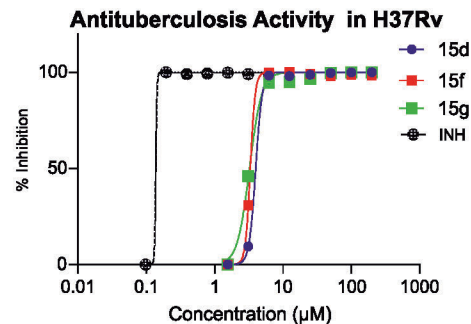
Department of Mechanical Engineering

Small Molecule Drugs for Treatment of Tuberculosis

Tuberculosis (TB) caused by *Mycobacterium tuberculosis* (Mtb) is one of the leading causes of death worldwide. According to the WHO report, an estimated 480,000 new MDR-TB and an additional 100,000 rifampicin-resistant TB (RR-TB) cases were reported. Among them, 50% cases are estimated to occur in China and India. The current anti-TB regime involves six to nine months long administration of a cocktail of antibiotics. However, in case of MDR and XDR-TB the treatment duration varies from several months to years with second line toxic drugs and rates of failure and mortality is very high. Moreover, incomplete clearance of tubercle bacilli often results in relapse of the disease leading to recurrence of the persistent drug tolerant bacteria. Therefore, there is an urgency to develop new drugs with potent therapeutic applications against

MDR-TB. Additionally, no drug has been developed for the treatment of tuberculosis from India and ours is one of the indigenous methods to address this challenge of tuberculosis and multi drug resistance in the world.

As a part of the drug discovery program for tuberculosis, we have synthesized >150 novel antibacterial pyridine ring fused heterocycle compounds such as pyrrollopyridines, indolopyridines, pyridofurans, pyridobenzofurans and benzofuran isatin hybrids using a newly discovered reaction in our laboratory, which are currently patented, and copyright protected in the USA and India. The newly developed heterocyclic compounds were expected to bind with acyl carrier protein domain of pks13 inhibiting the formation of mycolic acid. We have tested these 150



compounds against virulent and non-virulent mycobacterial strains and identified five furo[3,2-c]pyridine and furo[3,2-c]pyridine isatin hybrids exhibiting potent antimycobacterial activity at low micromolar concentrations without causing cytotoxicity on macrophage cells. These compounds are also active against clinical isolates of mycobacterium MTB H37Rv in 3-5 μM range of concentrations in comparison with standard antituberculosis drug isoniazid (INH, 0.31 μM). The most potent compounds are currently in preclinical in vivo studies to improve MDR and XDR-TB therapy.

Patent: USA Patent, US 11,427,596 B2, 2022; Indian Patent, IN 366986, 2021

Proposed Relevant Industries: Healthcare

Inventor: Dr. Chelvam Venkatesh (cvenkat@iiti.ac.in), Department of Chemistry

Early Diagnosis and Treatment of Prostate Cancer

Prostate cancer (PCa) is the 3rd largest cancer with an incidence of 14,14,259 (8%) leading to a mortality of 3,75,304 (4%) in 2020. Among Indian men, PCa rank 3rd with 34,540 cases and a mortality of 16,783 men. There is no cure for castration resistant prostate cancer and the mean survival time is 16-18 months. FDA approved diagnostic agents such as ProstaScint, Choline C11 and Axumin are expensive (US 3,700 to 9,500 per scan), unaffordable, cause immunoreactions and require long scanning sessions. The most popular 18FDG PET scan is non-targeted and produces false positives. Despite these limitations, 177Lu-PSMA-617 (Pluvicto™) became the very first FDA-approved radiopharmaceutical for treatment of PCa in March 2022. Therefore, there is a critical, unmet need

for development of cost-effective tools for PCa. The technology developed is targeted, selective and patented worldwide for PCa and it will be highly profitable with large number of consumers.

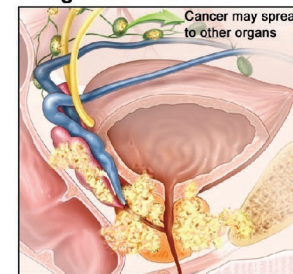
The developed technology or product aims to deliver early diagnostic and therapeutic tools for detection and treatment of prostate cancer (PCa). The radiopharmaceutical is composed of a prostate cancer targeting small molecule ligand, AAPT, attached to a peptide linker and chelating moiety to chelate radioactive isotopes such as ^{99m}Tc , ^{68}Ga or ^{177}Lu for diagnosis and therapy, respectively, by binding onto Prostate Specific Membrane Antigen (PSMA) receptors overexpressed on PCa.

Patents: Filed, Indian patent Application No. 201821044594; USA Patent Application no. 16695851.

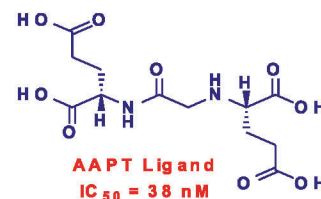
Proposed Relevant Industries: Healthcare

Inventor: Dr. Chelvam Venkatesh (cvenkat@iiti.ac.in), Department of Chemistry

Stage IV



Prostate Cancer



PCa Inhibitor



New Small Molecule Peptides for Treatment of Cancer

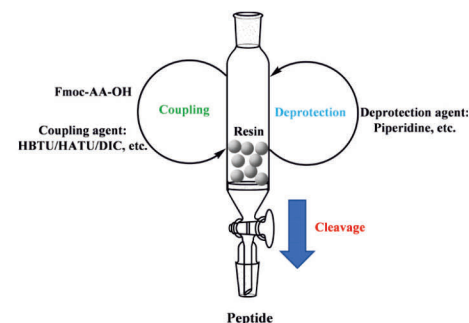
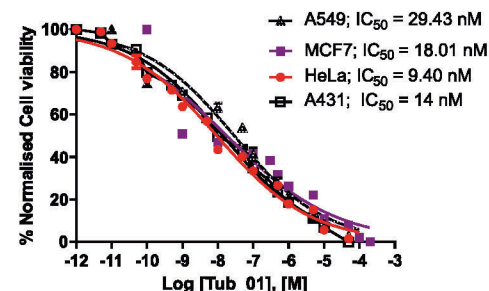
Prevalence of cancer worldwide and challenges in cancer treatment urge researchers to develop new and potent anticancer drugs. Anticancer drug potency and factors such as availability, ease of synthesis, serum stability, selectivity, pharmacodynamic and pharmacokinetic properties plays a crucial role in determining the clinical success of a drug.

Tubulin inhibitors such as tubulysin M is one of the most potent anticancer agents (IC_{50} of 0.02 nM) known to kill the cancer cells by inducing apoptosis. But the natural abundance of these inhibitors is very low, and the structural complexity escalates the challenges for its laboratory synthesis. We have developed a technology to design and synthesize a library of novel tubulin inhibitors which possess similar amino acid

interactions as compared to natural inhibitors.

Recent human clinical trial studies questioned the physiological stability of tubulin inhibitors due to its reduced efficiency in antitumor activity. This was overcome by employing 4-amino thiazole-2-carboxylic acid and unnatural β -amino acids as components of the inhibitors to avoid hydrolysis by proteases. As proof of concept, several tubulin derivatives were chemically synthesized in our laboratory, examined on human cancers of breast, skin, lung, and cervix and found to be active in 9-29 nM concentrations. The new inhibitors are protected with intellectual proprietary rights in USA and India. The inhibition potency of the inhibitors would further be evaluated in vivo for treatment of variety of cancers.

Cytotoxicity of Tubulin Inhibitor, 48 h



Patents: Granted, Indian patent Application No. 202021036140; Granted, USA patent, US 11,518,786 B2

Proposed Relevant Industries: Healthcare

Inventor: Dr. Chelvam Venkatesh (cvenkat@iiti.ac.in), Department of Chemistry

A Composition for Sepsis and Method Thereof

Sepsis, a common and potentially life-threatening systemic condition, is caused by microbial infection and often results in impaired function of the lungs, kidneys, or other vital organs. Since the early 1980s, numerous therapeutic agents for treating sepsis have been assessed in randomized controlled clinical trials. However, with few exceptions, the results from these trials have been disappointing, and there is currently no specific approved therapeutic agent for treating sepsis. To improve this unsatisfactory outcome, researchers will need to identify more appropriate therapeutic targets, enhance their methods for selecting candidate compounds for clinical development, and implement improved designs for clinical trials.

Patent: Filed, Indian Patent Application No. 202321038927

Proposed Relevant Industries: Pharmaceuticals

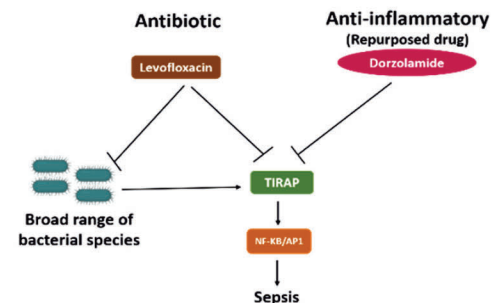
Inventors: Rajat Atre, Rahul Sharma, Prof. Mirza S Baig (msb.iit@iiti.ac.in),
Department of Bioscience & Bioengineering

We proposed a novel combination of a broad-spectrum antibiotic, levofloxacin, and a repurposed anti-inflammatory drug, dorzolamide, to address the two distinct features of sepsis progression: killing bacteria and promoting the healing of injured organs by preserving homeostasis. We have proposed that the antibiotic used by us has anti-inflammatory effects, leading to a synergistic combination.

Preclinical studies have been completed. We are now proposing a Phase 1 clinical trial for the invention. The same invention has been submitted for patenting with reference number E-137/6170/2023/MUM and application number 202321038927.

The discovery of new drugs for sepsis could have a significant societal impact. Sepsis is a

Illustrates composition and working process of the composition of the present invention.



life-threatening condition that arises when the body's response to an infection causes widespread inflammation, leading to organ dysfunction. Developing effective drugs to treat sepsis could potentially save many lives and reduce the burden on healthcare systems. New drugs for sepsis could lead to improved patient outcomes, reduced hospital stays, and lower healthcare costs. Additionally, these drugs could help address the global challenge of antimicrobial resistance, as sepsis often involves antibiotic treatment.

Homoaromatic Peptides Mitigate FMR Poly-g-protein-mediated Toxicity and Alternative Splicing Defects in Fragile X-associated Tremor/ataxia Syndrome (FXTAS)

RNA plays an indispensable role in regulating biological functions. Still, expansion of certain sets of nucleotides is associated with repeat expansion neurodegenerative disorders such as Fragile X-associated tremor/ataxia syndrome (FXTAS)/ Fragile X-associated primary ovarian insufficiency (FXPOI). Expansion of CGG in the fragile X mental retardation 1 (FMR1) gene results in GG mismatch folds, forming noncanonical secondary structures (hairpin) which interrupt functional proteins, form toxic RNA foci, cause pre-mRNA splicing defects and mediate non-AUG translation (RAN) producing toxic protein aggregates (FMR Poly-G). The number of patients with this disorder is increasing day by day and the major population in India is still not aware. <https://twitter.com/fragilexindia>

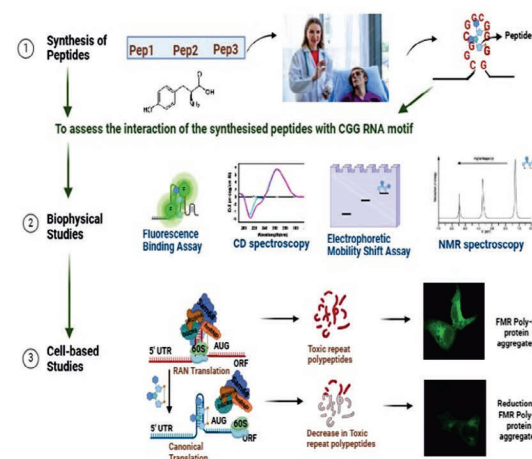
Patent: Under Process

Proposed Relevant Industries: Pharmaceuticals

Inventors: Mr. Krishna Singh, Dr. Tapas Ghosh, Prof. Amit Kumar (amitk@iiti.ac.in), Department of Biosciences and Biomedical Engineering, Prof. Apurba K. Das (apurba.das@iiti.ac.in), Department of Chemistry

/status/1418158495619186695 Homo-Aromatic Tyrosine-based peptides Pep1, Pep2, and Pep3 are the first peptide-based molecules designed as targeted therapeutic interventions by mitigating the formation of toxic FMR Poly-G aggregates. The technology owes its uniqueness to the tyrosine-based composition. Novel technical features involve high specificity, biological activity, low toxicity and immunogenicity, tuneable pharmacokinetics, structural versatility, customizability, and biocompatibility.

So far, the specific peptide drugs have been efficiently characterized through Biophysical approaches and successfully tested on FXTAS-cellular models with positive outcomes. Further, these can be exploited for the development of drugs and delivery systems.

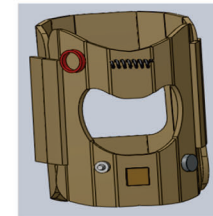
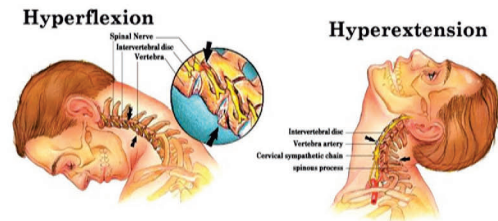


Flow diagram defining the working and functionality of the intervention. This technological approach first involved the synthesis of the Homo-aromatic Tyrosine Peptides followed by assessing their interaction with the (CGG)_{exp} (FXTAS causing) RNA motif through biophysical and cell-based studies. Biophysical characterization of the interaction was done using Fluorescence binding assay, Electrophoretic Mobility Shift Assay, Circular Dichroism (CD), and NMR spectroscopy. Cell-based approaches involved quantifying canonical GFP and non-canonical FMR Poly-G protein inclusions, cytotoxicity, and cell viability assessments.

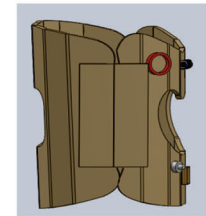
SMA Based Smart Cervical Collar

Cervical collars market is witnessing major shifts in trends in the healthcare sector. Earlier, the use of rigid cervical collars was widespread which were ideal in cases of accidents, wherein the spine is damaged and requires a center aligned positioned. However, most cases of neck injuries today do not meet the criteria for the widespread adoption of rigid collars. Hence, many hospitals and healthcare associations today are shifting towards the use of soft collars instead of conventional and rigid C cervical collars. The growing demand for these accounts for the rising cases of

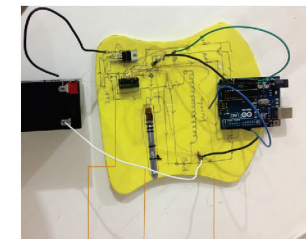
common injuries like neck pain or cervical spondylitis due to sedentary lifestyle, increase in elderly population and neck injuries in sports or defence. It uses piezo sensors are used for capturing the strain between neck and collar. It automatically adjusts pressure around the neck. It offers simple fabrication with shape memory alloys and microcontroller. The actuation is generated by using feedback mechanism. It reduces the effort of monitoring the correct wearing practice.



FRONT VIEW



SIDE VIEW

L293D IC
FLEX SENSOR
FOAM SHEET

Patent: Filed, Indian Patent Application No. 201721008038

Proposed Relevant Industries: Healthcare Industry Defence Sector Sports and Fitness Industry

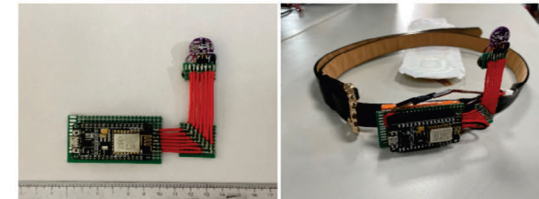
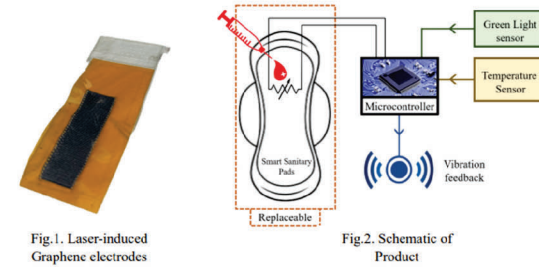
Inventors: Dr. Shilpa Raut, Senior Medical Officer, Prof. Palani I. A. (palaniia@iiti.ac.in),

Department of Mechanical Engineering

IoT-enabled Smart Absorbent Material and Sanitary Device

Presently, 61.4% of Indian menstruating women experience a sense of embarrassment about periods prevalent in society (The Hindu, 2023). In addressing this critical issue, Laser-induced graphene (LIG) as well as thin metal electrodes infused in sanitary pads present a promising solution for leakage detection due to their highly absorptive and electrically conductive nature. These electrodes can be strategically integrated into replaceable sanitary pads, enabling biofluid detection through resistivity changes without directly contacting the skin. The system is connected to a novel IoT device on the waist via thin flexible copper wires and facilitates the vibrational feedback around the waist area. Various clusters of sensor interfaces enhance

better health monitoring, detection, and feedback. The device is programmed to provide multiple stages of vibrational feedback upon instant menstruation blood contact, alerting users about the initiation of the period and/or potential leakage, and after complete saturation of the pads (notified to be replaced). Thus, health monitoring using vibration feedback sensors to warn the user of sanitary pad change. Replaceable sanitary pads infused with electrodes could be commercialized at a low manufacturing cost with a rechargeable device deployed on the waist, allowing consumers to know the status of sanitary pad saturation based on vibration feedback, as well as collect temperature and blood flow data for menstrual health monitoring via Wi-Fi and



Prototype developed

a mobile application. This concept can be further applied to (Adult) diapers, giving a much broader scope of service, which can be of use to almost all geriatric/severely injured patients and physically impaired. Currently the technology is at a TRL level 6.

Patent: Filed, Indian Patent Application No. 202321067853

Proposed Relevant Industries: Healthcare Sector

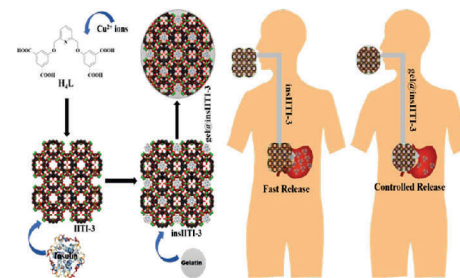
Inventors: Kailaash Pandiyan, Aditi T, Pragya Singh, Kanishka Goyal, Ayushi Agrawal, D J Mistry, Prof. Palani I A (palaniia@iiti.ac.in), Department of Mechanical Engineering

Role of Gelatin Coating With Copper-based Metal-organic Framework For Controlled Insulin Delivery

Diabetes has become a silent killer throughout the world and according to the international diabetes federation around 552 million people will be affected by diabetes. Diabetes mainly occurs in two types i.e., type 1 (T1DM) and type 2 (T2DM). Discovery of insulin in the last century is perhaps one of the most critical discoveries especially for healthcare system as all patients of T1DM and many patients of T2DM requires insulin therapy. According to Center for Disease Control and Prevention (CDC), USA the current insulin delivery system mostly takes place through insulin syringe, pen, pump and inhaler. However, the major limitations like cost, invasive and inconvenience during insulin shot etc. certainly affects the delivery and hampers the patient health. In view of this oral delivery is very beneficial but current oral delivery route of insulin faces major roadblock because of low bioavailability. In

the present invention a novel copper MOF (IITI-3) were prepared.

Herein, IITI-3 crystallizes in a tetragonal crystal system with space group $I4/mmm$ and shows a high Brunauer–Emmett–Teller (BET) surface area of $1026.5 \text{ m}^2/\text{g}$ with pore diameter (Barrett–Joyner–Halenda pore size distribution) of 3.413 nm . Since IITI-3 showed excellent pore diameter, structural stability and cytocompatibility thus were later used for insulin encapsulation in its pore and further coating with gelatin (gel@insIITI-3) for the controlled release of insulin. The release profile of insulin (with and without gelatin coating) was compared at blood and small intestine pH. The obtained result proved that gelatin offers extra barrier with the framework creating more controlled release as compared with without gelatin coating.



Synthesis of IITI-3 using new linker, Insulin encapsulation within IITI-3, coated with gelatin and their drug delivery release phenomenon (Adapted with permission ACS Materials Lett. 2023, 5, 4, 1100–1108. Copyright 2023, American Chemical Society).

Commercial aspects of the invention/technology developed: Gelatin coating which is providing extra barrier to the IITI-3 creating more controlled release of insulin and also helps in minimizing the direct contact with cells and IITI-3 thus also improving the biocompatibility of IITI-3.

So far the published work and the potential of coating majorly through synthetic or natural polymeric materials in creating microparticulate delivery systems with MOF motivated us to explore gelatin as a coating material to deliver insulin.

Patent: Under process

Proposed Relevant Industries: Pharmaceutical, Biotechnology and Healthcare

Inventor: Shaikh M. Mobin (xray@iiti.ac.in), Department of Chemistry

Room Temperature Phosphorescence

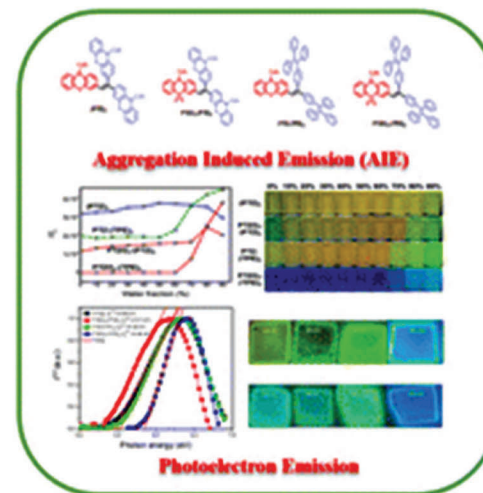
Room temperature phosphorescence (RTP) has attracted great attention for the scientific community for their wide applications in optoelectronic devices. However, these materials are still very scarce, partially due to the unclear mechanism and lack of designing guidelines.

Phenothiazineboronic ester derivatives were developed and investigated for

RTP. The materials are easy to prepare and cost effective.

The technology is currently in the large scale manufacturing.

The RTP materials are used in light-emitting diodes, anti-counterfeiting, sensors, and bioimaging. Therefore these materials are directly going to benefit for energy and health sectors.



Source: doi.org/10.1039/D3TC03921H

Patent: Nil

Proposed Relevant Industries: LED and Health Sectors

Inventor: Prof. Rajneesh Misra (rajneeshmisra@iiti.ac.in), Department of Chemistry

An Alternative To Cold Storages- Development of A Portable Kit for Visible Light Photo Dynamic Inactivation of Microbes on Food Surfaces From Ultraviolet Towards Visible Light: A Sustainable Future

Cold storage poses a significant environmental threat due to greenhouse gas emissions and carbon emissions. Solutions are needed to reduce greenhouse gas emissions and make the global food cold chain more sustainable. However, current decision criteria focus on energy efficiency savings and refrigeration emissions impact. Due to increasing cold storage charges for small and marginal farmers, new food storage methods should be explored. An alternative pathway using

Photodynamic Inactivation (PDI) of microbes is proposed for storing vegetables and grains in cold storage.

It is perceived that owing to the financial burden of the ever-increasing cold storage charges to small and marginal farmers, newer ways of food storage should come up. Thus, in this direction, we propose an alternative pathway to the existing usage of cold storage for storing vegetables and grains employing Photodynamic Inactivation (PDI) of microbes.

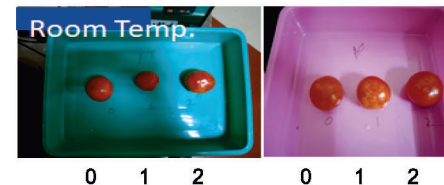
*Photodynamic Inactivation
Towards Microbes*



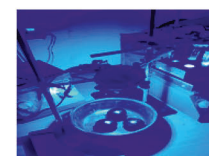
Patent: Filed, Indian Patent Application No. 202421010243

Proposed Relevant Industries: Agriculture Sector, Healthcare Sector, Food Industries etc.

Inventors: Niladri Sekhar Roy, Dr. Debayan Sarkar (sarkard@iiti.ac.in), Department Of Chemistry



2nd Phase with 1st Phase Expt.



Photosensitizer (PS) used – Riboflavin

0 – Blank

1 – Sprayed with 200 μ l PS + 5 ml H₂O

2 – Sprayed with 400 μ l PS + 5 ml H₂O

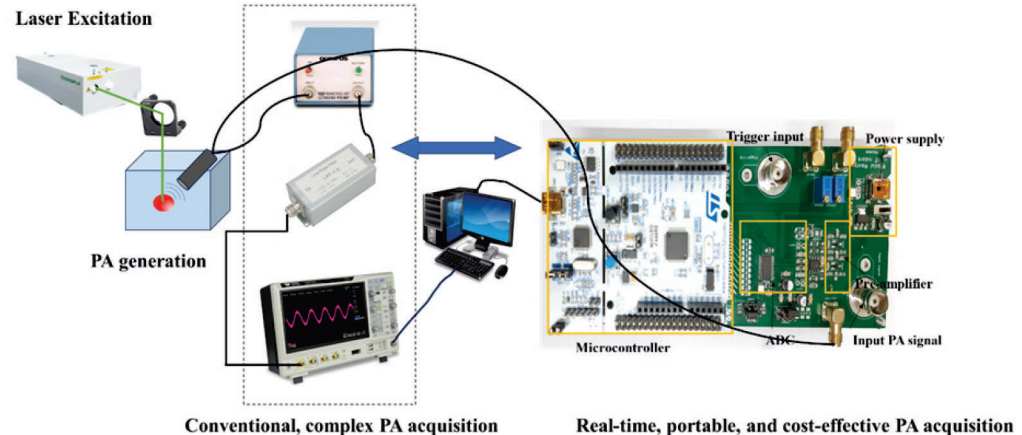
Once in a
day in
every set



Fast Cancer Screening Device for Early-stage Cancer Diagnosis, using a Quantitative Photoacoustic Spectral Response Technique

Medical diagnostics are crucial for treating diseases and timely diagnosis is pivotal for effective patient treatment and recovery, prompting a two-decade focus on early diagnosis. Advanced diagnostic techniques, notably the photoacoustic (PA) technique, have emerged. This non-invasive approach utilizes optical excitation and acoustic acquisition, offering high sensitivity and accuracy.

This research presents development of a real-time, cost-effective PA screening tool for early-stage cancer detection. Aimed at remote areas with limited medical facilities, the project focuses on an optical design for a compact pulsed laser diode (PLD) based PA system. The acquired PA signal undergoes analysis to extract PA spectral response (PASR) information,



assessing its potential as a rapid screening tool for breast disease in the Indian context, differentiating malignant and fibrocystic changes from normal fatty tissue. This developed technology is available as an instrument (Figure).

The developed Technology is at TRL 5. Field level investigations were performed at AIIMS Bhopal. The cost of the Conventional instrument is > 70 Lac while for the developed instrument it is being < 1 Lac.

Patent: Filed, Indian patents Application No. 202221056741, 202221050788

Proposed Relevant Industries: Healthcare Sector

Inventors: Suhel Khan, Prof. Srivathsan Vasudevan (svasudevan@iiti.ac.in), Department of Electrical Engineering

Developed Rapid Non-invasive Diagnostic Kits (TB-RAP) for Tuberculosis

Tuberculosis (TB), a highly infectious disease, infects 10 million people and kills 1.5 million people globally every year. Several TB diagnostic kits are available in the market. However, these kits are either costly, time consuming, less specific and less sensitive, which result in millions of cases going undetected. Therefore, it is crucial to develop rapid, precise and affordable TB diagnostic kits to allow early intervention.

We have developed non-invasive rapid, precise and affordable TB diagnostic kit

“TB-RAP”, which can detect TB from non-invasive samples such as saliva and sputum within few hours. Handling of this kit does not require trained manpower.

The technology is under Clinical validation using TB patient samples (TRL 6).

Non-invasive TB-RAP kit will help in early, fast and specific diagnosis of TB and avoid further risk and spread of disease. It does not require trained manpower.



TB-RAP KIT
Schematic representation of TB-RAP Kit

“S”- Saliva or sputum sample
“T”: Test Sample
“C”: Positive control

Patent: Under Process

Proposed Relevant Industries: Healthcare Sector

Inventor: Prof. Avinash Sonawane (asonawane@iiti.ac.in),
Department of Biosciences and Biomedical Engineering

Development of Acrylase Formulation to Reduce Acrylamide Carcinogen Formation in Processed Food Products

An increased consumption of processed food has resulted in sharp increase in the incidences of cancer development in human being. Studies have shown that cooking of starch and carbohydrate rich food products at high temperature produces a carcinogen called "Acrylamide", which increases risk of cancer development in humans.

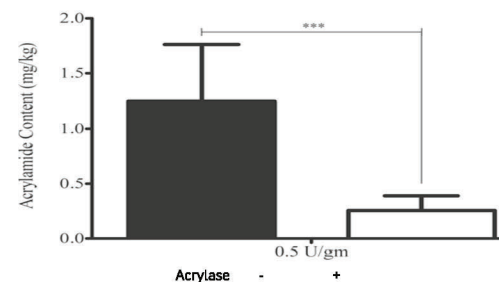
We have developed thermostable "Acrylase" enzyme formulation, which

reduced more than 90% acrylamide production in processed food products such as French fries, buns, bread and bakery products after treatment with Acrylase enzyme. Product formulation done for the technology (TRL6).

Acrylase will reduce acrylamide production in widely consumed processed food products, thus will reduce risk of cancer development and improve quality of human life.



Acrylamide containing processed food



Treatment with "Acrylase" reduced 90% acrylamide production in processed foods

Patent: Under Process

Proposed Relevant Industries: Food Sector

Inventor: Prof. Avinash Sonawane (asonawane@iiti.ac.in),
Department of Biosciences and Biomedical Engineering

Novel M-ASPAR Drug to Improve Treatment of Primary and Relapse Blood Cancer

L-asparaginase enzyme is most commonly used for the treatment of Acute Lymphoblastic Leukemia (ALL), type of blood cancer. Unfortunately L-asparaginase causes serious side effects in ALL patients such as allergy, neural disorder, blood clot formation, and toxicity to liver, pancreas and spleen. Moreover, L-asparaginase has limited success in relapse ALL treatment.

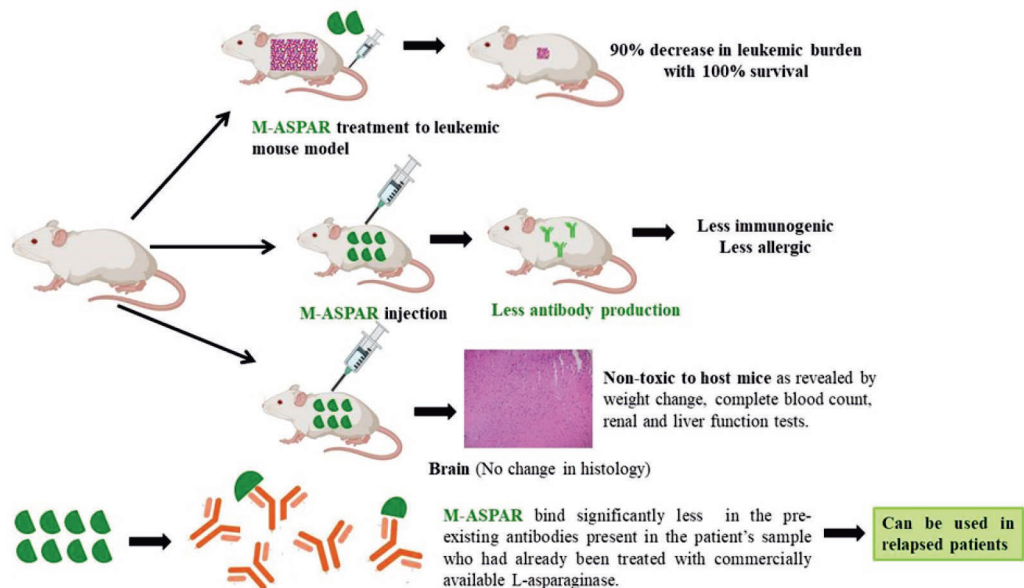
We have developed novel M-ASPAR drug that showed significantly reduced side effects, better therapeutic efficacy, and potential to treat relapse ALL. M-ASPAR is under Phase I/II clinical trial (TRL 8).

M-ASPAR is an indigenously developed drug, with reduced side effects and treatment cost, and can also improve the treatment of relapse ALL.

Patent: Granted, Indian Patent No. 365651

Proposed Relevant Industries: Healthcare Sector

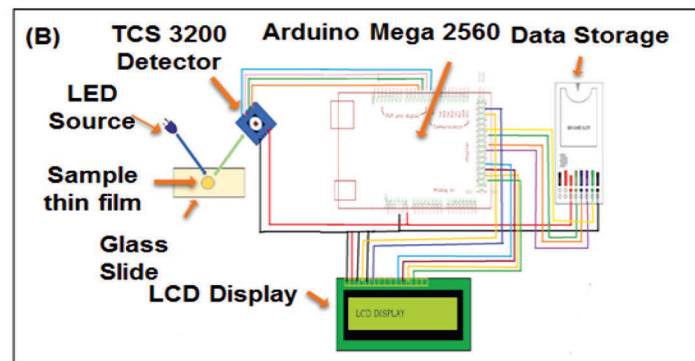
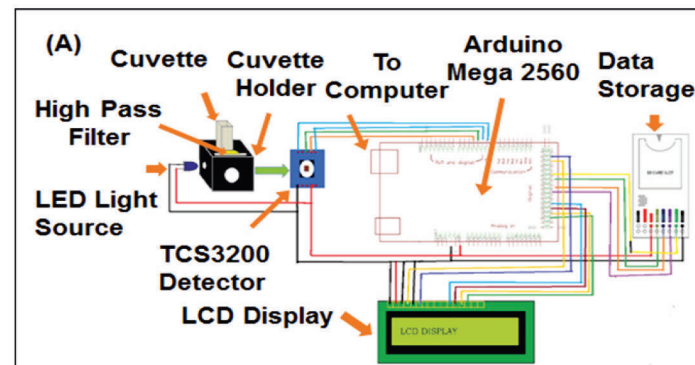
Inventor: Prof. Avinash Sonawane (asonawane@iiti.ac.in), Department of Biosciences and Biomedical Engineering



Acute Lymphoblastic Leukemia (ALL) is treated using a combination of drugs that includes L-asparaginase as a major component. However, administration of L-asparaginase causes serious side effects and the therapeutic efficacy of L-asparaginase is significantly reduced in relapse ALL patients. We have developed novel M-ASPAR drug which is nontoxic to kidney, liver, spleen, brain, bone. M-ASPAR killed 90% cancerous cells and 100% survival of cancerous mice was observed.

Portable Biosensing System and Method for Milk Spoilage and Adulteration Detection

This invention relates to the a portable biosensing system and method for milk spoilage and adulteration detection. The invention provides a color sensor-based device that is interfaced with the Arduino controller tested using a ratio-metric fluorescent assay. The computational coding in Arduino enables us to read the red-green-blue (RGB) parameters and display them on the liquid crystal display panel. The fluorescent responses were compared against a commercial fiber optic spectrometer. The processed data can be sent providing real-time information of milk quality to the buyer so that it helps to overcome the illegal practices during processing, packaging, and transportation.



Patent: Filed, Indian Patent Application No. 202121023242

Proposed Relevant Industries: Milk Manufacturers and Distributors

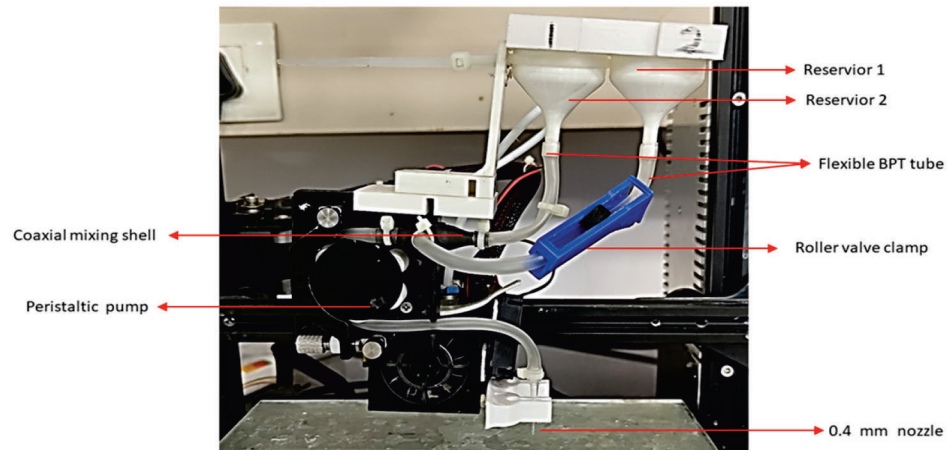
Inventors: Sandeep Choudhary, Tanmay Vyas, Abhijeet Joshi (abhijeet.joshi@iiti.ac.in),

Department of Bioscience & Bioengineering

Manufacturing (Including Smart, Advance and Industry 4.0)

System and Method for Direct Ink Writing

The present invention relates to advancements in Direct Ink Writing (DIW), an additive manufacturing method that involves the precise deposition and layering of viscoelastic inks for fabricating intricate 3D structures. The conventional DIW process involves pumping viscous liquid out of a nozzle, with solidification occurring through processes such as evaporation or UV curing. The invention introduces a novel system and process that enables dynamic changes in composite composition during printing. The invention also addresses the issue of inconsistent deposition by introducing a stepper motor-based peristaltic pump. This pump, integrated and controlled by the mainboard of an Ender-3 3D printer, provides a more defined and controlled



flow rate, enhancing the precision and reliability of the printing process. In addition to the real-time control of composite composition, the invention also fulfills the need for a system capable of creating large and composite structures, surpassing the limitations of existing setups. The versatility of the proposed system allows for the fabrication of intricate designs with precise internal architectures, catering to a broad spectrum of design applications. Patent(s): (If filed or granted)

Patent: Filed, Indian Patent Application No. 202321079655

Proposed Relevant Industries: Additive Manufacturing

Inventor: Dr. Girish C. Verma (girish.verma@iiti.ac.in), Department of Mechanical Engineering

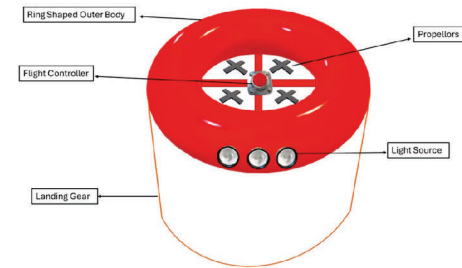
Design of Industrial Illumination Drone with Obstacle Avoidance

The project focuses on developing an industrial drone tailored for targeted illumination in specific areas, intended to replace conventional torch-mounted caps worn by labourers. This innovative solution enhances visibility and safety in industrial settings, offering a versatile and efficient alternative to traditional lighting methods. The drone's mobility and adaptability make it particularly well-suited for challenging environments, providing improved illumination precisely where needed, thereby optimizing work conditions for industrial workers.

Our proposal reimagines the use of industrial drones for focused illumination, introducing a novel technique. Our solution is unique in that it

uses drones not for cargo or surveillance but rather as a dynamic lighting source that replaces traditional torch-mounted caps. This innovative idea gives industrial surroundings a level of adaptability never seen before because the drone can navigate challenging environments and precisely place illumination where it is needed. This innovative application changes the way drone use is perceived by improving safety, effectiveness, and versatility. It tackles an unexpected use case, demonstrating our dedication to creative solutions that expand the potential of industrial drones to provide improved safety and visibility.

As of now currently the technology is in ideation stage. As technology ideas transform into prototypes, collaboration, funding, and ethical considerations



become crucial for successful development.

The project's influence on society transcends the industrial domain. It establishes a standard for creative uses of drone technology and demonstrates how these self-governing machines may be customized to address particular needs in a variety of industries. Industry adoption of these developments has a knock-on impact that makes society as a whole more technologically advanced, secure, and productive.

Patent: Nil

Proposed Relevant Industries: Manufacturing, Infrastructure Development, Construction

Inventors: Dr. Devesh Mishra, Dr. Sumit Gautam (sumit.gautam@iiti.ac.in), Department of Electrical Engineering

Non-Contact Technology for High Quality Finishing of Bevel Gears

A Novel concept of twin complementary cathode gears (Fig A) has been envisaged to develop non-contact technology for imparting high quality finishing to bevel gears via electrochemical honing (ECH) process for which machine is also developed as depicted in Fig. B. Commercially used alloy 20MnCr5 was used as the bevel gear material. It has provision to supply either continuous or pulsed DC power supply leading to pulse-ECH (PECH). PECH has given better performance than ECH. It improved the bevel gear

quality up to 6 DIN standard. Plasma nitriding has also been used to enhance performance of PECH. The current TRL of the technology is TRL4-5.

It is a non-contact, sustainable, environment friendly, and cost-effective process for imparting high quality surface finish to bevel gears which enhance their performance and service life.

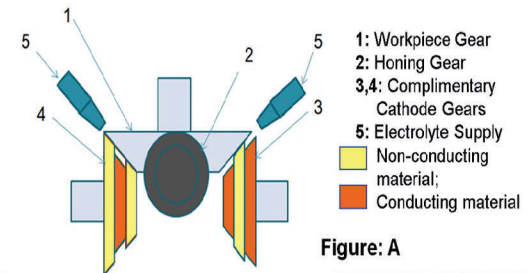


Figure: A

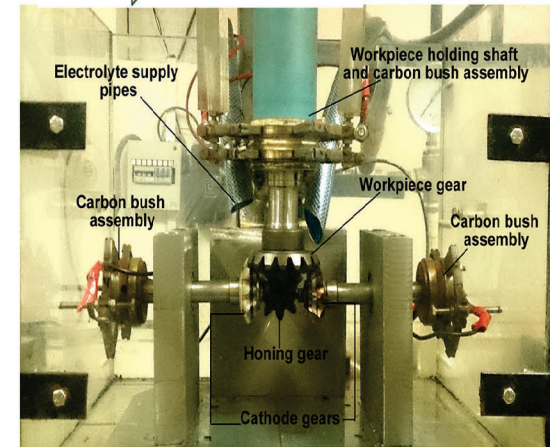


Figure: B

Patent: Nil

Proposed Relevant Industries: Automobile, Marine, Avionics, Home Appliances, and any Industry using and/or testing of Gears

Inventors: Javed Habib Shaikh, Sunil Pathak, Prof. Neelesh Kumar Jain (nkjain@iiti.ac.in), Department of Mechanical Engineering

Abrasive Flow Finishing Machine for High Quality Finishing of Cylindrical and Conical Gears

There are challenges in imparting high quality finish of cylindrical and conical gears.

Abrasive flow finishing (AFF) machine along with fixtures has been developed to impart high quality finish to spur, helical and bevel gears. Mixture of molding clay, silicon carbide abrasives, and silicone oil has been as putty for finishing different types of gears. It has improved the gear quality up to 7 DIN standard. The machine is very robust. It can finish multiple gears simultaneously. It is being explore to improve surface finish of additively manufactured parts.

Patent: Nil

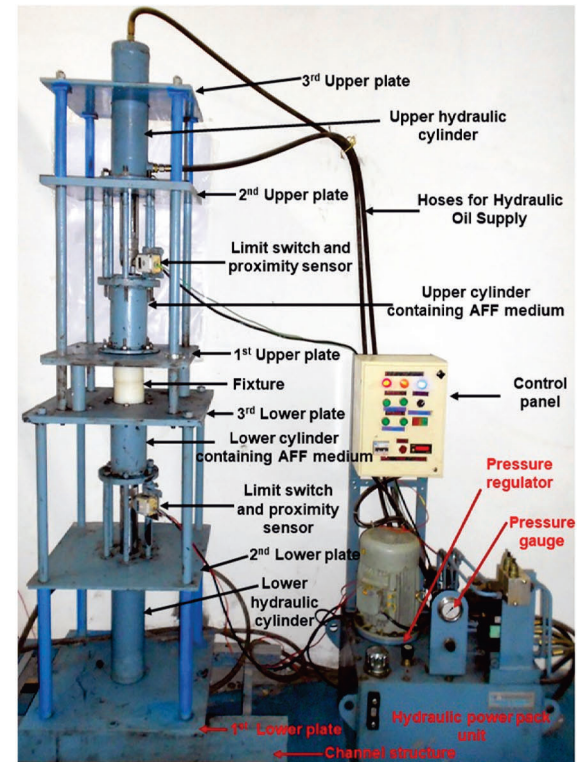
Proposed Relevant Industries: Automobile, Marine, Avionics, Home Appliances, and any Industry using and/or testing of Gears

Inventors: Anand Petare, Prof. I.A. Palani, Prof. Neelesh Kumar Jain (nkjain@iiti.ac.in), Department of Mechanical Engineering

Use of laser texturing of the gears before AFF process considerably enhanced performance of the AFF processing gear finishing.

The current TRL of the Technology is 3-4.

It is sustainable, highly flexible, safe, and very cost-effective process for very quality finish of cylindrical and conical gears. It does have any harmful emissions. Cost of the developed machine: Rs. 5 Lacs whereas Cost of Commercially available machine is at least Rs. 70 Lacs.



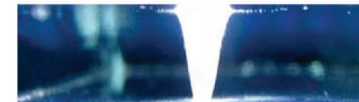
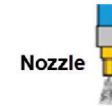
Micro-Controlled 3-Axis Machine for Abrasive Jet Machining (AJM) Process

An innovative and flexible machine has been developed for machining of thin ceramics using AJM process. The developed machine has micro-control over the movement along the three axes. It has linevac for efficient mixing of the abrasives and the compressed air. The developed machine drilled 0.5 mm diameter hole in 200 micro thick silicon wafer and drilled holes in the 5 to 10 mm thick glass plates. It can also be used for controlled sand blasting for improving

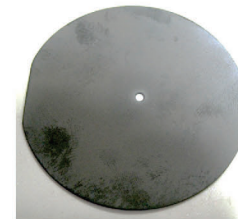
fatigue strength of different materials. The current TRL of the technology is 4-5. It is 3 axes micro-controlled, safe, flexible, highly inexpensive machine (Cost of the Developed Machine is Rs. 1 Lac where as cost of the commercially machine is at least Rs. 35 Lacs) which can be used for various machining applications for thin ceramics, semi-conductors, and highly brittle materials.



Front View and Side View of the Developed AJM Machine



Hole Drilled in 8 mm thick Glass Plate



0.5 mm dia hole drilled in a silicon wafer

0.5 mm dia hole drilled in a silicon wafer

Patent: Nil

Proposed Relevant Industries: All the Industries that Require Machining of very thin Ceramics and Semi-conductors, and Highly Brittle Materials

Inventors: Prasad Kulkarni, Pratik Bagal, Devkant Singh, Prof I.A. Palani, Prof Neelesh Kumar Jain (nkjain@iiti.ac.in), Department of Mechanical Engineering

Single Flank Roll Tester for Functional Performance of Cylindrical Gears

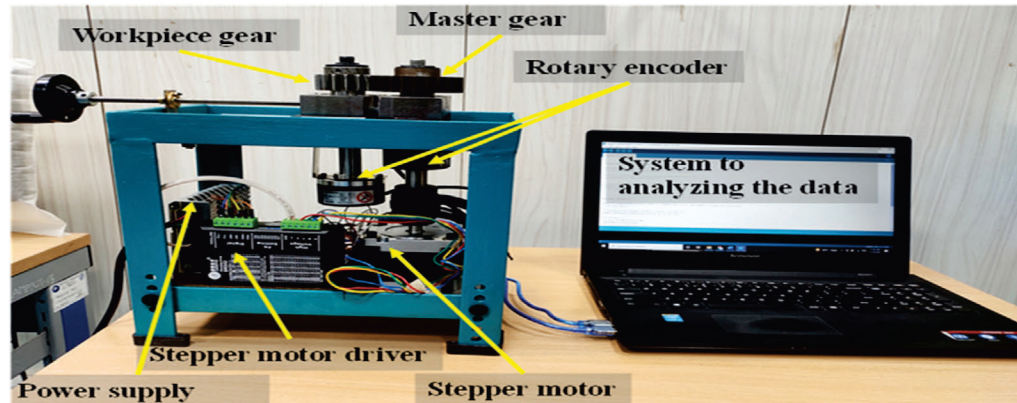
An innovative, table-top, Arduino programmed single flank roll tester has been developed to assess the Total Transmission Error (F'_t), Tooth-to-Tooth Transmission Error (F'_i); Total or Cumulative Pitch Error of any cylindrical gear (F'_p) using Rotary encoder, stepper motor, its drive and its power supply unit. The Current TRL of the technology is 4-5.

It is an accurate, very compact, and highly economical equipment (i.e., Cost of the developed equipment is Rs. 80,000 whereas cost of commercially available equipment is at least Rs. 35 Lacs) whose data can be acquired through a laptop/PC

Patent: Nil

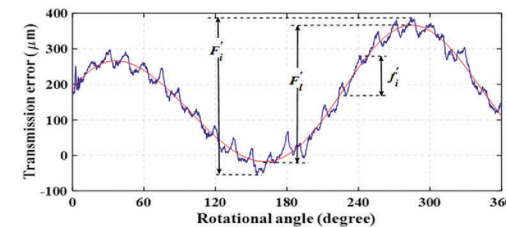
Proposed Relevant Industries: Automobile, Marine, Avionics, Home Appliances, and any Industry using and/or testing of Gears

Inventors: Dr. Vivek Rana, Prof Neelesh Kumar Jain (nkjain@iiti.ac.in), Department of Mechanical Engineering



Photograph of the Developed Single Flank Roll Tester

using a pen drive and can be analysed through Ms Excel written program. It is almost ready for transfer to the Industry.



Sample Results from Single Flank Roll Tester

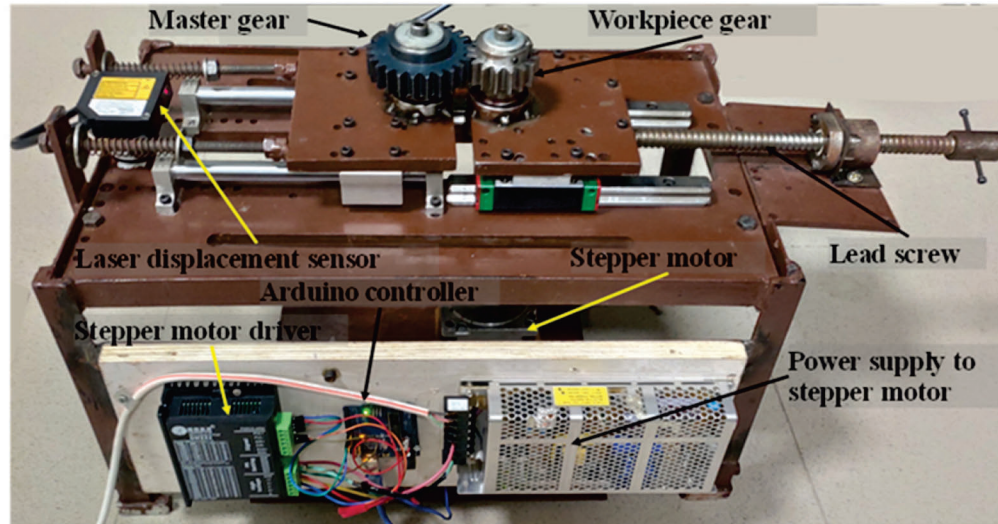
Double Flank Roll Tester for Functional Performance of Cylindrical Gears

Photograph of the Developed Double Flank Roll Tester

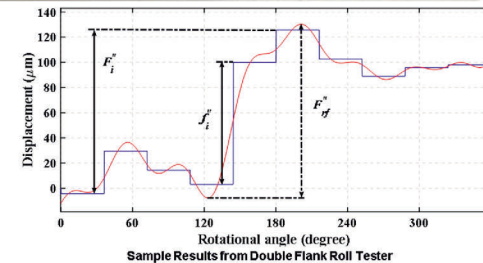
Dual or double flank roll testing of cylindrical gears have been designed.

An innovative, table-top, Arduino programmed double flank roll tester has been developed to find the Total Composite Error; (F''_t), Tooth-to-tooth Composite Error (F''_d); Radial Runout any cylindrical gear (F''_r), using Laser Displacement Sensor, Lead Screw, Stepper motor, its drive, and power supply unit. The current TRL of the Technology is 4-5.

It is an accurate, very compact, and highly economical equipment (i.e., Cost of the developed equipment is Rs. 90,000 whereas cost of commercially available equipment is at least Rs. 25



Lacs) whose data can be acquired through a laptop/PC using a pen drive. It is almost ready for transfer to the Industry.



Sample Results from Double Flank Roll Tester

Patent: Nil

Proposed Relevant Industries: Automobile, Marine, Avionics, Home Appliances, and any Industry using and/or testing of Gears

Inventors: Rajat Kasliwal, Anand Petare, Prof. Neelesh Kumar Jain (nkjain@iiti.ac.in)

Noise and Vibrations Test Rig for Cylindrical and Conical Gears

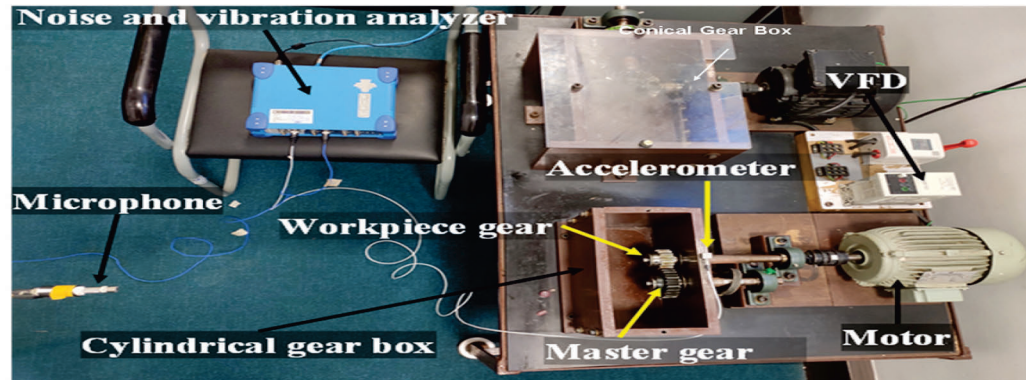
This technology is about analysis of Noise and Vibrations of Conical and Cylindrical Gears.

An innovative and compact test rig has been developed to assess Vibrations and Noise Levels in the Frequency and Time Domain at Different Speed and Applied Load to any Cylindrical or Conical Test/Workpiece Gear and at Gear Mesh Frequency (GMF); and Source of Noise with help of Noise and Vibration Analyzer, Accelerometers, Microphone, and Sound Intensity Probe. It uses one motor each for gear box for cylindrical and conical gear which are controlled by a Variable Frequency Drive (VFD). The current TRL of technology is 3-4.

Patent: Nil

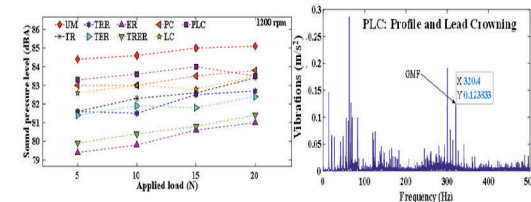
Proposed Relevant Industries: Automobile, Marine, Avionics, Home Appliances, and any Industry using and/or testing of Gears

Inventors: Gaurav Kumar, Rahul Kashyap, Anand Parey, Prof. Neelesh Kumar Jain (nkjain@iiti.ac.in), Department of Mechanical Engineering



Photograph of the Developed Test Rig for Noise and Vibrations

It is very compact and highly economical equipment (i.e., Cost of the developed equipment is Rs. 2 Lacs whereas cost of commercially available test rig is at least Rs. 40 Lacs) whose data can be acquired through a Noise with help of Noise and Vibration Analyzer system.



Sample Results for Noise and Vibration Signals

Non-Contact Flank Modification Technology for Spur Gears

A novel non-contact technology and machine (Fig. 1a) have been developed to impart five flank modifications namely tip relief, root relief, end relief, flank crowning, and profile crowning to spur gears using pulsed electrolytic dissolution (PED) process. It required development of 5 cathode gears (Fig. 1b) to impart these flank modifications. The developed machine has provisions to impart either of any five flank modifications, their combination or all 5 flank modifications simultaneously.

Results of extensive experimentations revealed that the developed cathodic gears also reduced flank surface roughness and completely removed the hob cutter marks and cracks from the flank surfaces of modified spur gear. The modified gears showed better functional performance and demonstrated considerably reduced noise and vibration characteristics than the unmodified gears. Five theoretical models are also developed to predict each type of flank modification.

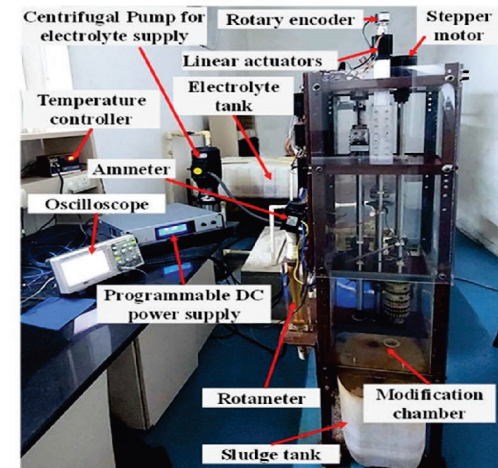


Fig. 1a

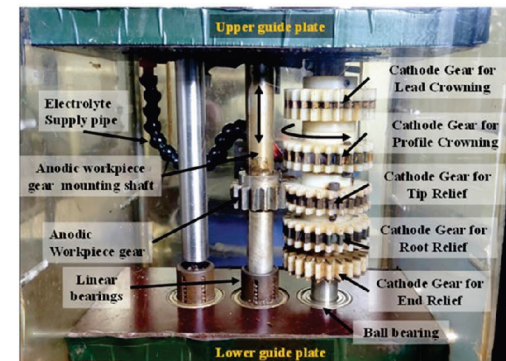


Fig. 1b

Patent: Granted, Indian Patent No. 484056

Proposed Relevant Industries: Automobile, Marine, Avionics, and any industry using gears

Inventors: Vivek Rana, Sunil Pathak, Prof. Neelesh Kumar Jain (nkjain@iiti.ac.in),

Department of Mechanical Engineering

μ -Plasma based Additive Manufacturing Technology for Metallic Materials

Additive manufacturing machine has been developed for the metallic materials using micro-plasma transferred arc. It uses maximum current up to 20 A and maximum power up to 440 watts only. It has computer numerical control over 5-axes. It has provisions to supply deposition material in powder form, wire form, or both combined. It has been used additive manufacturing of the following materials:

Titanium alloys: Ti6Al4V; Ti6-Al-4V-xCr-yNi Alloys

Knee implant materials: Co-Cr-Mo-xTi, Ti-Ta-Mo-Nb-Zr High Entropy Alloy (HEA)

Superalloy: Inconel 625

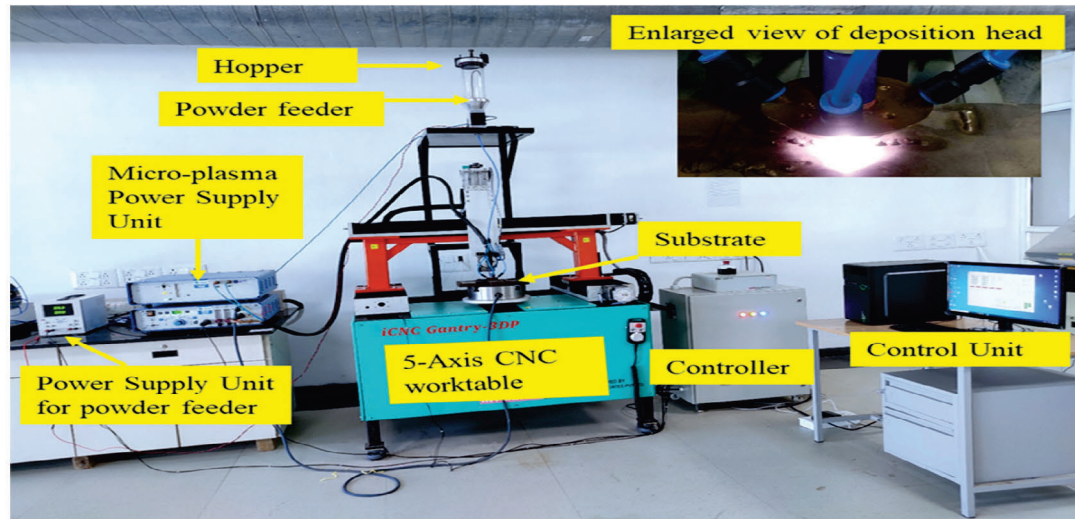
Tool and Die materials: Stellite, P20, HD12

Patent: Granted, Indian Patent No. 464408

Proposed Relevant Industries: Coating, Cladding, and Industries using AM for Metallic Materials

Inventors: Mayur S Sawant, Pankaj Kumar, Prof. Neelesh Kumar Jain (nkjain@iiti.ac.in),

Department of Mechanical Engineering



Shape Memory Materials: Ni-Ti-xCu

It has also been used for micro-joining of thin sheets (< 3 mm thickness) of stainless steel, mild steel. It is also being used to develop high and medium entropy alloys, shape memory materials, functionally graded materials.

A Method and Apparatus for Transferring Heat from Stationary/moving Surfaces Using Impingement Jet

The disclosed invention addresses the thermal and fluid characteristics of thermal systems involving impinging jets, with special focus to examine the heat transfer characteristics of stationary and moving test surfaces. The apparatus comprises essential components such as a test foil, a run-out table with multiple test beds, stepper motors, ball screws, a moving plate, an auto transformer, sensors, electrical cables, a fluid supply unit, a nozzle, and a thermal imaging device.

The uniqueness of this invention includes the analysis of heat transfer characteristics of test surface under dynamic situation which include the incorporation of stepper motors, ball screws, sensors and a thermal imaging camera to record temperature data with high spatial resolution which enhances

the accuracy in performance prediction under various operating condition as applicable to various industrial applications.

The thermal characteristics of moving surfaces involving infrared thermal imaging techniques during jet impingement cooling is limited in the literature.

Present invention has strong societal impact; this provides research advances in heat transfer characteristics of moving surfaces. This technology can be potentially adopted in various industries such as metallurgical processing, paper drying, textiles and industries that incorporate cooling of moving surfaces. This innovation can be used to optimize thermal management systems, improve thermal efficiency, and development of more energy-efficient technologies.

Patent: Granted, Indian Patent No. 471000

Proposed Relevant Industries: Metallurgical Processing Industries, Steel Industries, Paper and Textile Industries

Inventors: Avadhesh Kumar Sharma, Akash Kumar Jain, Mayank Modak, Prof. Santosh Kumar Sahu (sksahu@iiti.ac.in), Department of Mechanical Engineering

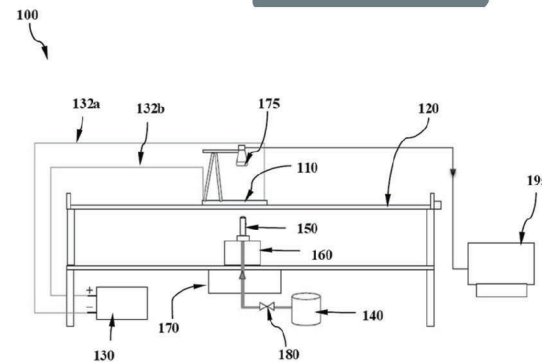


Figure 1

A heat transfer apparatus (100), comprising: a test foil (110) having a horizontal surface; a run-out table (120) comprising at least two test beds, at least two stepper motors, at least two ball screws and a moving plate, designed to receive the test foil on the moving plate, wherein the surface of the test foil is configured to move in a linear direction of movement converted from a rotational movement of two stepper motors through two ball screws; an auto transformer (130) connected to the test foil (110) through at least two electrical cables (132a and 132b); at least one fluid supply unit (140); at least one nozzle (150) connected to the fluid supply unit (140) through a gear box (160) and a micro pump (180), and disposed below the run-out table (120) so as to discharge the fluid to the test-foil (110) on the run-out table (120) through the nozzle (150); and a thermal imaging capturing device (175) mounted on the moving plate (127); characterized in that, the test foil (110) on the moving plate is heated to a first temperature level by supplying a test current using the auto transformer (130) and the nozzle (150) discharges the fluid to the hot test foil (110) when the test foil (110) is stationary or moving in the linear direction of movement with a constant linear velocity while the thermal imaging capturing device (175) measures the temperature of the moving or stationary hot test foil (110) on the run-out table (120).

In-Situ Temperature Monitoring and Feedback Control in the Wire Arc Additive Manufacturing Process

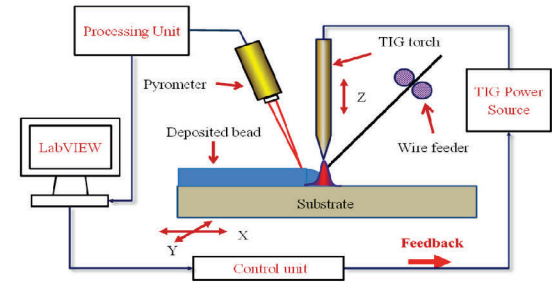
Gas tungsten arc welding (GTAW) is a versatile process used in various applications like surface hardening and additive manufacturing. It is cost-effective and easy to handle, however the harmful radiation has led to a decrease in skilled operators, which necessitates smart automation of the process.

The nominated technology automates the process and allows programmable control. It has been used for real-time monitoring and control of the wire arc additive manufacturing (WAAM) process temperature, Fig. 1. The temperature during the process is measured using a ratio pyrometer, which is then used to regulate the GTAW current/power to maintain the desired temperature. This technology can control a wide temperature range (400–1600 °C) for various applications, including

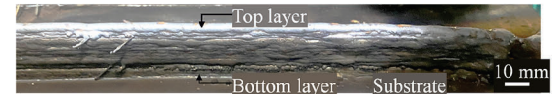
stationary and moving heat sources, and single and multi-bead deposition for additive manufacturing. The effects of temperature control on the bead geometry and mechanical properties were also investigated and published.

The novelty lies in its simple method for programmable control of the GTAW power source. This is achieved by replacing the foot pedal with a dedicated electronic circuitry, including a data acquisition system and a relay. The feedback control system, implemented using LabVIEW software and an inbuilt PID tool, enhances the quality and stability of various GTAW applications. This is evident from Fig. 2a and b.

Current Status of the Technology: The technology readiness level (TRL) of the work could be considered at level 4, as the technology has been already validated in a laboratory environment. The work has



Schematic for temperature monitoring and control for wire arc additive manufacturing.



Temperature-dependent feedback control for the multilayer deposition with the moving heat source at a deposition speed of 0.15 m/min, wire feed speed of 2.5 m/min, and setpoint temperature of 1250 °C for 1–5 layers, (b) temperature controlled multilayer deposited wall.

shown the proof of concept and the basic functionality of the temperature control system. The work was also supported by Drishti CPS Chanakya fellowship.

Patent: Nil

Proposed Relevant Industries: Aerospace and Medical Implants.

Inventors: Anas Ullah Khan, Dr. Yuvraj K Madhukar (yuvrajmadhukar@iiti.ac.in), Department of Mechanical Engineering

Wide Area-Monitoring of the Indian Electricity Grid for Enhanced Visibility

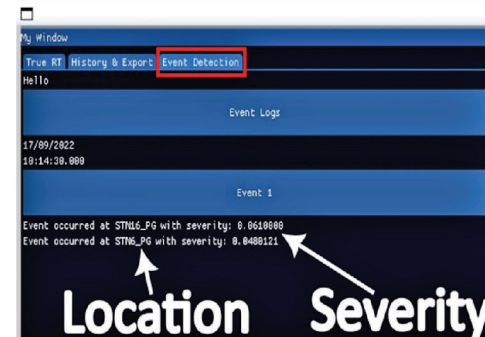
The proliferation of measurement devices generates vast data, thus offering a higher level of granularity and real-time insights that were previously unavailable. Centralized information from strategically positioned monitoring devices aids load dispatch center operators in optimizing grid operations. Our Make-in-India software addresses the challenge of costly and non-customizable foreign solutions for power grid monitoring. Currently at TRL4, the solution provides a cost-effective and scalable solution. Developed in C++, it features algorithms for detecting grid events, visualisation of real-time data, along with a data

historian for offline analytics. Tested at laboratory environment on a Real-time Digital Simulator, the technology offers concealed backend computations, an interactive GUI, and visual alarms, thus reducing the likelihood of critical grid failure events. With a focus on reducing operator cognitive load by automating grid analytics, it enhances efficiency in power grid operations, particularly benefiting rural areas prioritized during load shortages.

Patent: Filed, Indian Patent Application No. 202321014760

Proposed Relevant Industries: Electrical Utilities

Inventors: Adnan Iqbal, Prof. Trapti Jain (traptij@iiti.ac.in) Department of Electrical Engineering



Portable Integrated Stand for Constant and Falling Head Permeability Apparatus

In the domain of Geotechnical Engineering (Civil Engineering), the Permeability test holds significant importance for understanding the engineering properties of soil. However, conventional permeability testing equipment, typically wall-mounted, lacks versatility and presents constraints regarding space, flexibility, and accessibility. Researchers and engineers encounter difficulties in performing permeability tests on diverse materials, particularly at remote construction sites..

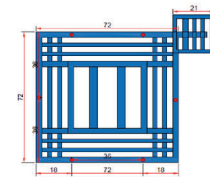
The uniqueness resides in the “shape and configuration” of the designed product. The stand is furnished with precise controls and gauges to ensure the accurate measurement and control of water flow rates during tests. Additionally,

it features a user-friendly interface, enabling engineers and researchers to efficiently configure and monitor the testing process. The designed apparatus provides a secure base that can be easily set up on any flat surface, eliminating the requirement for wall mounting. This enhances adaptability, space efficiency, and portability and results in significant time and cost savings. Furthermore, it offers flexibility in testing environments, empowering engineers and researchers to conduct consistent and reliable permeability tests, even at remote construction sites.

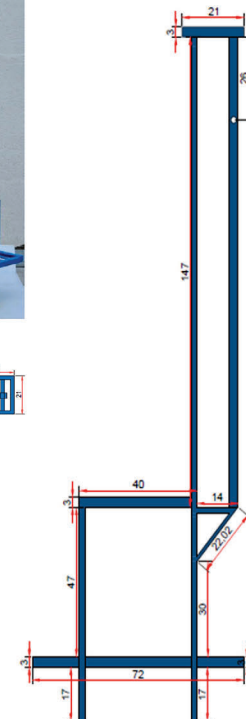
Developed technology is now ready for practical implementation and utilization by industries and academic institutions (TRL-8 level).



ISOMETRIC VIEW



TOP VIEW
ALL DIMENSION IN CENTIMETER



FRONT VIEW
ALL DIMENSION IN CENTIMETER

Patent: Register Design No.393005-001 at IPO

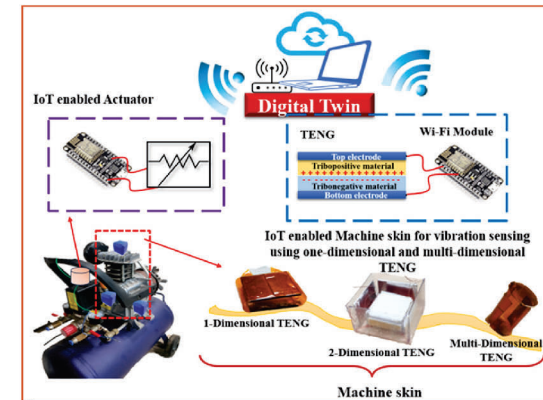
Proposed Relevant Industries: Manufacturing

Inventors: Monika Dagliya, Nitin Tiwari, Dr. Neelima Satyam (neelima.satyam@iiti.ac.in)

Design and Development of Triboelectric Nanogenerator-Based Machine Skin Integrated with Smart Actuator for Digital Twin Development

In industries, Diagnostics of machines plays a key role in detecting any minor defects. Advancements in technology have brought smart machinery with in-built sensors. However, the old conventional machinery currently deployed majorly in developing country's industries, needed to be modified to shift from Industry 4.0 toward Industry 5.0. The product is proposed to develop a Machine skin, which is an array of customizable self-energizing smart sensors. The IoT-enabled Triboelectric Nanogenerator (TENG) based low-frequency vibration sensor is used which generates voltage signals corresponding to the vibration. The Machine skin can be customized for any old conventional

machine considering the size, shape, vibration frequency range, and direction. Any minor defects can be detected by the anomaly in the vibrations. The TENG will send data to the Digital Twin of the machine, for analysis of the vibration signal, which will serve many applications like condition monitoring, predictive maintenance, and alert generation. The Technology has a TRL level between 2-3. The Digital Twin will send the signal to the IoT-enabled potentiometer (actuator) forming a closed-loop system, which will change the rotation per minute of the compressor, delaying the failure of the component and allowing us more lead time to arrange the alternative so that the production line won't halt.



Schematic of the Machine skin and actuator on the air compressor incorporated with its Digital Twin

Patent: Nil

Proposed Relevant Industries: Manufacturing, Heavy Industries

Inventors: Diksha Jaurker, Prof. Suhas S Joshi, Dr. Vibhor Pandhare, Prof. Palani I A (palaniia@iiti.ac.in),

Department of Mechanical Engineering

Implementation of Laser Decal Transfer Towards Laser μ -3D Printing

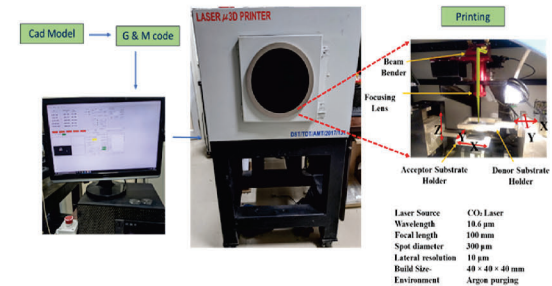
In microfabrication, different lithography has been used for the manufacturing of sensors, actuators, flexible electronics components. However, the process requires different mask patterns for the printing of complex shapes. Moreover, new technology such as screen printing, inkjet printing etc. has certain limitation such as specific material, nozzle clogging or the slow unstable printing process. In this regard, μ -3D printer combines the principle of laser direct writing technique and additive manufacturing technology. The developed Laser- μ 3D printer is maskless printing technology that used thin film as feed material to print three dimensional structures without any chemical and physical

change in materials. The process fabricate multimaterial with three-dimensional structure in micron scale with different composite material such as metals, polymers, biomedical and alloys. The technology has a capability to print components in minimum thickness of $2\text{ }\mu\text{m}$ for the fabrication of microelectronics components such as meta antennas, band pass filters, strain gauges etc. Currently, the machine is at TRL - 8 and ready for the commercialization. The Laser μ -3D printing process will boost the fabrication process of micron scale 3D structures to fulfill the increasing demand of sensors and actuators in the electronics industries.

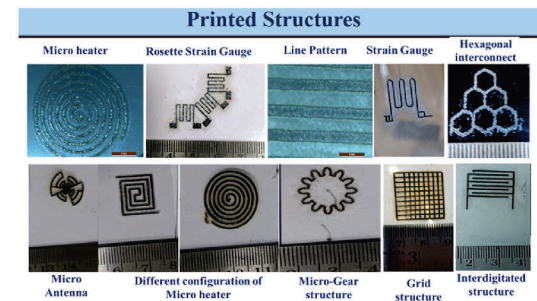
Patent: Filled, Indian Patent Application No. 202221022267

Proposed Relevant Industries: Microfabrication, Semiconductor Printing, Flexible Electronics

Inventors: Dr. Anshu Sahu, Prof. Vipul Singh, Prof. Palani I A (palaniia@iiti.ac.in), Department of Mechanical Engineering



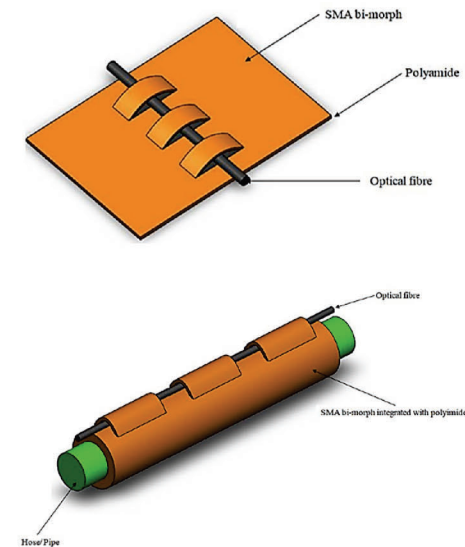
Laser μ -3D Printer developed in-house at IIT Indore



Strained SMA Bimorph & Spring Based Condition Monitoring System for Fluid Leak Detection in Hydraulic Hoses SMA

Monitoring Temperature in Hydraulic packs used in heavy industry is a challenging task. The technology on sensor system for detecting and monitoring fluid leakage in a hydraulic hose is the key focus. The sensor comprises a shape memory alloy (SMA) bimorph having an inner surface and outer periphery with a plurality of clamps, and an optical fiber disposed within the plurality of clamps on the outer periphery of the shape memory alloy (SMA) bimorph. The sensor is wrapped around the hydraulic hose to detect or monitor leakage of fluid in the hydraulic hose through a measurement of bending loss of optical fiber as result

of change in shape of shape memory alloy (SMA) bimorph due to the change in temperature before the fluid leaks leading change in bending loss in the optical fiber thus due to change in temperature of the leaking fluid, and leakage of fluid is detected or monitored at the near ends of the hydraulic hose through a measurement of change in resistance of wound strained shape memory alloy (SMA) wires. The system further may comprise of IOT enabled controller module connected with the sensor to display a status of the fluid leakage in the hydraulic hose, through mobile app. The technology has TRL level closed to 4.



Patent: Filed, Indian Patent Application No : 202221022267

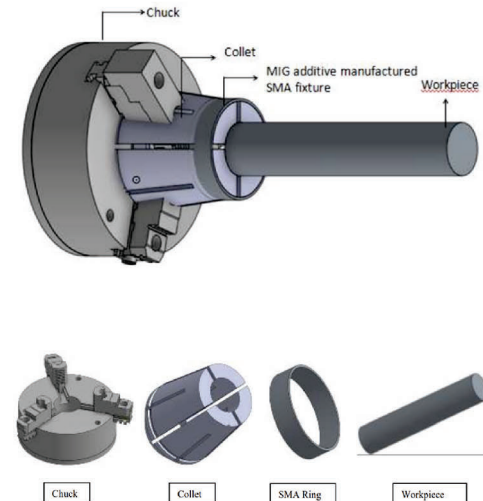
Proposed Relevant Industries: Automobile, Ship building, Heavy and Manufacturing Industries

Inventor: Prof. Palani | A (palaniia@iiti.ac.in), Department of Mechanical Engineering

Metal Inert Gas (MIG) Based Additive Manufacturing Technique For Fabricating Shape Memory Alloy Ring

Vibrations during machining operations produces frictional heat which causes thermal expansion and deteriorates machine components. It also causes wobbling which limits work quality due to dimensional errors and poor surface finish of work pieces. A shape-memory alloy (SMA) is an alloy that can be deformed when cold but returns to its pre-deformed ("remembered") shape when heated. Shape Memory Alloys are used as passive vibration damper as they dissipate frictional heat energy and dampen vibrations. NiTi SMAs in

particular, have unique thermomechanical behaviors such as shape memory effect and pseudoelasticity, which have made them attractive candidates for structural vibration control applications. NiTi SMAs are prepared using powder metallurgy, thermal spray, Plasma melting etc., but use of MIG additive manufacturing in its preparation has strategic advantages. The Technology is close to TRL level 5.



Patent: Filed, Indian Patent Application No. 201721007136

Proposed Relevant Industries: Proposed Relevant Industries: Manufacturing and Machine tool industry, Heavy industry

Inventors: Inventors: Prof. Bhupesh K Lad (bklad@iiti.ac.in), Prof. Palani I A (palaniia@iiti.ac.in), Department of Mechanical Engineering

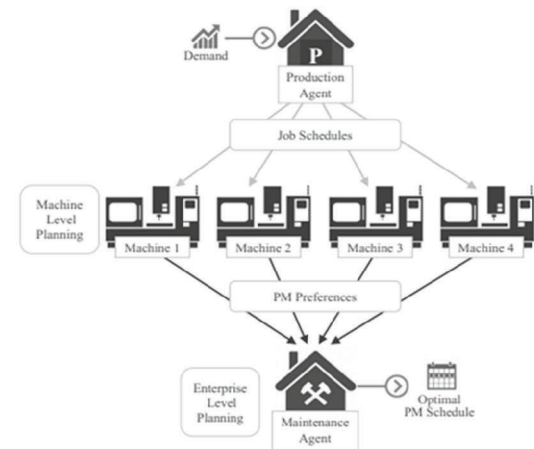
Manufacturing

Method and System for Providing Smart Communications for Distributed Operations Planning in an Industrial Network

This invention relates to a method and system of providing smart communications for distributed operations planning in an industrial network. More particularly, the present disclosure relates to a novel communication method facilitating intelligent communications and decision making for distributed operations planning, such as, but not limited to, maintenance scheduling, production

scheduling/sequencing, inventory management, quality control etc., within the industrial network. The novel communication method helps in making faster, autonomous and more-informed decisions under dynamic conditions within any industrial environment.

A software solution using this invention for industrial decision making is currently under development.



Patent: Filed, Indian Patent Application No. 201621007003

Proposed Relevant Industries: Any Manufacturing Industry

Inventors: Namit Agrawal, Miroojin Bakshi, Kartikeya Upasani, Prof. Makarand S. Kulkarni,

Dr. Vibhor Pandhare, Prof. Bhupesh Kumar Lad (bklad@iiti.ac.in),

Department of Mechanical Engineering

Robotics, Sensors & Actuators

Shape Memory Alloy Flexible Smart Mirrors for Opto-Mechatronics Applications

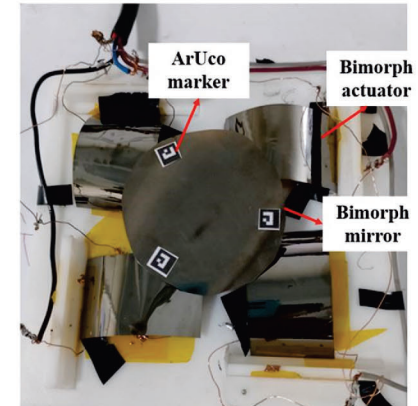
Conventionally used technologies in Fast Steering Mirrors (FSM) like Piezoelectric Transistors (PZT) and Voice coil actuators have limitations such as larger weight, complex production and assembly, higher power consumption and hysteresis. Using Shape Memory Alloy (SMA) thin film bimorphs as actuators provided a light weight and more power efficient mechanism for steering mirrors. The complexity and fragility of the actuation mechanism can be reduced. The SMA based Stewart platform arrangement provides an arrangement for mirror steering with three degrees of freedom. The arrangement utilizes four electrically actuated bimorph arms in a Stewart platform arrangement to achieve rotational motion about x and y axes and single translational motion along z axis of a

mirror. The bimorph was fabricated by depositing a thin film of shape memory alloy (Nitinol) on 75 μm Kapton Polyimide sheet as a substrate. The Kapton Polyimide provides the reverse bias force that helps regain the shape of the bimorph after removal of the actuation power. Moreover, the motion of mirror will be tracked by a camera using computer vision. The output from the camera can be utilized as feedback to controller for adjusting the power supply to achieve precise positioning. The control over mirror inclination in turn leads to better positioning of the laser beam reflected from the surface of inclined mirror. The technology has attempted the use of SMA based soft actuators and mirrors for laser beam steering for the first time.

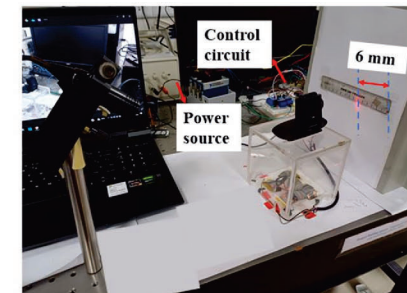
Patent: Filed, Indian Patent Application No.202321055165

Proposed Relevant Industries: Optics, Precision Manufacturing Related Industries.

Inventors: Kaushal Gangwar, Prof. Palani I A (palaniia@iiti.ac.in), Department of Mechanical Engineering



Flexible mirrors in the form of Stewart platform



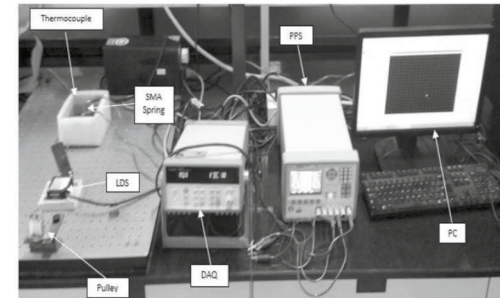
After actuation

Thermo-mechanical Test Bench for Reliability Estimation of Shape Memory Alloy (SMA) Springs

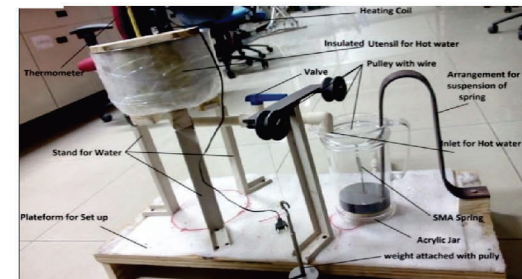
Shape memory alloys (SMA) are smart materials that have a specific functionality of returning back to their original shape after deforming when it is heated with a temperature ranging from 80-130 degree Celsius. This interesting shape memory effect has led to their extensive industrial application as actuators. Rapid response is observed in a SMA spring when subjected to heating in the first few tens to hundred thermo-mechanical cycles. Industrial application of SMA

rings often involves repeated actuation. Such repeated actuations may lead failure of a SMA spring and breakdown of the machinery.

Hence, reliability of the SMA spring during repeated actuation is a critical parameter to be considered for its successful utilization in various industries. The as developed system efficiently predicts reliability of a SMA spring and has a capability to opt for small displacement also. The technology is at a TRL level 6.



Testbed for Electrical Actuation of SMA



Testbed for hot water actuation of SMA

Patent: Granted, Indian Patent Application No. 201621007005

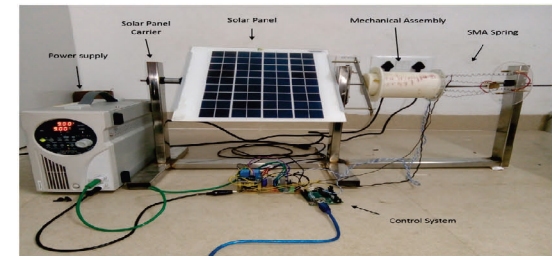
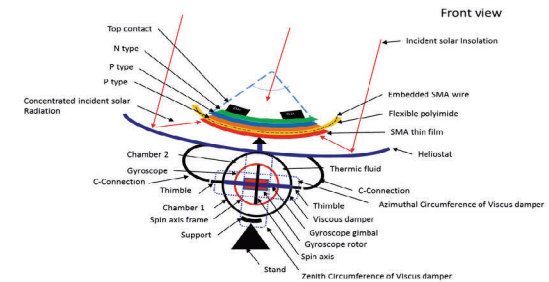
Proposed Relevant Industries: Aerospace, Automobiles, Robotics, Machine Tool, Civil Constructions, Biomedical and Defence Equipment

Inventors: Prof. Bhupesh K Lad (bklad@iiti.ac.in), Prof. Palani I A (palaniia@iiti.ac.in), Department of Mechanical Engineering

A Dual Axis Continuous Solar Tracking System Using Shape Memory Alloy Bimorph Based Solar Panel

Source of energy for several years now and have the potential for much greater contribution over the years to come. Significant research endeavors have been made towards improving their efficacy of which a major thrust has been towards appropriate solar tracking. Solar panels within existing farms are mostly fixed at an angle so as to maximize the incidence of light on the surface. The fixed angle is governed by factors such as the latitude and longitude of the place, the time of the year, surrounding conditions, general environment. In spite of the best intentions, the total solar energy 'captured' using such fixed panels is on an average a woeful 40%. This is because solar panels are able to effectively capture 90% of the light only

when the angle of incidence of the sun is at 0 degrees above perpendicular to the panel plane. This capture percentage rapidly drops as the incidence angle of the sun moves away towards 90 degrees. At experimental levels, several endeavors have been made towards 'tracking' the path of the sun and developing movable solar panels that progressively maintain their face towards the angle of incidence of the sun. The advanced mode for doing this is through utilization of unused energy so called exergy also. The utilization of exergy through smart materials can harness more energy as well as reduce the consumption of active energy required in conventional system to drive the stepper motors connected to light Dependent Resistors for maximum power point



trapping. If the smart materials are coupled to flexible solar panel the shedding loss will also be encountered. The system comprises of smart materials and flexible solar panel enabled with passive energy dependent dual axis synchronous tracking system is illustrated in figure. The Technology is at TRL level 6.

Patent: Granted, Indian Patent Application No. 201721026063

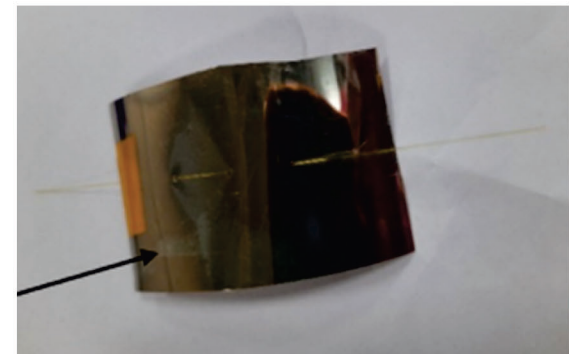
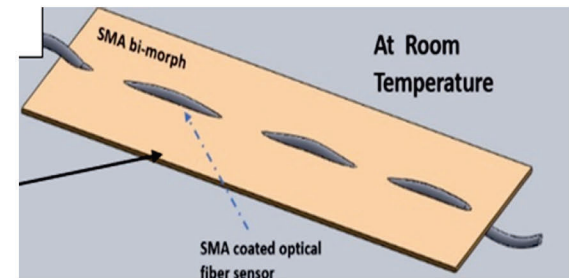
Proposed Relevant Industries: Solar Panel, Energy Sectors, Semiconductor Printing, Flexible Electronics

Inventors: Prof. Vipul Singh (vipul@iiti.ac.in), Department of Electrical Engineering, Prof. Palani I. A. (palaniia@iiti.ac.in), Department of Mechanical Engineering

SMA Coated Optical Fiber Sensor for Cryo Temperature Sensing

The SMA coating on optical fiber induces bending/ displacement in the fiber at low temperature range which results in attenuation of optical signal passes through it. Such attenuation of signal refers to the sensitivity of the fiber at low temperature. Moreover, incorporating the SMA coated fiber inside SMA bimorph imposes more bending which results in enhanced attenuation in optical signal. Therefore, the improved sensitivity is detected at low temperature range. Such a method of sensing low temperature through optical fiber sensor is a novel technique which can compete with the existing

sensing technology investigated so far. Moreover, it's a very user friendly and cost-effective technique where only the bending of SMA coated fiber plays a crucial role towards sensing the low temperature. Therefore, we can claim that such SMA coated optical fiber sensor will hold a great promise towards the low temperature sensitivity in comparison to the conventional FBG based cryo-sensor. It provides a wide platform to investigate the space structural monitoring systems with the usage of advanced functional smart material namely shape memory alloy based optical fiber sensing.



Patent: Under Process

Proposed Relevant Industries: Space Related industries, Industries dealing with low Temperatures

Inventor: Prof. Palani | A (palaniia@iti.ac.in), Department of Mechanical Engineering

Design and Development of a Gesture-based SMA-actuated Robotic Hand for Human-machine Interface

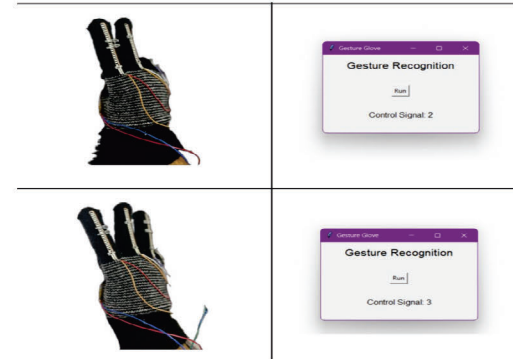
Bomb disposal is a real challenge in defense as even in the best of cases, the safety of soldiers disposing of it is always at risk. The utilization of specifics of Industry 5.0, i.e., a hand gesture-based human-machine interface, has not yet been explored and utilized in defense, neither in literature reports nor in real-life discussions with soldiers on the ground. The proposed idea is focused on developing a gesture-based shape memory alloy actuated robotic hand that is closed-looped with human

gesture input and visual feedback. The project's human-machine interface (HMI) component utilizes a glove equipped with flex sensors. These sensors capture user gestures, and a machine learning algorithm interprets this data, enhancing gesture recognition accuracy. The classified gestures are then swiftly transmitted to the robotic hand wirelessly, forming a seamless link between user intent and robotic action. The technology is under TRL -5 and can be deployed in fields.

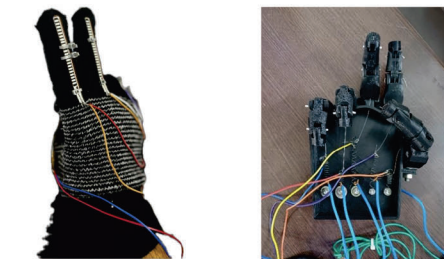
Patent: Under Process

Proposed Relevant Industries: Defense and Industry 5.0

Inventors: K A Vyvaswath, Mr. Arpit Singh, Prof. Palani I A (palaniia@iiti.ac.in), Department of Mechanical Engineering



Gesture Control



Man machine interface with Robotic Hand

Completely Visible-Blind Ultraviolet Photodetectors

Ultraviolet radiation is electromagnetic radiation from 10 nm to 400 nm. It is shorter than radiation in the visible spectrum but longer than X-rays. There are defined three UV bands. UV-A—wavelengths: 315–400 nm; UV-B—wavelengths: 280–315 nm; UV-C—wavelengths: 100–280 nm. The sun emits the entire range of UV radiation; therefore, the radiation of the UV-A range and part of the UV-B radiation range reaches the Earth's surface with other visible solar radiation. Therefore, in order to detect UV light, a need of filtering is required in conventional detectors, which is quite expensive affair.

We have developed solar-visible range blind UV photodetector which sees only UV light.

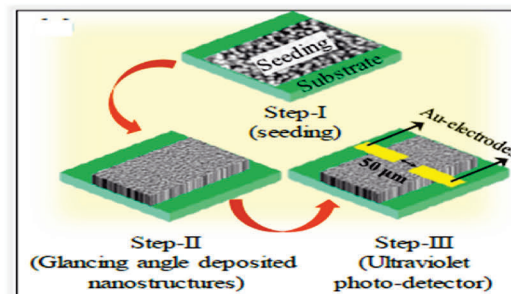
Patent: Nil

Proposed Relevant Industries: UV photodetectors are widely used in the industrial area (flame detectors, fire alarm systems, extreme UV lithography), Environment studies, national security (missile defense, explosives detection, forensic analysis), in fields such as medicine (UV imaging, protein analysis, and DNA sequencing) or biology (biological agent detection), and when dealing with environmental issues (ozone detection, air pollution determination, disinfection, and decontamination).

Inventors: Prof. Krushna R. Mavani (krushna@iiti.ac.in), Department of Physics

It is highly sensitive for UV light and fast, responds in seconds. This photodetector is small in size, can fit anywhere. This detector does not need any filtration of visible light. The figure demonstrate three-stage development process using laser and sputtering technologies. We have used pulsed laser deposition technique to grow highly crystalline and yet porous nanostructured thin films. The porosity allows the light to penetrate deep, while high crystallinity of ZnO nanostructures makes this detector completely visible-blind.

Several researchers have reported different designs of UV photodetectors using ZnO materials, but most of these are not



‘completely’ visible-blind and lack comparable sensitivity due to low quality crystallinity and presence of impurities.

This photodetector can be used in a variety of areas as mentioned in a column below. This can be used for sensing UV light even in presence of other visible light. Hence this can be effectively used for environmental study. Too much ultraviolet radiation causes skin cancer, such detectors can be used to estimate the safe level of UV-light dose during skin-tanning process.

Smart Cities & Infrastructure (Including Smart Mobility)

Drone-AI Technology for Wide-Area Crowd-Counting in Surveillance and Security Applications

Crowd management in smart cities is critical to providing residents with the necessary safety and security. Automated crowd counting is a key subtask involved in crowd management. This technology offers an intelligent drone-based solution for wide-area crowd counting. In drone-based crowd counting, particularly in scenarios where the crowd size surpasses the field of view of a single frame, the key challenge is that a person is highly likely to appear in multiple frames, leading to inaccuracies in counting. This technology addresses the challenge by generating non-overlapping images through a systematic aerial approach. The drone video is fed to an image extraction algorithm, which employs a sampling approach to obtain inherently

non-overlapping images, creating a series of distinct frames capturing the entire crowd. In this way, the developed technology overcomes the aforementioned problem. The total crowd count can be accurately estimated by summing the counts of the individuals in each of these non-overlapping frames/images.

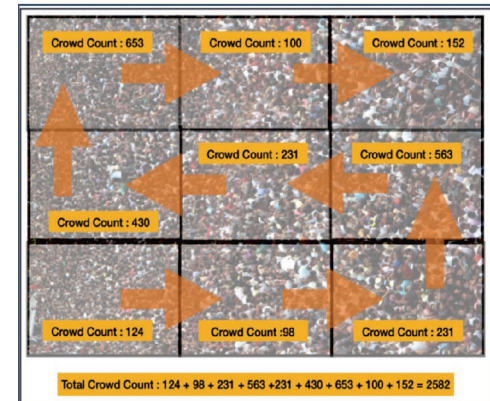
A functional prototype has been field-tested in an operational environment, providing a realistic assessment of its performance and capabilities.

This technology can be used to effectively manage large crowds in public places (mainly to prevent human stampedes) based on the estimated crowd count/density.

Patent: Under Process

Proposed Relevant Industries: Law Enforcement Agencies and Large Event Organizers

Inventors: Harshwardhan Chaube, Harsh Bardhan, Siddharth Singh Savner, Dr. Vivek Kanhangad (kvivek@iiti.ac.in), Department of Electrical Engineering



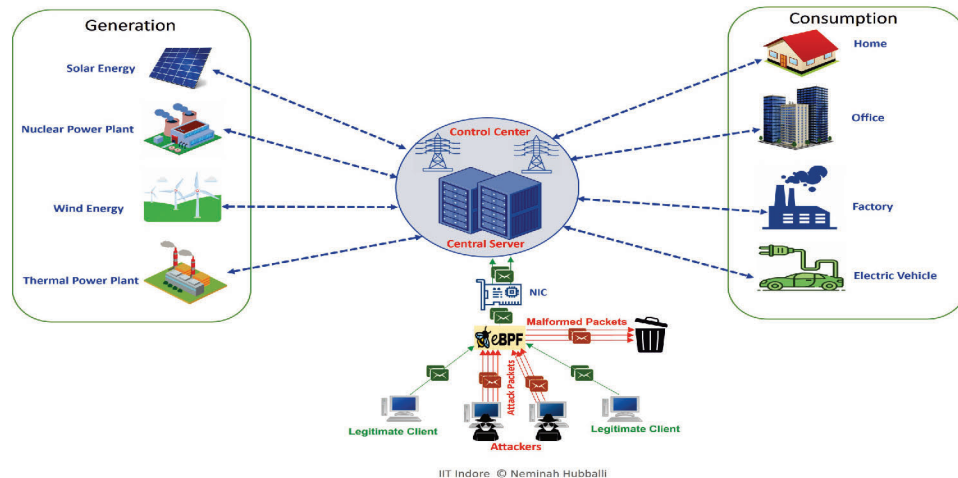
GridProtect: Protecting the Electrical Grid Networks from Resource Depletion Cyber Attacks

Modern electric grid networks use Information and Communication Technology (ICT) for exchanging data between various components of the grid network. Typically, sensors deployed in these networks bring measurement data to the control centre over TCP/IP networks. There are application layer communication protocols like Modbus and IEC-104 available as standards for this communication. In this technology development effort, we consider a new variant of Denial-of-Service attack called resource depletion attack which can be generated with random application layer messages being sent to the control centre. A large number of such messages can cripple control centre risking the safety of grid.

Patent: Nil

Proposed Relevant Industries: Powergrid

Inventor: Dr. Neminath Hubballi (neminath@iiti.ac.in), Department of Computer Science and Engineering



This technology enables mitigating resource depletion attack to safeguard grid infrastructure. The idea is to filter packets not conforming to the standard format and structure at the Network Interface Card (NIC) level. This is achieved through custom screening code running at programmable NICs. We used such programmable NICs to screen and filter Modbus and IEC-104 packets not generated according to the standards. By dropping all such illegal packets at the NIC itself; it provides significant savings in resources (CPU cycles and memory utilized) to the control centre.

GOBAiR - A Novel Cow Dung Based Foaming Agent For Developing Low Cost Sustainable Light Weight Construction Materials

India has over 5.3 million, non lactating stray cattle. The problem of stray cattle can be avoided if by-products like dung can provide sufficient economic returns.

Light weight concrete is popular for high thermal insulation and lower dead load. Available light weight alternatives use heavy machinery and chemical based foaming agents. The market is growing and ripe for intervention.

GOBAiR is first-of-its-kind cow dung based foaming agent. GOBAiR is an eco-friendly, low-cost, easy to use alternative of chemical based foaming agents. GOBAiR does not require autoclaving, further reducing the cost of concrete production. GOBAiR can be used for on-

site casting, precast panels, flooring, bricks and blocks with light-weight and thermal insulation applications.

GOBAiR used for developing a light weight block, density: 1400 kg/m³; G-12 grade (IS 2185 (part 4): 2008); 24% cheaper than available blocks; Stronger than bricks (12 – 14 MPa). At the current stage, the developed technology is at TRL 4-5.

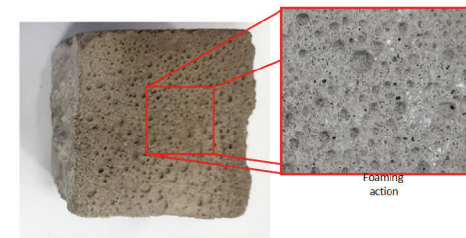
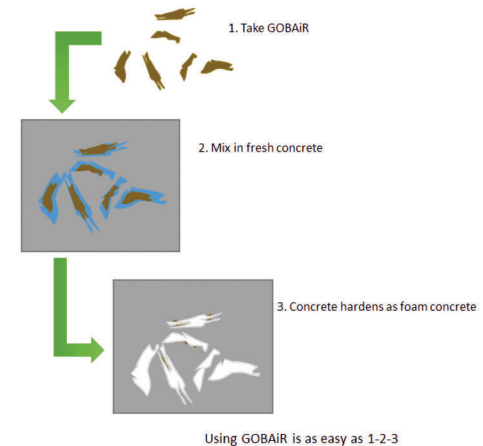
GOBAiR provides: Better economy for cow dung, prevent stray cattle Thermal insulation for lower cooling / heating electricity requirements Eco-friendly construction, Better GRIHA & LEED score Light weight construction for better economy

Patent: Filed, Indian Patent Application No. 202421010279

Relevant Industries: Gaushalas; Precast Light Weight Concrete Manufacturers;

Fly ash Brick Manufacturer; AAC Block Manufacturer

Inventors: Sanchit Gupta, Prof. Sandeep Chaudhary (schaudhary@iiti.ac.in), Department of Civil Engineering



Monitoring Infrastructure Faults with YOLOv5, Assisting Safety Inspectors (Smart City)

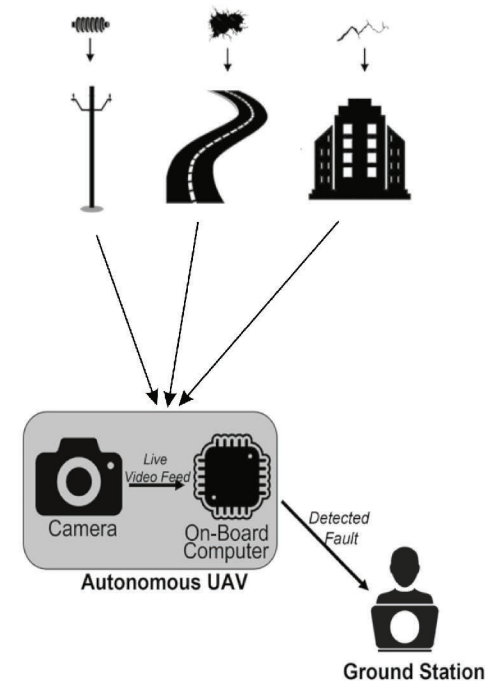
With billions of dollars annually invested in global infrastructure, ensuring the safety of large-scale structures such as buildings, bridges, and pipelines is paramount. However, the increasing number of projects, often on tight schedules causing public inconvenience, has led to pressure to expedite approvals.

We've introduced an autonomous, multiple fault detection method in infrastructure inspections, covering various fault classes like electrical, road, and civil faults. The 2SA method, utilising the object detection algorithm, effectively detects faults. It employs a master-slave mechanism, where a master algorithm (MDA) directs multiple slave algorithms (SDAs). MDA classifies fault images based on visual input and forwards them to fine-tuned SDAs, each focusing on

specific fault criteria (Electrical, Road, and Civil). Training and validation accuracies for each category demonstrate the system's overall accuracy (approximately 93% RMS value). The system is implemented on an AI device and achieves near real-time recognition times of around 90 milliseconds. The 2SA approach is lightweight and suitable for integrating drones for remote inspections, enabling a single autonomous drone to address multiple infrastructure issues. Ongoing studies aim to enhance the system's redundancy and versatility.

We've successfully prototyped the algorithms and tested the payload integration with different sensors like camera, LiDAR,. Currently, communication protocols and algorithms are under development.

Multiple Infrastructure Inspection



Patent: Nil

Proposed Relevant Industries: Manufacturing, Infrastructure Development, Construction

Inventors: Harsha Avinash Tanti, Kumar Sheshank Shekar, Prof. Abhirup Datta (abhirup.datta@iiti.ac.in), Department of Astronomy, Astrophysics and Space Engineering

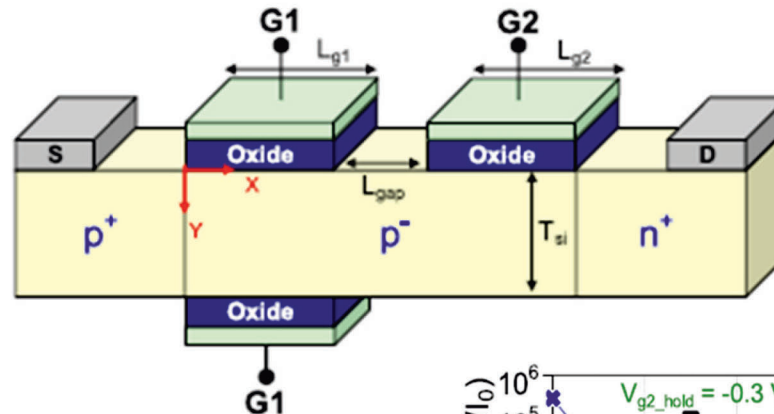
Semiconductors

Multiple Gate Tunneling Field Effect Transistor Device for Capacitorless Dynamic Memory

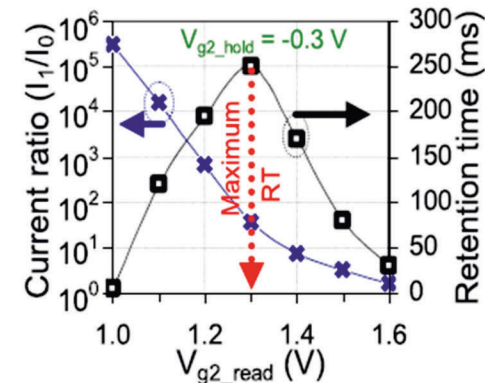
The claimed architecture has three distinct independent gate terminals of which two gates (electrically connected) are at the front and back interfaces of the intrinsic region. The second front gate is used to create electrically induced potential well for the charge storage, an essential feature of capacitorless (1T) dynamic memory.

Portable electronic gadgets including smart phones and Internet of Things (IoT) deployments require cloud services for which high-density and cost-effective DRAM is essential. A versatile mobile system-on-chip necessitates a matching DRAM capability to serve the needs of the society.

Schematic illustration of multiple gate tunneling field effect transistor for application as capacitorless dynamic memory.



Retention time and current ratio as a function of bias applied at gate-2 during read bias of the capacitorless DRAM.



Patent: Filed, Indian Patent Application No. 201621007078

Proposed Relevant Industries: Semiconductor Industry

Inventors: N. Navlakha, Prof. Abhinav Kranti (akranti@iiti.ac.in),
Department of Electrical Engineering

Multiple Gate Junctionless MOSFET (Metal Oxide Semiconductor Field Effect Transistor)

Brief Writeup explaining the Problem Statement, Uniqueness of the Solution, current Status of the Technology & Societal Impact: The present invention discloses a multiple-gate Junctionless Metal Oxide Semiconductor Field Effect Transistor (JLMOSFET) capable of super steep/sharp transition from off-state to on-state at very low operating/supply voltage through misalignment between front and back gates.

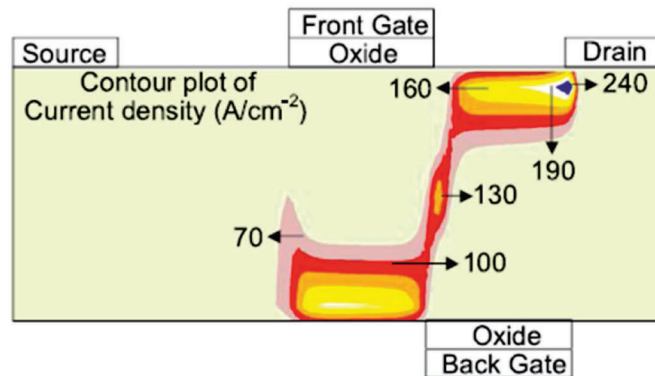
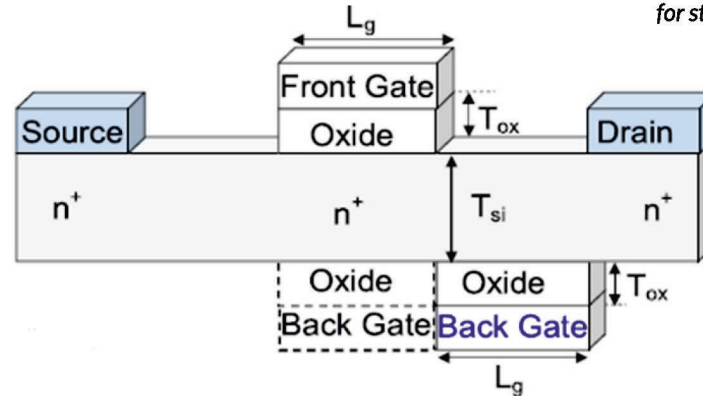
The functionality of electronic gadgets is governed by transistors which switch from low to high state. This switching of current by a decade requires at least 60 mV of gate bias. A reduction in the gate voltage translates into lower power consumption and energy efficient circuits and systems, which will be beneficial logic circuits.

Patent: Granted, Indian Patent No. 431061

Proposed Relevant Industries: Semiconductor Industry

Inventors: M. Gupta, Prof. Abhinav Kranti (akranti@iiti.ac.in),
Department of Electrical Engineering

Schematic illustration of misaligned front and back gates in junctionless transistor for steep current switching.



Current density contour highlighting the advantages of misaligning front and back gates in junctionless transistor.

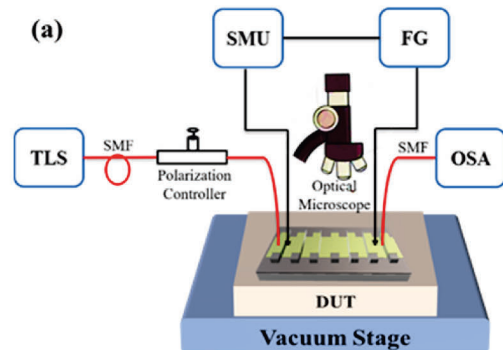
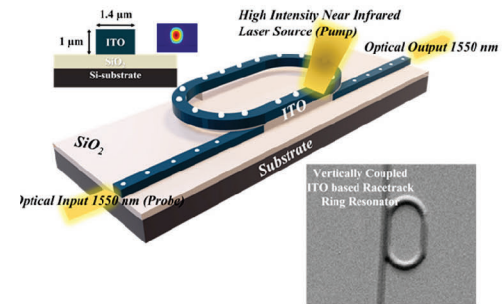
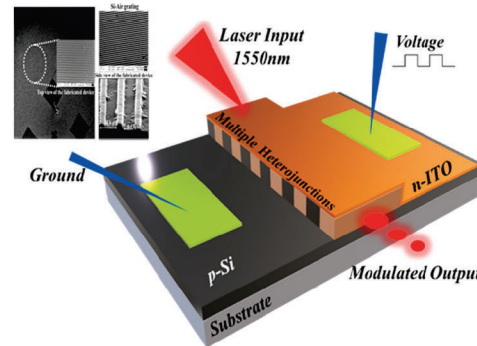
Semiconductor Heterojunction Technology for Chip-scale Photonic Devices

We are utilizing semiconductor heterojunctions for realizing chip-scale devices with a cost-effective fabrication approach. The technology is also helpful for building bio-chemical sensors.

The technology for semiconductor heterojunctions has been developed over the years for electrically and optically tunable photonic devices e.g. The epsilon near zero in ITO has been achieved with engineered processing of ITO and number of devices based on Si-ITO heterojunctions have been

developed. Proof-of-concept Devices have been developed.

The technology can be utilized to make sensing devices for early optical detection of (protein biomarkers causing) deadly diseases.



Patent: Published, Indian Patent Application No. 202321010734

Proposed Relevant Industries: Telecom Industry, Data Centres, Sensor Manufacturers

Inventor: Prof. Mukesh Kumar (mukesh.kr@iiti.ac.in), Department of Electrical Engineering and Centre for Advanced Electronics

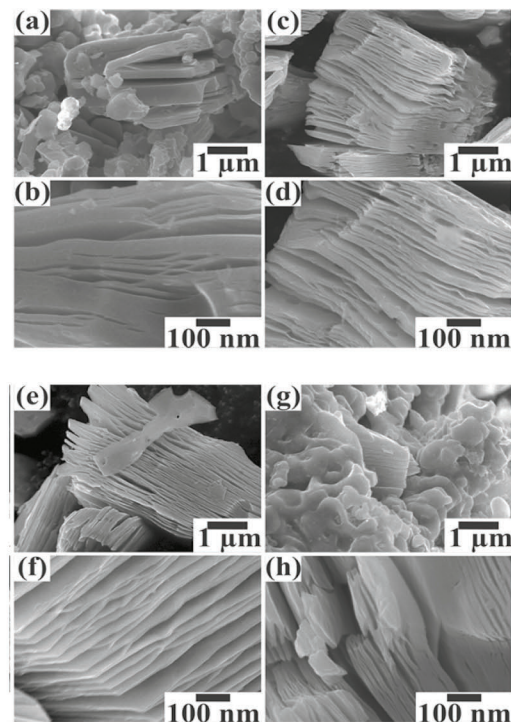
Mass Production of >99% Ti₃AlC₂ MAX Phase for High Quality 2D Layered MXene

Quality of MXene depends on the MAX phase purity, which eventually affects its property and applications. To obtain, high purity Ti₃AlC₂ MAX phase, high end vacuum technique are used which add extra cost to it. At present 10 gm MAX phase cost ~25,000 to 30,000/-.

The Cost and purity issues are addressed in our present invention by synthesizing the MAX phase at ambient air pressure. The >99% pure of MAX phase has produced 2D laminar Ti₃C₂ MXene sheets with a high interlayer spacing having accordion-like nanostructures morphology. Such, 2D laminar Ti₃C₂ MXene nanosheets possess high electrical conductivity and

mechanical stability rendering multifunctional applications in green hydrogen production, photovoltaics, electrochemical energy storage, photocatalysis, photothermal tumor ablation, etc. Furthermore, the present technique is industrially feasible to synthesize large yields in ambient. The current TRL of the technology is 4.

In this invention, Ti₃AlC₂ MAX phase has been synthesized at ambient pressure whereas in the high end vacuum technique, a significant amount of energy is consumed to maintain vacuum. Therefore, with the present invention, energy consumption can be reduced for the mass production of Ti₃AlC₂ MAX.



Patent: Filed, Indian Patent Application No. 202321043993

Proposed Relevant Industries: Semiconductor, Energy Storage and Conversion, Coating, Bio-related, etc.

Inventors: Ravindra Jangir, Ekta Choudhary, Prof. R. S. Devan (rupesh@iiti.ac.in), Department of MEMS,

Photoconductive Device for THz Emission and Detection with Metal-semiconductor and Metal-insulator-semiconductor Contact Electrodes

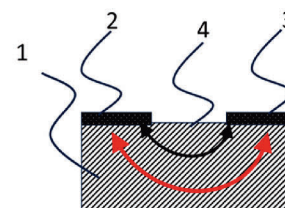
Terahertz is an emerging technology with a lot of potential applications in imaging, spectroscopy, telecommunication, etc. Photoconductive THz devices are one of the most popular techniques for THz generation and detection. However, their efficiency and fabrication and operational costs need to be improved to make this technology practically affordable.

Our new metal-insulator-semiconductor (MIS) design makes photoconductive THz devices electrically robust and efficient. It also simplifies the device fabrication process, and hence the cost, by reducing the number of lithography layers required from 4 to 3 layers only. I will also reduce

the operation cost of these devices by enabling low bandgap semiconductors like Ge to be used for device fab, making them compatible with cost efficient fibre lasers.

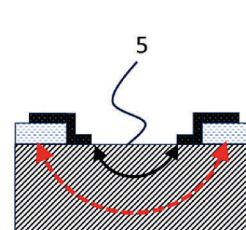
Simulation done, devices under fabrication and testing phase. A DPIIT recognized startup company THzInnovations Pvt Ltd has been incorporated and incubated at ACE IITI to commercialize the technology.

Our invention will boost the research and development work on THz devices and applications.

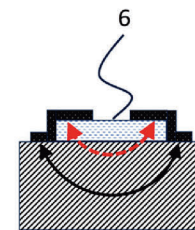


(a)

(a) Unnecessary current (red line) also flows in the device causing heating and breakdown.



(b)



(c)

(b&c) Unnecessary current paths are blocked (dotted red lines) in our new designs.

Patent: Filed, Indian Patent Application No. 202321062886

Proposed Relevant Industries: Semiconductors

Inventors: Dr. Abhishek Singh (asingh@iiti.ac.in) CAE, Prof. Mukesh Kumar (mukesh.kr@iiti.ac.in), Department of Electrical Engineering

Design and Development of High Temperature Setup For Temperature Dependent Energy Band Gap Measurements for Semiconductors

The knowledge of temperature dependent band gap for semiconductors is very important especially to determine the utility of such materials for high/low temperature and space applications.

The setup is completely design to work as ambient conditions i.e. without any vacuum station etc.

The developed setup has been used to measure the temperature dependent band gap in the range of 300K to 500 K

and the obtained data is published in various research publications.

The Government of India has launched national semiconductor mission, and the present technology will boost the Indian manufacturing industry to invest in the scientific instrumentation. Furthermore, the data obtained from such setup will be useful for semiconductor industry and will help the industry to choose the required semiconductors for a required temperature range etc.

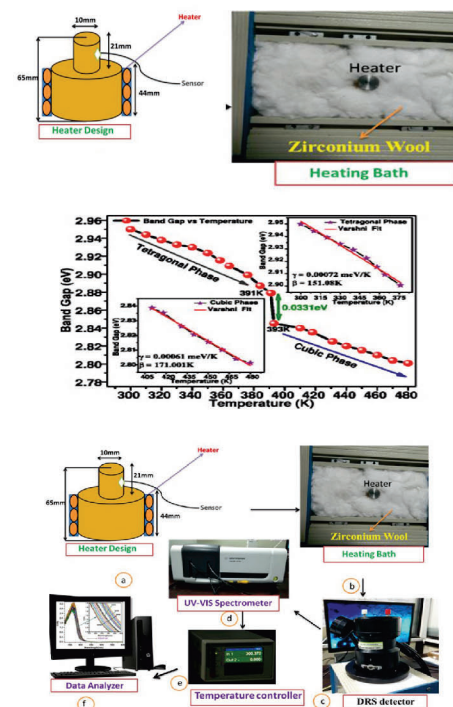


Image showing various parts, obtained data and its integration with UV-Visible spectrometer

Patent: Nil

Proposed Relevant Industries: Scientific Instrumentation and Semiconductor Industry.

Inventors: Prof. Pankaj R. Sagdeo (prs@iiti.ac.in), Department of Physics

Low Leakage-high Stability Differential Positive Feedback Controlled 10T (DPFC10T) SRAM Cell

Lower write-ability, low read/write static noise margin and high leakage power. (The designing of SRAM cell in the subthreshold regime has prominent need of ultra-low power embedded memories. SRAM design remains challenging and becomes more interesting due to the rapid advancement of CMOS technologies and with increased demand of on-chip memory in the wireless implantable and wearable biomedical sensors.

The invention namely the solution to the problem: Positive feedback controlled 10T SRAM cell for low leakage power with enhanced read-write stability. The write and read operation is controlled by write word line (WWL) and read word line (RWL) through access transistors M1-M2 and M9-

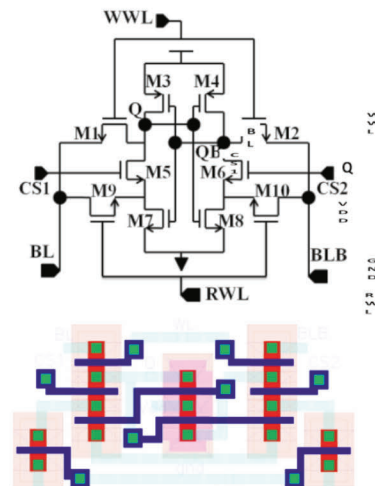
Patent: Granted, Indian Patent No. 370308

Proposed Relevant Industries: Industries Related with Semiconductor, FPGAs, Sophisticated Biomedical Instruments, Wireless Communication and Sensors

Inventor: Pooran Singh, Prof. Santosh Kumar Vishvakarma (skvishvakarma@iiti.ac.in), Department of Electrical Engineering

M10, respectively. The positive feedback controlling is advanced through two NMOS transistors M5 and M6. These two transistors are activated by control signals CS1 and CS2, which helps to improve the read-write speed, static noise margins and leakage power of the cell.

The proposed 10T SRAM cell with enhanced read-write stability and low leakage power offers significant societal impact by revolutionizing the performance and energy efficiency of battery-operated systems. In the realm of ultra-low voltage (ULV) operating devices, such as biomedical implants, the innovation ensures reliable data storage and retrieval with minimal power consumption, extending the lifespan and functionality of life-saving medical devices.



Proposed differential positive feedback controlled 10T (DPFC10T) SRAM cell (a) Schematic. (b) Layout

This advancement finds utility in portable electronic devices, fostering sustainability by reducing power demands and environmental impact. Ultimately, the proposed 10T SRAM cell addresses critical challenges in diverse sectors, promoting the development of more reliable, energy-efficient, and sustainable technologies with far-reaching societal benefits.

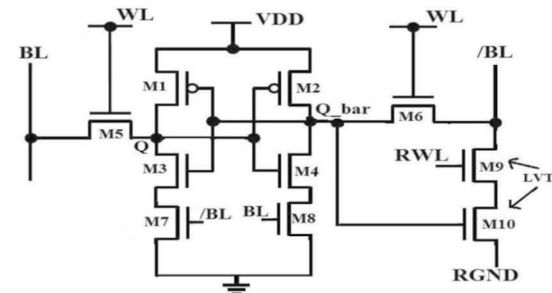
An Ultra Low Power, Read Decoupled-Differential Write, 10T SRAM Cell with Higher Read/Write Noise Margin

SRAM design has been challenging due to the continuous technology scaling, and therefore the stability of SRAM gets vulnerable by the unnecessary noise due to the process-voltage-technology variations. Apart from it, most of the times cache memories of the processor remains in standby mode, causing unwanted leakage power consumption during subthreshold operation, and it demands to suppress the power consumption of SRAM memory. Moreover, the SRAM density is getting worse with the technology scaling due to the decreasing I_{read}/I_{leak} which limits the number of cells that can be connected to a column of memory. Looking at these issues related to the memory designs, conventional memory designs are needed to be

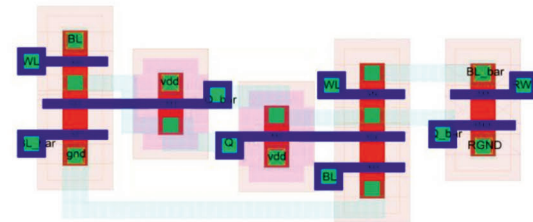
reconsidered so that they can successfully operate at ultra low voltage applications.

Low- V_{th} (LVT) devices in read path improve the read performance, while threshold voltage technique in read path along with the stacking affect in cross coupled inverter improves the power consumption and read/write stability.

The proposed 10T SRAM cell can successfully provide the considerable reduction in leakage power with improved read speed and better read/write stability for subthreshold regime of operation. Hence, it is capable to potentially be embedded with the ultra-low power battery operated applications such as wireless sensors, mobile and other hand held devices, biomedical implants, cache memories and other microcontroller based applications.



(a)



(b)

Proposed 10T SRAM cell (a) Schematic
(b) Layout

Patent: Granted, Indian Patent No. 358866

Proposed Relevant Industries: Consumer Electronics, Biomedical Applications, High Performance Computing etc.

Inventors: Vishal Sharma, Dr. Santosh Kumar Vishvakarma (skvishvakarma@iiti.ac.in), Department of Electrical Engineering

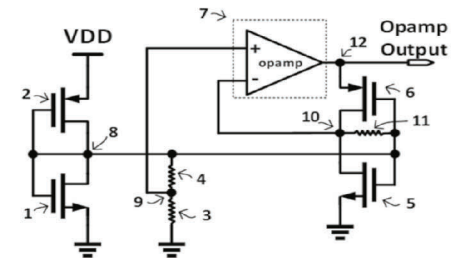
A Constant Transconductance Bias Device

A high-speed cleaner clock is required from frequency synthesizers and clock-data recovery circuits for wireline as well as wireless communication applications.

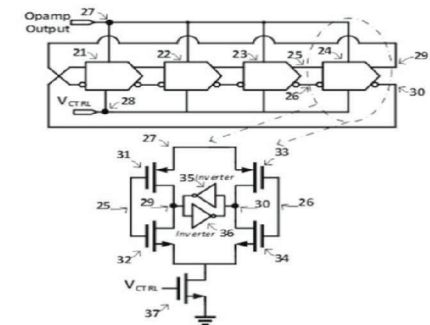
An objective of the present invention is to provide a constant transconductance bias device to reduce PVT variation in ring oscillators. The proposed constant gm device does not depend on the square-law characteristic of MOS and therefore much more reliable and robust for advanced CMOS technology nodes. The present invention relates to a constant transconductance bias device to reduce PVT variation in ring oscillators. This invention presents a negative feedback system to mitigate the PVT variations in Ring Oscillator (RO). The proposed device is to adjust the supply voltage of the inverter

such that the negative feedback will compensate for the changes at the supply node of the RO. A constant transconductance (g_m) technique has been adopted to control the supply node of the RO across PVT.

The proposed constant gm device provides an on-chip solution to control VCO frequency over PVT variations. The proposed invention consists of three major parts, one reference voltage generator, one negative feedback using Op-Amp, and a VCO. A negative feedback loop consisting of Op-Amp tracks transconductance of replica circuit and generates biasing for ring oscillator. This supply independent biasing of the ring oscillator tries to keep the oscillation frequency in contact across PVT.



The reference biasing generator circuit consisting of a self-biased inverter forming servo loop with transistor M1-M2.



The architecture of the used VCO used in constant gm device.

Patent: Published, Indian Patent Application No. 202321073981

Proposed Relevant Industries: Analog Devices

Inventors: Kumar Ravi, Nagulapalli Rajasekhar, Prof. Santosh Kumar Vishvakarma (skvishvakarma@iiti.ac.in), Department of Electrical Engineering

Power on Initialization of SRAM Cell for FPGA

Memory is one of the important blocks of any electronic device. 6T SRAM is one of the standard memory cells used in industries due to its high speed, stability, volatile behavior, reliability, compatibility with CMOS technology and high-density capacity. During startup or reset, SRAM memory cells may need to be configured to a certain state, such as Zero State. For some applications, like testing, the initialization step is essential. A reset circuit is used to accomplish the reset, which consumes huge power on startup. On a single integrated circuit chip, there may be millions or billions of memory cells that need to be initialized. For high-volume devices, this initialization

Patent: Under Progress

Proposed Relevant Industries: Advanced Micro Devices

Inventors: Narendra Singh Dhakad, Govindu Sathvik Reddy, Radheshyam Sharma, Prof. Santosh Kumar Vishvakarma (skvishvakarma@iiti.ac.in), Department of Electrical Engineering

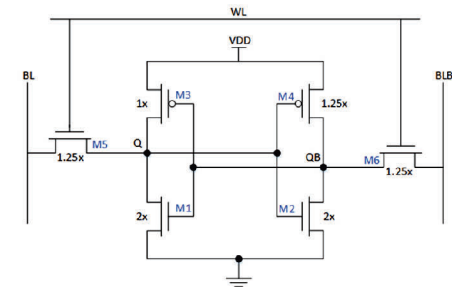
process requires testing time, which can be rather expensive.

An Automatic power on initialization mechanism for SRAM memory cell is proposed, where the sizing of one PMOS transistor is increased to force the storing node to the initial condition. This improves energy efficiency, reduced delay and circuitry for initialization of memory.

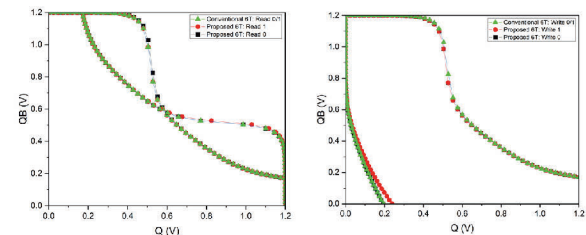
Design functionality has been validated on simulation level.

Societal Impact: It has great potential to be applied in low-power electronics applications such as; portable electronic devices, field programmable gate arrays (FPGAs), and sophisticated medical instrumentations.

Image of the Technology with illustrations



Proposed asymmetric 6T SRAM design for self reset on power up.



Static noise margin (SNM) comparison of proposed asymmetric SRAM cell with standard SRAM cell at 1.2V supply

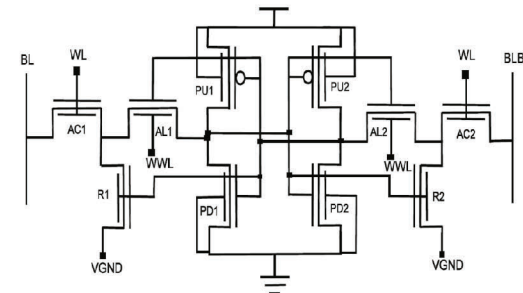
Read Recharge (RRC) Based Process Variation Tolerant 1T1R1P SRAM cell

Stable and ultra-low power on-chip SRAM is now mandatory to achieve higher reliability and longer battery life for portable applications that comprise Modern SOC's. The designing of SRAM in the sub-threshold regime has elevated the need for process variation tolerance and high-performance embedded memories, mainly SRAMs. The benefit of device operation in a sub-threshold regime is that it provides a minimum energy point with a loss in speed by three orders of magnitude and leads to higher current sensitivity toward the process variations

The major advantage of the proposed SRAM cell is improved stability and read performance. The unique SRAM cell topology using investigated read recharge

circuit (RRC) techniques refreshes the storing node in every read cycle. Hence, the novel feature of the proposed SRAM cell is its topology by adding two N-type FinFET transistors with the access path of the SRAM cell. It removes read failure using extra added N-type FinFETs. Applications of the proposed RRC 1T1R1P SRAM cell can potentially be in low voltage and medium frequency operations like Biomedical Implants, Wireless Sensing, etc.

The proposed SRAM will significantly improve the life of these electronic systems. Modern portable systems are designed only for a 3-year life; hence, these trends can be changed by the proposed technology.



Read recharge based proposed RRC 1T1R1P SRAM cell with read write current paths

Patent: Granted, Indian Patent No. 413266

Proposed Relevant Industries: Semi Conductors, Chip Design

Inventors: Nandakishor Yadav, Prof. Santosh Kumar Vishvakarma (skvishvakarma@iiti.ac.in), Department of Electrical Engineering

P-N Tuned Differential 8T Static Random Access Memory (SRAM) Cell

The designing of SRAM in the sub-threshold regime has elevated the need of ultra-low power embedded memories mainly SRAMs. The benefit of MOSFET operation in sub-threshold regime provides minimum energy point with the loss in speed by at least three orders of magnitude and leads to higher current sensitivity towards the process variations. In sub threshold regime, the hold stability, write-ability and read disturb in of SRAM bit-cell are severe problems and worsen with the scaling of MOSFET to sub-nanometer technology, thereby augmenting the failure rate of memory operations.

The HSNM are similar for both (8T and 6T) cells. The strong connection of bit-line to Q/QB makes 6T more prone to read disturb. The 8T has cut the feedback and therefore

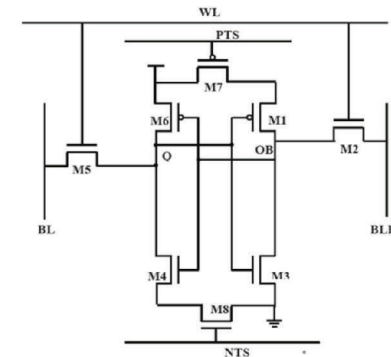
bit-line has very less disturbance on Q/QB. The read margin is 560mV for 8T while 6T flip the stored data during read operation and causes read failure. The P and N tuning reduces the fight between access and pull-up/pull-down transistor, the WTP is lower (240mV) for 8T and 6T has WTP at 270mV.

The SRAM cells improved efficiency contributes to faster data access and manipulation, boosting overall computing device performance. Its energy-efficient design aligns with sustainability goals, potentially extending battery life in portable devices. In the realms of artificial intelligence and machine learning, the SRAM cell accelerates algorithms, fostering advancements in image recognition, natural language processing, and various AI applications.

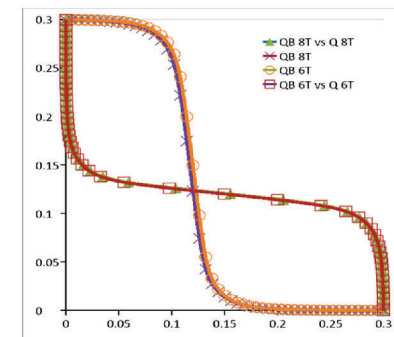
Patent: Granted, Indian Patent No. 406860

Proposed Relevant Industries: Semiconductors Chip Design

Inventors: Chandrabhan Kushwah, Prof. Santosh Kumar Vishvakarma (skvishvakarma@iiti.ac.in), Department of Electrical Engineering



Proposed 8T SRAM Cell



High-Performance Double Gate Tunnel Field Effect Transistor For Low Power Applications

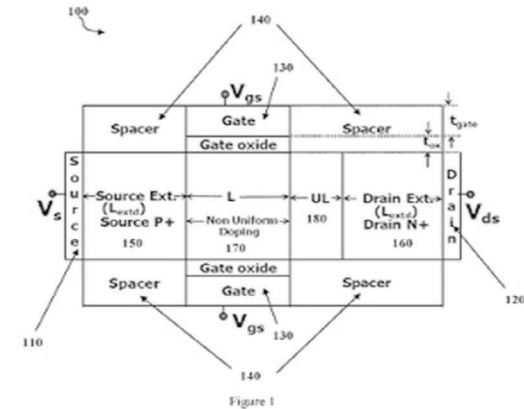
The developed technology provides a lateral asymmetric channel (LAC) doping profile for tunnel field effect transistor to improve analog /RF performance compared to uniform doping (UD) profile.

It is observed from the investigation and comparison results of simulations that the performance of DG-TFET is improved with the lateral asymmetric channel (LAC) doping profile and with underlap (UL) feature. Further, the underlap (UL) feature mitigates the ambipolar behaviour of DG-FET. The

improvement of performance is mainly observed in terms of on-state current (I_{on}), sub-threshold swing (SS) and reduction of gate-drain capacitance resulting to

improvement in cut-off frequency (f_t). This substantial improvement makes DG- TFET, a high performance device suitable for low power system-on-chip (SoC) design and applications such as biomedical implants, mobile multimedia gadgets, neuro signal processors.

The tunnel field effect transistor has a potential to reduce leakage current and to provide subthreshold swing lower than 60 mV/dec. The tunnel field effect transistor gives better performance for supply voltages below 0.5 V because of steep subthreshold swing. Hence, the tunnel field effect transistor (TFET) is more suitable for low power system on chip (SoC) designs containing digital, analog and RF circuit blocks. The present disclosure provides a



lateral asymmetric channel (LAC) doping profile for a double gate tunnel field effect transistor to improve analog / RF performance compared to the uniform doping (UD) profile. In the lateral asymmetric channel (LAC) doping profile, the channel region of tunnel field effect transistor is doped asymmetrically such that the doping concentration at the source side is higher than drain side.

Patent: Granted, Indian Patent No. 388463

Proposed Relevant Industries: Biomedical Implants, Mobile Multimedia Gadgets, Neuro Signal Processors

Inventors: Vikas Vijayvargiya , Prof. Santosh Kumar Vishvakarma (skvishvakarma@iiti.ac.in), Department of Electrical Engineering

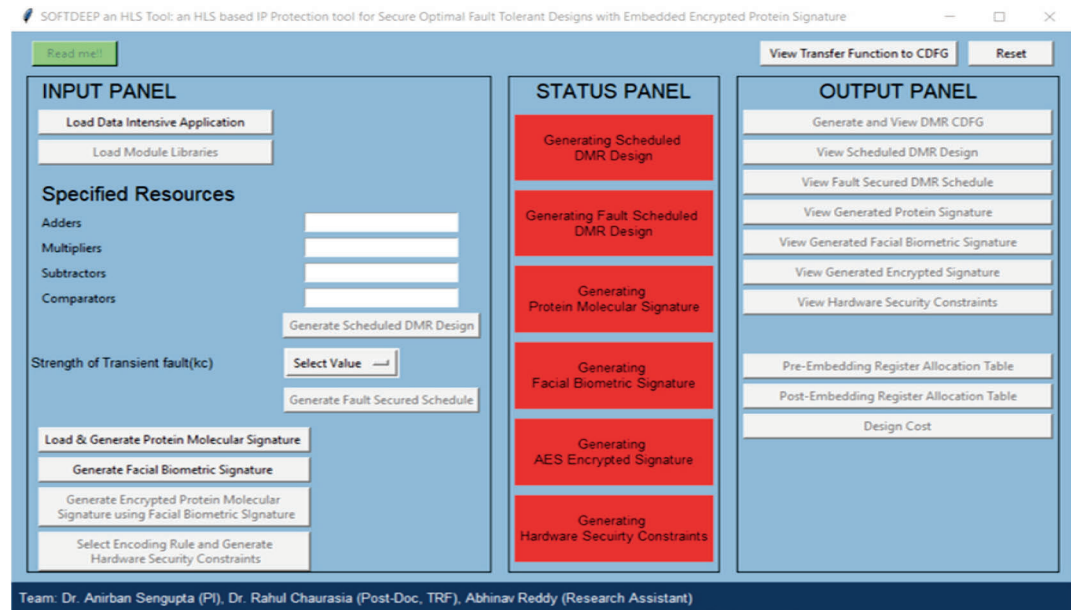
SOFTDEEP: An HLS Based IP Protection Tool for Secure Optimal Fault Tolerant Designs with Embedded Encrypted Protein Signature

Prof. Anirban Sengupta and his team have developed a Molecular biometric based hardware security tool to simulate and analyse the design space exploration method producing secure design solutions for data intensive application frameworks with ability of k-cycle transient fault detection and/or error correction and detective control against piracy and false claim of ownership threats and generation of an optimal k-cycle transient fault detectable and /or fault correctable datapath processors with embedded protein biometric signature sample of an intellectual property (IP) vendor during high-level synthesis of integrated circuits (ICs).

Patent: Nil

Proposed Relevant Industries: VLSI, Hardware Security

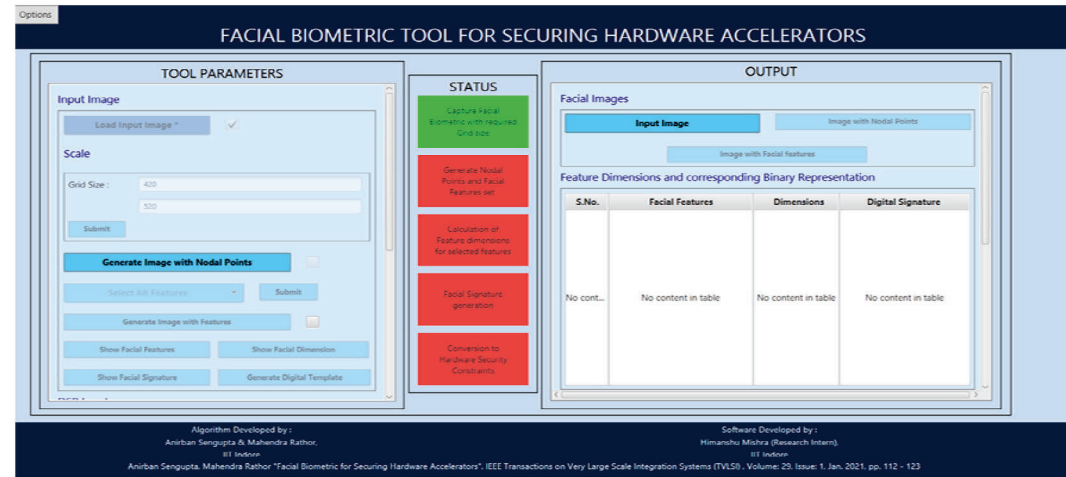
Inventors: Rahul Chaurasia, Prof. Anirban Sengupta (asengupta@iiti.ac.in),
Department of Computer Science and Engineering



Faciometric Hardware Security Tool

The Faciometric hardware security tool has been developed to simulate and analyze the functionality of facial biometric based approach for securing DSP hardware accelerators against piracy and false claim of ownership threats.

The left portion of the tool shows the panel for providing required inputs to the tool, right portion shows the panel with output buttons to see the intermediate and final outputs of the facial biometric based hardware security approach. The panel in the middle shows the status of the intermediate steps (i.e. capture facial biometric with required grid size, generate nodal points and facial features set, calculation of feature dimensions for selected features, facial signature



generation and conversion to hardware security constraints) in generating hardware security constraints from a captured/input facial image. The Faciometric hardware security tool accepts the DSP application input in the form CDFG along with the resource constraints. Further, it also shows scheduling and registers allocation pre and post embedding facial signature constraints, onto the output window. The embedded facial signature in the hardware accelerator design can be used as a unique digital evidence to secure against piracy and false claim of ownership threats

Patent: Nil

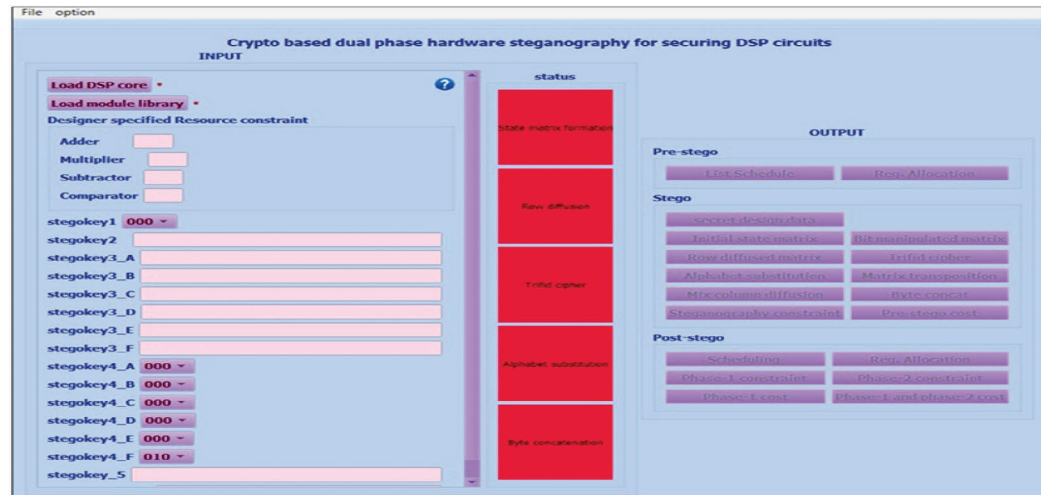
Proposed Relevant Industries: VLSI, Hardware Security

Inventors: Mahendra Rathor, Prof. Anirban Sengupta (asengupta@iiti.ac.in),
Department of Computer Science and Engineering

Crypto-Steganography Tool

Crypto-Stego tool simulates and analyses the functionality of crypto-based steganography approach for securing DSP hardware accelerators against piracy and false claim of ownership threats.

Objective of the tool: The left portion of the tool shows the panel for providing required inputs to the tool, right portion shows the panel with output buttons to see the intermediate and final outputs of the crypto-based steganography approach. The panel in the middle shows the status of the key-driven steps (i.e. state matrix formation, row diffusion, Trifid cipher, alphabet substitution and byte concatenation) of the crypto-based steganography approach. Initially, these status bars remain Red. Upon applying the stego-key, the respective status bar turns Blue. The Crypto-Stego tool accepts the DSP



application input in the form CDFG along with module library and resource constraints. The tool shows all the intermediate steps of crypto-based steganography and the finally generated stego-constraints at the output. Further, it also shows scheduling and registers allocation pre and post embedded steganography constraints, onto the output window. The embedded steganography constraints in the hardware accelerator design can be used as digital evidence to secure against piracy and false claim of ownership threats.

Patent: Nil

Proposed Relevant Industries: VLSI, Hardware Security

Inventors: Mahendra Rathor, Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

KHC-Stego Tool: Key-Triggered Hash-Chaining Driven Steganography Tool

KHC-Stego tool simulates and analyses the functionality of key-triggered hash-chaining driven steganography approach for securing DSP hardware accelerators against piracy and false claim of ownership threats.

Objective of the tool: The left portion of the tool shows the panel for providing required inputs to the tool, right portion shows the panel with output buttons to see the intermediate and final outputs of the key-triggered hash-chaining based steganography approach. The panel in the middle shows the status of the intermediate steps viz. CDFG scheduling of DSP application, encoding selection, executing hash-chaining process and insert constraints. Initially, these status bars remain red. Upon applying the inputs, the respective status bar turns green. The KHC-



Stego tool accepts the DSP application input in the form CDFG along with module library and resource constraints. The tool shows output of intermediate steps of key-triggered hash-chaining based steganography, finally generated stego-constraints, the security metric in terms of probability of coincidence, pre and post-steganography design cost. The embedded steganography constraints in the hardware accelerator design can be used as digital evidence to secure against piracy and false claim of ownership threats

Patent: Nil

Proposed Relevant Industries: VLSI, Hardware Security

Inventors: Mahendra Rathor, Prof. Anirban Sengupta (asengupt@iiti.ac.in), Department of Computer Science and Engineering

KSO-PW tool -: Key-driven Structural Obfuscation and Physical Level Watermarking

Prof. Sengupta and his team have developed a KSO-PW tool to simulate and analyse the functionality of Key-driven structural obfuscation and physical level watermarking approach for securing DSP hardware accelerators against reverse engineering, piracy and false claim of ownership threats. The left portion of the tool shows the panel for providing required inputs to the tool, right portion shows the panel with output buttons to see the intermediate and final outputs of the structural obfuscation and physical level watermarking based double line of defence approach. The panel in the middle shows the buttons for entering secret SO-keys (for multiple structural transformation techniques viz. loop unrolling, partitioning, ROE, THT and folding-knob) and vendor's signature for watermarking. Since ROE is not applicable for FIR application, therefore

Patent: Nil

Proposed Relevant Industries: VLSI, Hardware Security

Inventors: Mahendra Rathor, Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

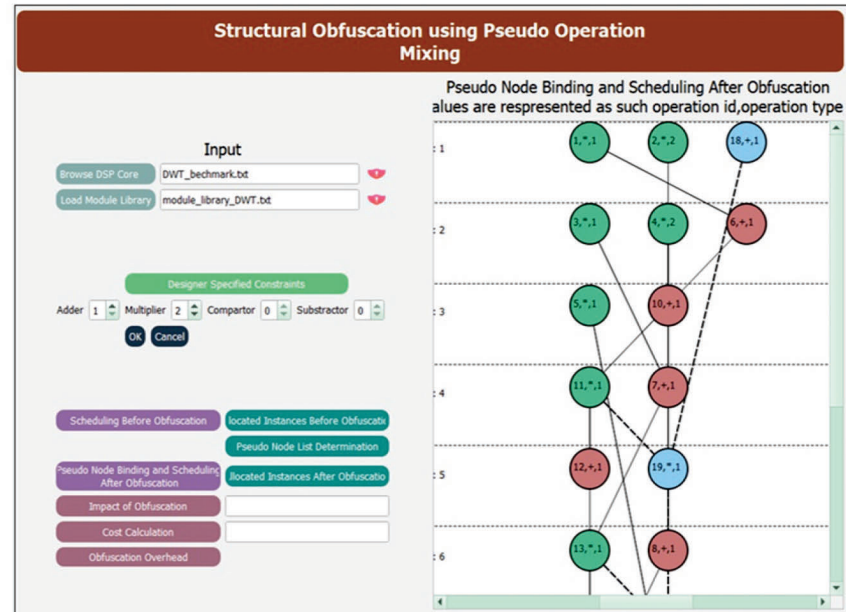
Key Based Multiphase Structural Obfuscation with Physical Level Watermarking

Primary Inputs	Key Inputs	Output
Upload your DSP application file Upload File... ☒ FIR_loop.txt X	Enter Key value for Partitioning 5 Enter	Column 1 : x4 -> 7,8 Column 2 : x4 -> 9,10 Column 3 : x4 -> 11,12 Column 4 : x4 -> 13,14
Upload your Unroll DSP file Upload File... ☒ FIR_loopunroll.txt X	Enter Key value for THT 5 Enter	Block : 8 Column 1 : A -> 1,2,3 Column 2 : d2 -> 1,2,3,4,5 Column 3 : x2 -> 1,2,3,4,5,6,7,8 Column 4 : x2 -> 9,10
Upload your Library file Upload File... ☒ ResourceAreaAndLa... X	Enter Key value for Folding 4 Enter	View Final Floor Plan
Upload your Baseline Constraints file Upload File... ☒ IIR_Constraints_Base... X	Enter Signature αβββγγ Enter	> Watermark Metrics > Final Cost Total runtime = 22249ms
Upload your Constraints file Upload File... ☒ FIR_Constraints.txt X	α β γ CLR	
Done Select New Key		

the button for entering the ROE key input remains invisible. It is noteworthy in the GUI of KSO-PW tool that for a DSP application, only those secret key-buttons are activated for which the corresponding structural transformation techniques are applicable. The KSO-PW tool accepts the DSP application input in the form CDFG along with module library file and resource constraints file. The tool shows outputs of all intermediate steps of structural obfuscation and watermarking approach and finally generated watermarked floorplan of the obfuscated design. Further it also shows design cost before performing structural obfuscation and watermarking (i.e. baseline design cost), design cost after intermediate steps and the final design cost.

POM-SO tool -: Pseudo Operation Mixing Based Structural Obfuscation Tool

Prof. Sengupta and his team have developed a POM-SO tool (pseudo operation mixing based structural obfuscation tool) to simulate and analyse the pseudo operation mixing based obfuscation approach for securing DSP hardware accelerators against reverse engineering (and Trojan insertion). Objective of the tool: The left portion of the tool shows the panel for providing required inputs to the tool and right portion shows the panel to see the intermediate and final outputs of the pseudo operation mixing based structural obfuscation approach. The POM-SO tool accepts the DSP application input in the form CDFG along with module library and resource constraints. The tool shows intermediate steps of pseudo operation mixing and finally generated structurally transformed scheduled and resource allocated DFG at the output. This output can be used to generate a structurally obfuscated RTL design of a DSP application which is unobvious to an attacker and can hinder reverse engineering.



Patent: Nil

Proposed Relevant Industries: VLSI, Hardware Security

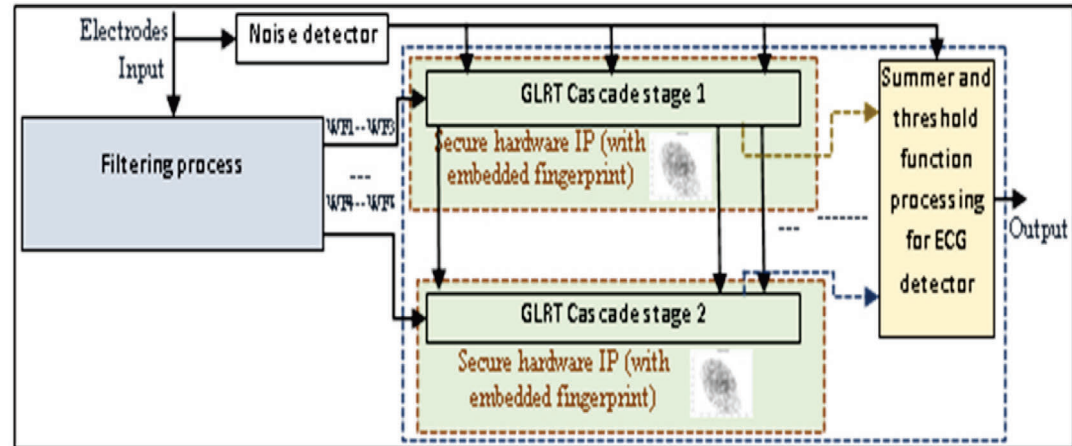
Inventors: Mahendra Rathor, Prof. Anirban Sengupta (asengupt@iiti.ac.in), Department of Computer Science and Engineering

Secure Hardware of GLRT Cascade Using Color Interval Graph Based Embedded Fingerprint for ECG Detector

(a) Presents the design methodology of generalized likelihood ratio test (GLRT) hardware intellectual property (IP) core for ECG detector.

(b) Presents a secure GLRT hardware IP core for ECG detector using fingerprint biometric-based hardware security methodology during High Level Synthesis.

(c) Presents Color Interval Graph (CIG) framework and register transfer level (RTL) datapath of a secure GLRT hardware micro IP core and secure GLRT hardware cascade IP core.



Patent: Filed, Indian Patent Application No. 202321037433

Proposed Relevant Industries: Healthcare, Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupt@iiti.ac.in), Department of Computer Science and Engineering

A Hardware Security Method to Design Secure Hardware Accelerators for Cardiac Pacemaker

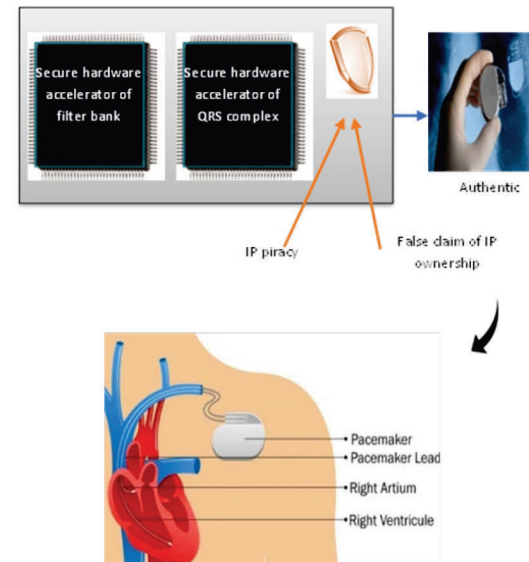
A novel hardware accelerator for filter bank and QRS complex detector for implantable cardiac pacemaker.

A novel secure design flow with AES-256 for generating secure version of hardware accelerators for implantable cardiac pacemaker against IP piracy. This ensures robust security by enabling detection and isolation of pirated unsecured hardware accelerators before integration into implantable pacemakers, which otherwise may lead to fatal consequences for the patients.

The proposed invention presents novel secure high level synthesis

methodology that is capable to generate secure RTL datapath design for filter bank and QRS complex for implantable cardiac pacemaker.

The secure hardware accelerator design generated using proposed approach ensures higher robustness in terms of lower probability of coincidence (proof of ownership) and tamper tolerance (strong digital evidence) compared to proposed secure hardware accelerator design integrated with steganography, watermarking, digital signature and automatic signature insertion.



Patent: Filed, Indian Patent Application No. 202321036317

Proposed Relevant Industries: Healthcare, Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in),

Department of Computer Science and Engineering

Offset Compensated Data Sensing Technique For Low Energy Embedded SRAM

Continuous downscaling of the technology has led to an increased integration density and improved device performance however, it has also led to increased process variations including, random dopant fluctuation (RDF) and line edge roughness (LER). This has become serious issues for SAs offset and resulted in a significant loss in the memory ready yield.

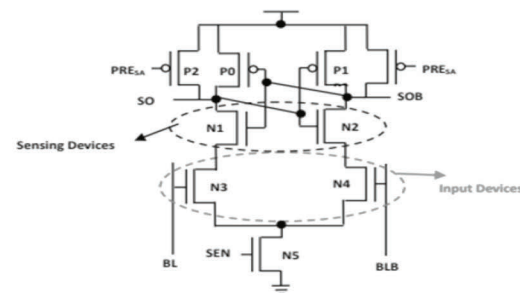
The proposed solution addresses the issue of variability-induced data sensing failure in embedded SRAM, which has become a significant problem due to increased process variations resulting from continuous downscaling of technology. The document presents an innovative Differential Current Compensated Sense Amplifier (DCC-SA) as a solution to

minimize the impact of offset voltage on SRAM power consumption and read latency. The DCC-SA dynamically adjusts the overdrive potential of the sensing devices to compensate for branch current mismatch due to threshold voltage offset, resulting in reduced bit-error-rate, lower energy consumption, and improved input-referred offset. This unique approach offers advantages over existing methods, such as increased offset tolerance and reduced power-delay product, making it suitable for low-energy SRAM applications in low-power processors designed for IoT applications. Additionally, the proposed solution demonstrates robustness against inter-die and intra-die variation through Monte Carlo simulations, further highlighting its uniqueness and effectiveness in addressing the challenges

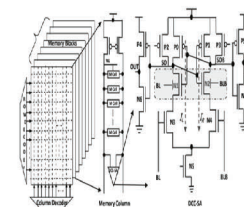
Patent: Granted, Indian Patent No. 394437

Proposed Relevant Industries: Semiconductors

Inventors: Dr. Bhupendra Singh Reniwal , Dr. Santosh Kumar Vishvakarma (skvishvakarma@iiti.ac.in) , Department of Electrical Engineering



Prior art, Conventional Current Latch Sense Amplifier



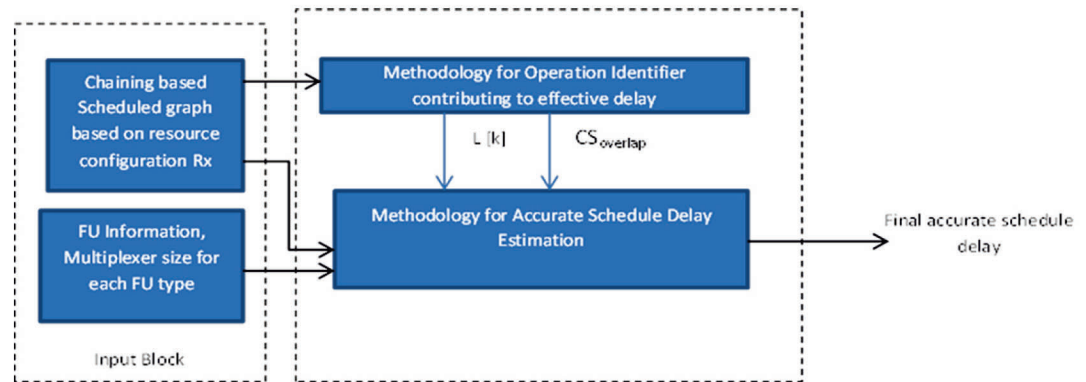
Proposed Differential Current Compensated Sense Amplifier

associated with embedded SRAM design.

This innovative sense amplifier design addresses the critical challenge of variability-induced failures in embedded SRAMs, which are essential in modern SoCs for applications like IoT and medical devices.

Improved Schedule Delay Estimation Process for Datapath During High Level Synthesis of Application Specific Processors

An improved schedule execution delay estimation process during high level synthesis of application specific processors is disclosed. In one implementation, a novel improved execution delay estimation methodology during scheduling in high level synthesis (HLS) for application specific processors is disclosed. Execution delay estimation from a schedule during HLS is normally determined by considering the delay of only the functional units in each control step. However, this estimated delay value from the schedule may not be a true indicator of the delay consumed by its equivalent datapath circuit. The



present invention accurately estimates the schedule delay than existing techniques. Ability to accurately estimate schedule delay helps in avoiding timing violation during design of application specific processors. Inaccurate delay estimation misguides

the designer during design space exploration in HLS with a solution that seems to apparently meet delay constraint, however in reality, the solution comprises of violation in timing constraint.

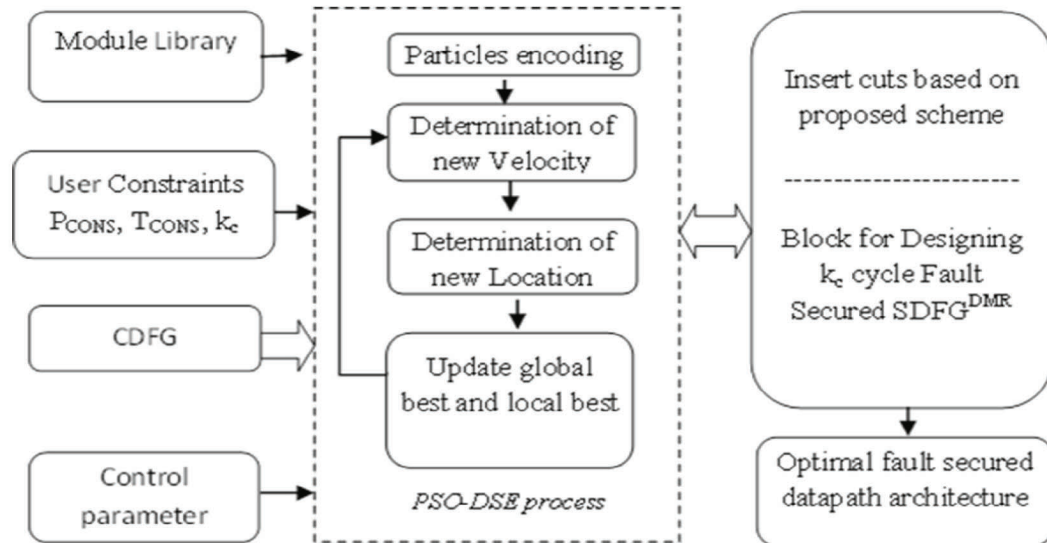
Patent: Granted, Indian Patent No. 458850

Proposed Relevant Industries: Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

Design Space Exploration of Optimal KC-Cycle Transient Fault Secured Datapath System with Intelligent Cut Insertion

In one implementation, a mechanism for generating a user-friendly, economical, adaptable and simplified system for exploring/designing a kc cycle transient fault secured datapath circuit for transient single and multi-cycle faults based on user power/area and delay budget with module that intelligently/aply applies cut insertion for delay reduction during high level synthesis, is disclosed. For achieving the same an apparatus is configured to design a kc cycle transient fault secured dual/double modular redundancy (DMR) system, for generating at least one scheduled data flow graph (SDFG) DMR systems, and thereby optimizing an operating expense (at least time



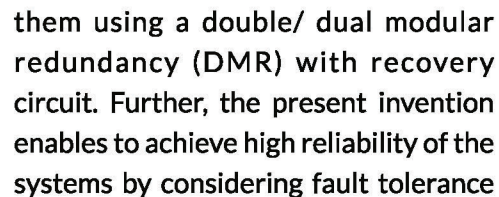
and/or resource) of the DMR system obtained based on user power- delay constraints, the apparatus comprising a receiving module, a SDFG generation module, and a hardware allocation module.

Patent: Granted, Indian Patent No. 432435

Proposed Relevant Industries: Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

The present invention discloses a system (apparatus) and method for design space exploration of an optimal single or multi cycle (k-cycle) transient fault detectable and /or error correctable data path which indicates design space exploration method producing design solutions with ability of k-cycle transient fault detection and/or error correction and generation of an optimal k-cycle transient fault detectable and /or fault correctable datapath that minimizes user specified power and delay (or performance) constraint, by detecting transient faults using a double/ dual modular redundancy (DMR)and/or correcting



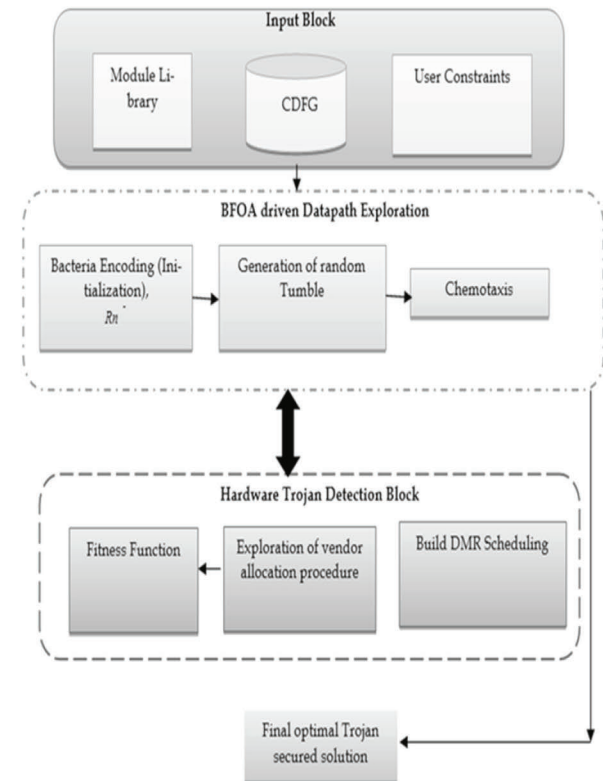
(detectability and/or correctability) as design metric (or constraint) besides power and execution delay during multi-objective design space exploration (DSE) in high level synthesis (HLS).

Inventor: Prof. Anirban Sengupta (asengupt@iiti.ac.in), Department of Computer Science and Engineering

Design Space Exploration of an Optimized Hardware Trojan Detectable/Secured Datapath During High Level Synthesis

An evolutionary algorithm (EA) driven novel design space exploration (DSE) of an optimized hardware Trojan secured datapath based on user power-delay constraint during high level synthesis (HLS) is presented. The present invention provides DSE for hardware Trojan detection includes a problem encoding technique that enables exploration of efficient distinct vendor allocation as well as enables exploration

of an optimized Trojan secured datapath structure. The exploration backbone for the present invention is bacterial foraging optimization algorithm (BFOA) which is known for its adaptive feature (tumbling/swimming) and simplified model. Results of comparison with recent approach indicated an average improvement in quality of results (QoR) of > 14.1%



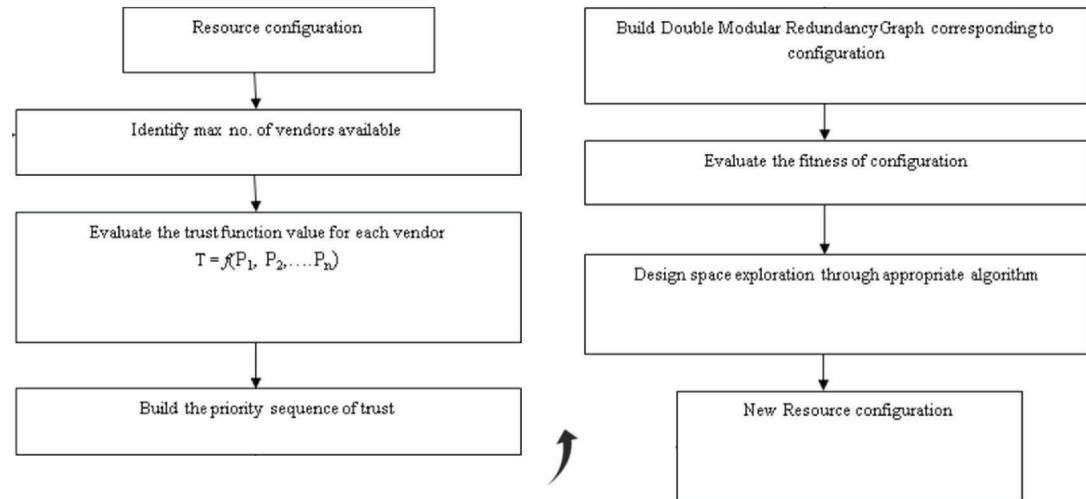
Patent: Granted, Indian Patent No. 430067

Proposed Relevant Industries: Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

Method and System for Automatic Fault Recovery and True Output Extraction During High Level Synthesis

Systems and method for transient fault isolation, hardware Trojan fault detection/isolation and true output extraction during high level synthesis of at least one other system are disclosed. The present invention discloses an efficient and cost effective equivalent circuit system with Double Modular Redundancy (DMR) scheme to isolate a correct output. In one implementation, the present invention provides a system comprising at least one comparator means, at least one OR-ing means, and at least one multiplexer means.



Patent: Granted, Indian Patent No. 484338

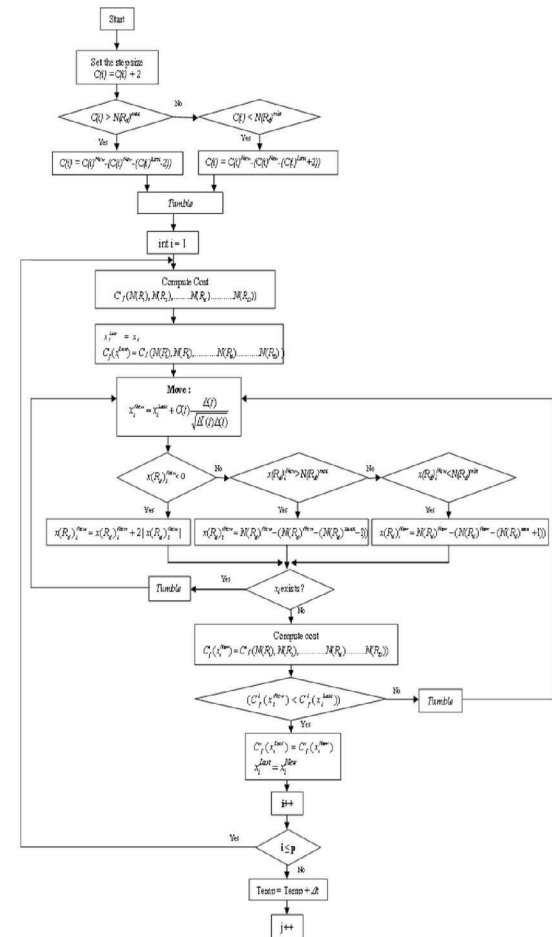
Proposed Relevant Industries: Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

Design Space Exploration System and Method There of Using A Bacterial Foraging Optimization Mechanism

An apparatus and method for automatically exploring a design space of an untimed CDFG during HLS, using a bacterial foraging optimization (BFO) mechanism, for designing or obtaining an application-specific processor (ASP) or Hardware Accelerator or Intellectual Property Core is disclosed. The apparatus comprises of one or more processing unit(s) configured to: initialize bacterium position corresponding to resource configuration, wherein said bacterium are uniformly distributed over said

design space; perform a chemotactic movement of said bacterium, by means of a specialized chemotaxis mechanism of said BFO, to enable change in position of bacterium from original or past position to new or present position; and disperse said new or present position, by means of a specialized dispersal mechanism of said BFO, to explore automatically said design space based on new or present position, if found optimal, obtain said ASP or Hardware Accelerator or Intellectual Property Core.



Patent: Granted, Indian Patent No. 366323

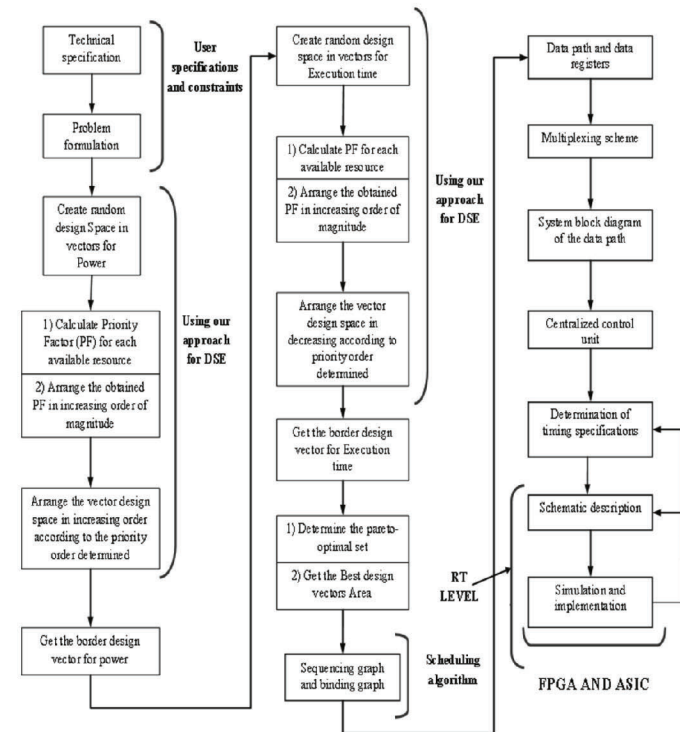
Proposed Relevant Industries: Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

System and Methodology for Development of a System Architecture Using Optimization Parameters

Described embodiments relate to methods, systems and computer readable medium for developing a system architecture. Resources constraints are defined, where each resource constraint corresponds to a maximum number of a each kind of resources available to construct the system architecture. Constraint values for each of at least three optimization parameters are defined, which includes a final optimization parameter. A design space is defined as a plurality of vectors representing different combinations of a number of each kind of resource available to construct the system architecture.

For each of the plurality of optimization parameters, a priority factor function is defined. A plurality of satisfying sets of vectors is determined for each of the optimization parameters except for the final optimization parameter. A set of vectors is determined based on an intersection of the plurality of satisfying sets of vectors for the optimization parameters. A vector is selected from the set of vectors based on the ordered list of vectors and the final optimization parameter, where the selected vector is for use in developing the system architecture.



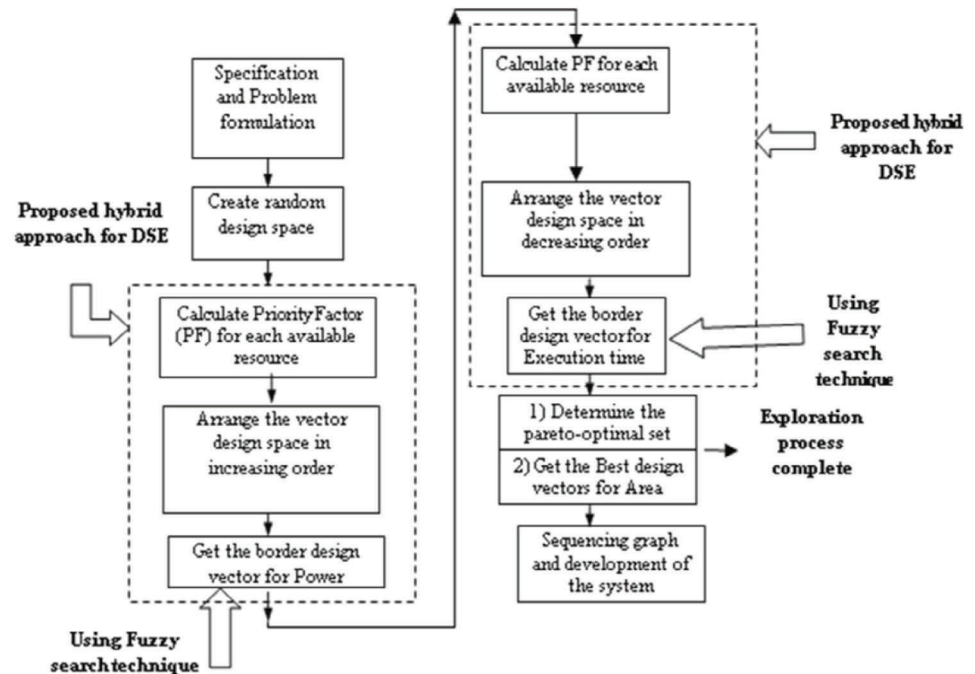
Patent: Granted, USA Patent No. 8,397,204

Proposed Relevant Industries: Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

System and Method For Development of System Architecture

Methods, systems, and computer readable medium for developing a system architecture that involves defining resource constraints for kinds of resources and constraint values for optimization parameters, and defining a design space as variants, where each variant is a vector. Satisfying sets of variants are determined for optimization parameters by assigning membership values to each variant of a universe of discourse set and performing a fuzzy search of a universe of discourse set using the corresponding membership values. A set of variants is determined based on an intersection of the satisfying sets of variants. An ordered list of variants is generated by sorting the set of variants and a variant is selected based on a position of the variant in the ordered list for use in developing the system architecture.



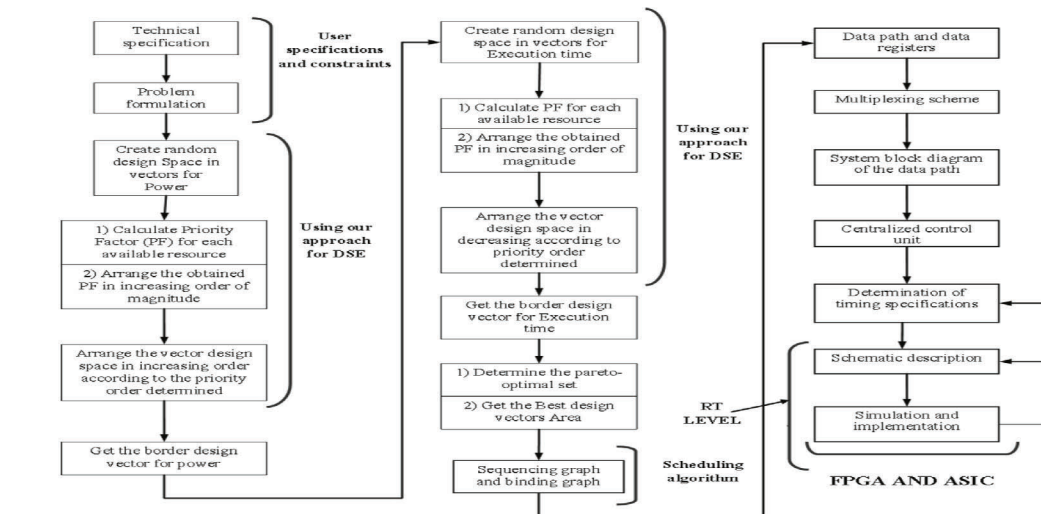
Patent: Granted, USA Patent No. 8,826,199 B2

Proposed Relevant Industries: Chip Design, Hardware Security, Defense

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

System and Methodology For Development of A System Architecture Using Optimization Parameters

Described embodiments relate to methods, systems and computer readable medium for developing a system architecture. Resources constraints are defined, where each resource constraint corresponds to a maximum number of a each kind of resources available to construct the system architecture. Constraint values for each of at least three optimization parameters are defined, which includes a final optimization parameter. A design space is defined as a plurality of vectors representing different combinations of a number of each kind of resource available to construct the system architecture. For each of the plurality of optimization parameters, a priority factor function is defined. A plurality of satisfying sets of vectors is determined for each of the



optimization parameters except for the final optimization parameter. A set of vectors is determined based on an intersection of the plurality of satisfying sets of vectors for the optimization parameters. A vector is selected from the set of vectors based on the ordered list of vectors and the final optimization parameter, where the selected vector is for use in developing the system architecture.

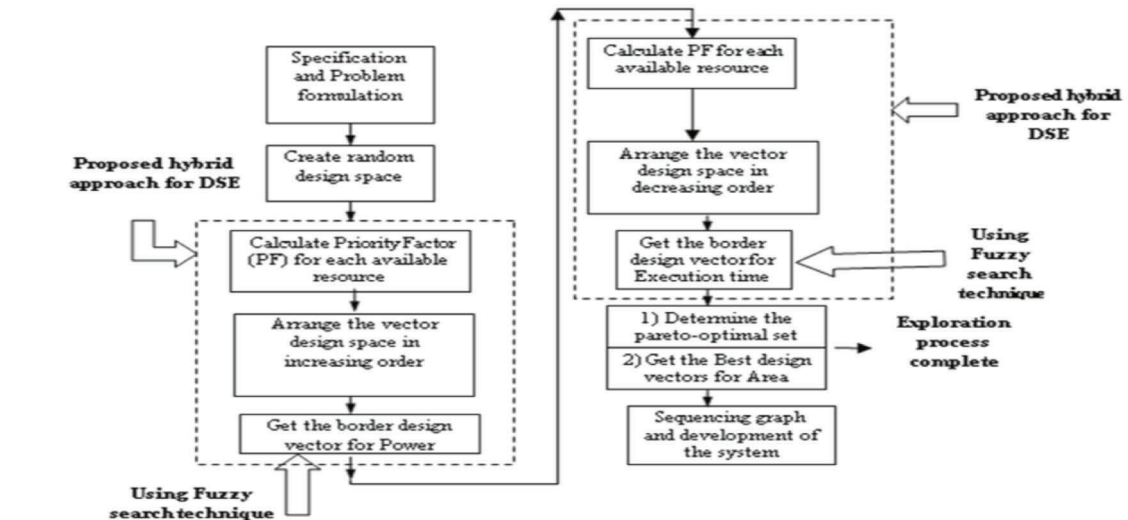
Patent: Granted, Candian Patent No. # CA2726091A1

Proposed Relevant Industries: Chip Design, Hardware Security

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

System and Method for Development of System Architecture

Methods, systems, and computer readable medium for developing a system architecture that involves defining resource constraints for kinds of resources and constraint values for optimization parameters, and defining a design space as variants, where each variant is a vector. Satisfying sets of variants are determined for optimization parameters by assigning membership values to each variant of a universe of discourse set and performing a fuzzy search of a universe of discourse set using the corresponding membership values. A set of variants is



determined based on an intersection of the satisfying sets of variants. An ordered list of variants is generated by sorting the set of variants and a variant is selected based on a position of the variant in the ordered list for use in developing the system architecture.

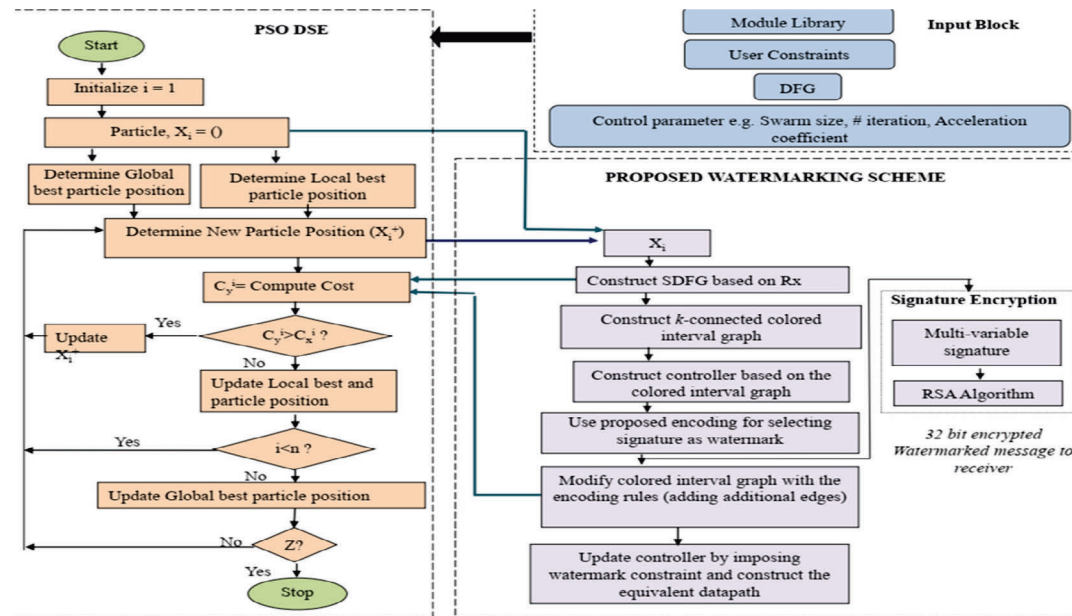
Patent: Granted, Candian Patent No. # CA2741253A1

Proposed Relevant Industries: Chip Design, Hardware Security, Defense

Inventor: Prof. Anirban Sengupta (asengupt@iiti.ac.in), Department of Computer Science and Engineering

Embedding Watermark Based on Multi-Variable Signature Encoding at Behaviour Level for Reusable IP Core Protection

Disclosed is an embedding watermark during high level synthesis at behavior level for reusable IP core protection. In one implementation, the present invention generates low cost watermarking solution during high level synthesis (HLS) based on multi-variable signature encoding for security of reusable IP cores. The watermark generated by the proposed approach satisfies the following properties: (a) low embedding cost (b) robustness (c) low watermark creation time (d) strong proof of authorship (e) lower hardware overhead (f) fault tolerance. Comparison with similar



technique revealed the present invention obtains watermarked solution with lower embedding cost with lesser storage overhead and creation/embedding time.

Patent: Filed, Indian Patent Application No. 4466/MUM/2015

Proposed Relevant Industries: Chip Design, VLSI Industries

Inventor: Prof. Anirban Sengupta (asengupta@iiti.ac.in), Department of Computer Science and Engineering

List of Patents of IIT Indore

List of Patents of IIT Indore

Granted

S. No.	Title of the Patent	Inventor	Status of the patent
1	A method for synthesizing nanoparticle or microsphere	Dr. Abhijeet Joshi	Granted
2	A sanitization device for a protective article	Dr. Ankur Miglani, Prof. Pavan Kumar Kankar	Granted
3	A method of maintenance for high-performance machineries employing axial piston pumps and multiple cylinders	Dr. Ankur Miglani, Prof. Pavan Kumar Kankar	Granted
4	Wheelchair equipped with Brain Computer Interface and Gesture Recognition	Dr. Gourinath Banda	Granted
5	Vertical Falling Film Gas Liquid Tower	Dr. Ritunesh Kumar	Granted
6	A mechanism of 2PRP-PRR Planar Parallel manipulator and a method thereof	Dr. Santhakumar Mohan	Granted
7	A Passive Parallel Sitting/Lying type Lower Limb Rehabilitation Robot with Leg Orthoses	Dr. Santhakumar Mohan	Granted
8	Hybrid underwater vehicle for ocean observations	Dr. Santhakumar Mohan	Granted
9	Essential amino acid based biodegradable and biocompatible nanoparticles for bio medical imaging and targeted drug delivery applications	Dr. Sharad Gupta	Granted
10	Ultrasonic Atomizer based ultrafine silk nanoparticles with long shelf life for targeted drug delivery and diagnostics	Dr. Sharad Gupta, Dr. Abhijeet Joshi	Granted
11	Portable Standalone vaccine carrier box with long duration temperature maintenance, monitoring and location tracker-Atmanirbhar Vaccine Carrier	Dr. Shilpa Raut, Prof. Devendra Deshmukh	Granted
12	Achieving super subthreshold swing (< 1 mV/decade) in multiple gate junctionless MOSFET through engineering the back gate position	Prof. Abhinav Kranti	Granted
13	Multiple Gate Tunneling Field Effect Transistor for Capacitorless Dynamic Random Access Memory Applications	Prof. Abhinav Kranti	Granted
14	Design Space Exploration System and Method Thereof Using a Bacterial Foraging Optimization Mechanism	Prof. Anirban Sengupta	Granted

15	Method and System for Automatic Fault Recovery and True Output Extraction during High Level Synthesis	Prof. Anirban Sengupta	Granted
16	Design Space Exploration of Optimal k-Cycle Transient Fault Tolerant Datapath Based on Multi-Objective Power-Performance Tradeoff	Prof. Anirban Sengupta	Granted
17	Method and Apparatus for Embedded Systems based Intervention for Energy Conservation/ System And Method For Electrical Energy Conservation	Prof. Anirban Sengupta	Granted
18	Improved Schedule Delay Estimation Process for Datapath during High Level Synthesis of Application Specific Processors	Prof. Anirban Sengupta	Granted
19	Design Space Exploration of Optimal Kc--Cycle Transient Fault Secured Data-path System with Intelligent Cut Insertion	Prof. Anirban Sengupta	Granted
20	Design Space Exploration Of An Optimized Hardware Trojan Detectable/Secured Datapath During High Level Synthesis	Prof. Anirban Sengupta	Granted
21	A smart road asset management system and method thereof	Prof. Aruna Tiwari	Granted
22	Novel Mutant L-Asparaginases	Prof. Avinash Sonawane	Granted
23	Metal-free, solvent-free synthesis of fused-pyrido hetrocycles: Biological efficacy against cancer and multi-drug resistant pathogens	Prof. Chelvam Venkatesh	Granted
24	Computer aided Design, development, synthesis and biological evaluation of third generation tubulysin family of compounds as anti cancer agents	Prof. Chelvam Venkatesh	Granted
25	A Metal Inert Gas (MIG) Based Additive Manufacturing Technique for Fabricating Shape Memory Alloy Ring	Prof. I.A.Palani	Granted
26	Strained SMA Bimorph & Spring Based Condition Monitoring System for Fluid Leak Detection in Hydraulic Hoses	Prof. I.A.Palani	Granted

27	Thermo-mechanical test bench for reliability estimation of Shape Memory Alloy (SMA) springs	Prof. I.A.Palani Prof. Bhupesh Kumar Lad	Granted
28	Design and development of self-energized solar tracking system using textured shape memory bimorph substrate based thin film solar panel	Prof. I.A.Palani, Prof. Vipul Singh	Granted
29	Magnetic Field Assisted Micro-Plasma Transferred Arc Additive Manufacturing	Prof. Neelesh Kumar Jain	Granted
30	Cathode Tool Design and Development for Spur Gear Tooth Flank Modification by Electrochemical Machining	Prof. Neelesh Kumar Jain	Granted
31	Modelling Calibration of Friction Parameters for Debris Flow	Prof. Neelima Satyam	Granted
32	Portable Integrated Stand for Constant and Falling Head Permeability Apparatus	Prof. Neelima Satyam	Granted
33	Ground Improvement Technique using Indigenous Bacteria for Biocementation of Expansive Soil Subgrades	Prof. Neelima Satyam	Granted
34	Process for Culturing Indigenous Bacteria for Treating Clays with Varying Plasticity to Improve Engineering Behavior	Prof. Neelima Satyam	Granted
35	System and method for biometric identification using ECG signals	Prof. Ram Bilas Pachori	Granted
36	Catalyst for low temperature hydrogen production	Prof. Sanjay Kumar Singh	Granted
37	Catalytic process for hydrogen production from polymeric polyethylene terephthalate (PET) waste	Prof. Sanjay Kumar Singh	Granted
38	A method and apparatus for transferring heat from stationary/moving surfaces using impingement jet	Prof. Santosh Kumar Sahu	Granted
39	P-N Tuned Differential 8T Static Random Access Memory (SRAM) Cell	Prof. Santosh Kumar Vishvakarma	Granted
40	Low leakage-high stability differential positive feedback controlled 10T (DPFC10T) SRAM Cell	Prof. Santosh Kumar Vishvakarma	Granted

41	Improved Performance of DG-TFET with Lateral Asymmetric Channel (LAC) Doping Profile an Underlap (UL) Feature/High Performance double gate tunnel field effect transistor for low power applications.	Prof. Santosh Kumar Vishvakarma	Granted
42	Offset Compensated Data Sensing Technique for Low Energy Embedded SRAM	Prof. Santosh Kumar Vishvakarma	Granted
43	An Ultra Low Power, read decoupled-differential write, 1T1 SRAM cell with larger read/write noise margin	Prof. Santosh Kumar Vishvakarma	Granted
44	Read Recharge (RRC) based process variation tolerant 1T1 Sram Cell	Prof. Santosh Kumar Vishvakarma	Granted
45	Dual Ion Beam Sputtered Cost-Effective and Non-Volatile Resistive Memory Devices	Prof. Shaibal Mukherjee	Granted
46	Hybrid Mesoporous Composites Gas Sensors	Prof. Shaibal Mukherjee	Granted
47	Organo-Acidified Zinc Oxide Carbon Monoxide Sensor	Prof. Shaibal Mukherjee	Granted
48	Ultrasensitive NO ₂ Sensor based on S and N Doped Carbon Dot Functionalized Tungsten Oxide	Prof. Shaibal Mukherjee	Granted
49	A Wide Range Variable Resistance Readout Circuit	Prof. Shaibal Mukherjee	Granted
50	Achieving high concentration of two-dimensional electron gas in capped ZnO based heterostructure for electron mobility transistor	Prof. Shaibal Mukherjee	Granted
51	High two-dimensional electron gas density in heterostructure of ternary/quaternary compounds based on Zinc Oxide material	Prof. Shaibal Mukherjee	Granted
52	A Method of Fabricating Zinc Oxide based Heterostructure for High Electron Mobility Transistor	Prof. Shaibal Mukherjee, Prof. Abhinav Kranti	Granted
53	A Method of Fabricating High Two Dimensional Electron Gas Density Yielding Zinc Oxide Heterostructure	Prof. Shaibal Mukherjee Prof. Abhinav Kranti	Granted
54	A Multi-Frequency Based Transceiver	Prof. Vimal Bhatia	Granted

55	Low cost, low power, and portable dual transceiver based on software defined radio	Prof. Vimal Bhatia	Granted
56	Method and Apparatus For Detection of Active Taps Location In OFDM System	Prof. Vimal Bhatia	Granted
57	Method and Apparatus for Low Power Source Spectrum Sensing	Prof. Vimal Bhatia	Granted
58	Method and apparatus for Anti-theft Fingerprint Biometry	Prof. Vimal Bhatia	Granted
59	Method and Apparatus for secure ear biomteric recognition using single shot fringe projection themography	Prof. Vimal Bhatia	Granted
60	A Device for Assessment of Seed Priming Treatments Using Biospeckle Analysis	Prof. Vimal Bhatia	Granted
61	System and Method For Emergency Services	Prof. Vimal Bhatia	Granted
62	A Swarf-based Substrate Used for Additive Manufacturing, and Process of Preparation of Same	Dr. Yuvraj Madhukar	Granted
63	Bio-Chem-Reactor for Biocementation and Method Thereof	Prof. Neelima Satyam	Granted

Under Examination

S. No.	Title of the Patent	Inventor	Status of the patent
64	Large Scale Contact Tracing for Covid-19	Dr. Chandresh Kumar Mourya	Under Examination
65	A modular reactor for manometric apparatus operable in hydrogen environment at high pressures and capable of handling powered/porous nanomaterials	Dr. Shailesh Kundelwal	Under Examination
66	A Standalone, portable blood pressure measurement device with remote monitoring	Dr. Shilpa Raut, Prof. Devendra Deshmukh	Under Examination
67	All Optical Modulation in Engineered Indium Tin Oxide based vertically Ring Resonator employing Epsilon Near Zero State	Prof. Mukesh Kumar	Under Examination

Published

S. No.	Title of the Patent	Inventor	Status of the patent
68	Method and System for detection and determination of failure and downtime of a fluid-powered system	Dr. Ankur Miglani, Prof. Pavan Kumar Kankar	Published
69	A Six Degree of Freedom Parallel Manipulator in RPRS Configuration	Dr. Santhakumar Mohan	Published
70	Green Synthesis of Biocompatible and Near Infrared Active Iron Oxide Nanoparticle for Deep Tissue Imaging and Therapy	Dr. Sharad Gupta	Published
71	Development of Portable Sensor Based Canine Pregnancy Detection System	Dr. Debasis Nayak, Prof. Ram Bilas Pachori	Published
72	Embedding Watermark based on Multi-Variable Signature Encoding at Behaviour Level for Reusable IP Core Protection	Prof. Anirban Sengupta	Published
73	Resistive switching based on π -conjugated compound	Prof. Apurba K Das	Published
74	System and method for sign language gesture recognition	Prof. Aruna Tiwari	Published
75	Method and System for Providing Smart Communications for Distributed Operations Planning in an Industrial Network	Prof. Bhupesh Kumar Lad	Published
76	New Small Molecule inhibitors/Ligands for Early Diagnosis and Therapy of Prostate Specific Membrane Antigen (PSMA+) Cancers and Neurodegenerative Diseases	Prof. Chelvam Venkatesh	Published
77	Design and Development Shape Memory Alloy Actuated Smart Cervical Neck Collar	Prof. I.A.Palani	Published
78	A Universal Testing Machine for analysis of physical properties of the Thin Film sheets and method thereof	Prof. I.A.Palani	Published
79	Inchworm Inspired Shape Memory Alloy Bimorph-based Stewart Platform for Opto- mechatronic System and Method there of	Prof. I.A.Palani	Published
80	Engineered Nanophotonic Structure Based on Electrically Controlled Composite Materials for Biochemical Sensing	Prof. Mukesh Kumar	Published

81	Integrated Mass Spring Damper and Liquid-Circular Angular Accelerometer System for Structural Strength Analysis	Prof. Neelima Satyam	Published
82	Apparatus and Methods for Noise-Aware and Energy-Efficient Pulse Rate Variability and Heart Rate Variability Analysis	Prof. Ram Bilas Pachori	Published
83	Apparatus, Systems and Methods for Quality-Aware Energy-Efficient Respiration Rate Estimation from Photoplethysmography (PPG) Signal	Prof. Ram Bilas Pachori	Published
84	Apparatus, Systems and Methods for Noise-Aware Energy-Efficient ECG Signal Analysis and Cardiovascular Disease Diagnosis and Prediction	Prof. Ram Bilas Pachori	Published
85	Apparatus, Systems and Methods for Quality-Aware Energy-Efficient PPG Signal Analysis and Cardiovascular Disease Diagnosis and Prediction	Prof. Ram Bilas Pachori	Published
86	Apparatus, Systems and Methods for Contextual Information Aware Physiological Parameter Analysis and Intelligent Human Disease Prediction and Diagnosis Networks	Prof. Ram Bilas Pachori	Published
87	System and Method for Predicting Parkinson's Disease	Prof. Ram Bilas Pachori	Published
88	π -Conjugated Compound for Resistive Switching, Device, and Method of Fabrication	Prof. Shaibal Mukherjee	Published
89	Silicon Compatible Yttria-based Memristive Crossbar Array and A Method of Fabrication Thereof	Prof. Shaibal Mukherjee	Published
90	System and Method for Monitoring and Detecting Leakage of Toxic Gases to Enable User Alerts	Prof. Shaibal Mukherjee	Published
91	System and Method for Point-of-Care Diagnosis and Monitoring of Uric Acid Levels	Prof. Shaibal Mukherjee	Published
92	A Method to Control Two Dimensional Electron Gas Mobility and Carrier Density of Oxide-based Heterostructure	Prof. Shaibal Mukherjee	Published

93	Instrument to acquire real time dynamic photoacoustic signal and display acoustic spectrum (using high speed signal conditioning) for biomedical tissue diagnosis	Prof. Srivathsan Vasudevan	Published
94	Method and Apparatus for Recording, Archiving, Media Management and Playing back of a Telephone Call	Prof. Vimal Bhatia	Published
95	Method Device and Apparatus for Managing Phone/Device Profile based on an event	Prof. Vimal Bhatia	Published
96	Low cost identification of road congestion for traffic management	Prof. Vimal Bhatia	Published
97	System, method and apparatus for low complexity Non-Orthogonal Multiple Access (NOMA) receiver for mixed Constellation	Prof. Vimal Bhatia	Published
98	Method and Apparatus for low complexity Natural Gradient based OFDM Channel Estimator	Prof. Vimal Bhatia	Published

Filed

S. No.	Title of the Patent	Inventor	Status of the patent
99	Portable biosensing systems for milk spoilage and adulteration deduction	Dr. Abhijeet Joshi	Filed
100	Recombinant organophosphate hydrolyzing enzyme immobilized fluorescent composites for the detection and degradation of organophosphates compounds	Dr. Abhijeet Joshi, Dr. Prashant Kodgire	Filed
101	Development of improved ballistic performance concrete slab by incorporating different geometrical shapes as reinforcement subjected to projectile impact	Dr. Abhishek Rajput	Filed
102	Photoconductive device for THz emission and detection with metal-semiconductor and metal-insulator-semiconductor contact	Dr. Abhishek Singh	Filed

103	A sanitization device for face masks	Dr. Ankur Miglani, Prof. Pavan Kumar Kankar	Filed
104	Medical Emergency Portable Stretcher	Dr. Ashish Rajak	Filed
105	A Portable kit for Visible Light Photodynamic Inactivation of Microbes and Method thereof	Dr. Debayan Sarkar	Filed
106	Novel FDM-based 3D Printing with Integrated Direct Ink Writing Mechanism	Dr. Girish Verma	Filed
107	Myelin Protein Antigenic Epitopes Presented by Major Histocompatibility Complexes, a Driver to Multiple Sclerosis	Dr. Hem Chandra Jha	Filed
108	Novel Synergistic Combination therapy Based on Levofloxacin and Dorzolamide for the Treatment of Sepsis	Dr. Mirza S Baig	Filed
109	Novel Compound and method thereof to address the TIRAP mediated chronic inflammatory signalling	Dr. Mirza S Baig	Filed
110	System, Apparatus, and Method for Heart Rate Determination of a user Wearing a Face Mask	Dr. Puneet Gupta	Filed
111	Robust Remote Photoplethysmography Estimation By Denoising Eulerian and Lagrangian Pulse Signals Using Contrastive Learning	Dr. Puneet Gupta	Filed
112	Wideband Power Divider using Substrate Integrated Waveguide for Millimeter-Wave Applications	Dr. Saptarshi Ghosh	Filed
113	Estimating Adsorption Capacity of Solid Substrates using Molecular Dynamic Simulations	Dr. Shailesh Kundelwal	Filed
114	A cost-effective Synthesis of Reduced Graphene Aerogels Doped with Titanium Nanoparticles for Adsorption of Gases	Dr. Shailesh Kundelwal	Filed
115	Security Aware Design Methodology for Designing Secure Hardware Accelerators for Implantable Cardiac Pacemaker	Prof. Anirban Sengupta	Filed
116	Secure Hardware IP of GLRT Cascade using Color Interval Graph based Embedded Fingerprint for ECG Detector	Prof. Anirban Sengupta	Filed

117	A novel E.coli L-Asparaginase (EcA) variant of Acute Lymphoblastic Leukemia (ALL)	Prof. Avinash Sonawane	Filed
118	Laser decal transfer based μ -3D Printer	Prof. I.A.Palani	Filed
119	IoT-based smart Sanitary pad for menstrual health monitoring	Prof. I.A.Palani, Kailaash Pandiyan, Aditi T, Pragya Singh, Kanishka Goyal, Ayushi Agrawal, D J Mistry	Filed
120	A Method for Measuring Hydrological Resilience of a Region in Response to Warming Shifts	Prof. Manish Kumar Goyal	Filed
121	Method and System for Determining Spatiotemporal Characteristics and Predicting the State of Atmospheric Rivers (AR)	Prof. Manish Kumar Goyal	Filed
122	Nanophotonic Resistive Switch based on Tapered Copper-silicon Structure with Low Power and High Extinction Ratio	Prof. Mukesh Kumar	Filed
123	Method of large-scale, flexible electrochromic devices using novel viologen	Prof. Rajesh Kumar	Filed
124	GOBAiR, a Cow dung-based foaming agent and Resulting Lightweight Construction Materials thereof	Prof. Sandeep Chaudhary	Filed
125	Constant Transconductance Bias Technique to Reduce PVT Variation in Oscillators	Prof. Santosh Kumar Vishvakarma	Filed
126	A Multi-wavelength pulsed Laser Excitation Photoacoustic (PA) Screening Apparatus	Prof. Srivathsan Vasudevan	Filed
127	Respiratory motion phantom for radiotherapy treatment using moving platform	Prof. Srivathsan Vasudevan	Filed
128	System and method for quantifying the angular stability status of a power grid	Prof. Trapti Jain	Filed
129	Biomolecular Condensate Matrix enabled Conductive Polymer Hydrogel: Versatile insitu Oxidant Templating Preparation	Prof. Tridib Kumar Sarma	Filed

Under Process

130	A portable single grain dispenser	Dr. Ankur Miglani, Prof. Pavan Kumar Kankar	Under Process
131	A device for precision dispensing, sorting and quality indexing of both damaged and healthy grains, millets and nuts.	Dr. Ankur Miglani, Prof. Pavan Kumar Kankar	Under Process
132	Application of synthetic jet using flapping wings for thermal management and energy harvesting.	Dr. Harekrishna Yadav	Under Process
133	Multiphoton (Two and Three-photon) Excited Fluorescence for the Identification and Differential of X and Y- chromome-bearing Sperms for Semen Sorting	Dr. Sharad Gupta	Under Process
134	Sodium rich Al substituted P2/P3 biphasic cathode for Na ion batteries	Dr. Sunil Kumar	Under Process
135	Homoaromatic Peptide mitigate FMR pol-G-protein mediated toxicity in fragile X-associated Tremor/Ataxia Syndrome (FXTAS)	Prof. Amit Kumar	Under Process
136	Antifungal and antibacterial hydrogel	Prof. Apurba K Das	Under Process
137	Heat curing based vat-geopolymerization based 3-D printing process	Prof. Sandeep Chaudhary	Under Process
138	Ingredients and Methodology to Develop Shape Stable and Flame Retarding Phase Change Composite for Thermal Management of Battery Modules	Prof. Santosh Kumar Sahu	Under Process
139	Oven-based Synthesis and Modified Selective Precipitation Purification for High Aspect Ratio and Better Purity of Silver Nanowires	Prof. Vipul Singh	Under Process
140	System And Method For Wide-area Crowd Counting Using Drones and Artificial Intelligence	Prof. Vivek Kanhangad	Under Process
141	Stoichiometrically Pptimized $[V_2O_2 + \xi(OH)_3 - \xi]$ for Supercapacitors with Electrochromic Color Indicator	Prof. Rajesh Kumar	Under Process
142	Customizing acceptor/donor Type Counter Ions For Selective Enhancement of Electrochromic Device Performance Parameter.	Prof. Rajneesh Misra, Prof. Rajesh Kumar	Under Process
143	A Technique for Designing Curved Frequency Selective Surface	Dr. Saptarshi Ghosh	Under Process

Translational Research Fellowship: A step towards Lab to Land Ecosystem

To inculcate a translational research ecosystem among the students, a Translational Research Fellowship scheme has been initiated by IIT Indore. The main objective of the Fellowship is to encourage students who have developed technologies and are aspiring for upgrading the technology for potential commercialization under the respective faculty member's mentorship. This fellowship is open for undergraduate, post graduate and Ph. D. students who are on the verge of completing their degree. Five students have been awarded with Translational Research Fellowship till date.



(TRF)



TRL 1-3
(IIT Indore
Ph.D scholar,
B.Tech and PG
students)

Handholding with IPR and
Techno Commercial Expert

TRL 5 and above

List of Awardees of Translational Research Fellowship

S. No.	Name of the Student	Name of the Supervisor	Domain
1	Mr. Rahul Chaurasia	Dr. Anirban Sengupta	Hardware Security
2	Mr. Gyanesh Patnaik	Dr. Abhishek Rajput	Material for Defense
3	Mr. Chandrabhan Patel	Dr. Shaibal Mukherjee	Smart sensors & Environmental Sustainability
4	Mr. Anikeit Sethi	Dr. Aruna Tiwari	Smart City Infrastructure
5	Mr. Sanchit Gupta	Dr. Sandeep Chaudhary	Infrastructure Development

AH9. A Point-of-Care (PoC), IoT-enabled Uric acid Sensor System

Shaibal Mukherjee*, Chandrabhan Patel, Mayank Dubey, Vikash Kumar Verma, Sumit Chaudhary

Indian Institute of Technology Indore

*Email: shaibal@iiti.ac.in

Abstract

The development of an IoT-enabled uric acid sensor addresses critical challenges in healthcare by offering a real-time, cost-effective solution for monitoring uric acid levels in biological fluids. Abnormal uric acid levels are linked to severe diseases, necessitating rapid and reliable detection. The sensor, currently at Technology Readiness Level 6, demonstrates efficacy in lab tests and ongoing clinical trials with AIIMS Bhopal. Its uniqueness lies in providing continuous, user-friendly monitoring, covering a broad concentration range. This innovation is particularly relevant in India, where over 7.8 million people suffer from chronic kidney diseases. Implementation promises improved health monitoring, reduced healthcare costs through timely interventions, enhanced quality of life for chronic disease management, and a shift towards preventive healthcare. This breakthrough aligns with global health goals, promising a transformative impact on healthcare delivery and public health outcomes.

Present TRL: 6



Fig. IoT-enabled portable uric acid sensor system integrated with android/iOS mobile application for real-time monitoring.

AF5. Bhu-Samvardhak

Shaibal Mukherjee*, Vikash Kumar Verma, Chandrabhan Patel, Mayank Dubey, Sumit Chaudhary

Indian Institute of Technology Indore

*Email: shaibal@iiti.ac.in

Abstract

The agriculture sector in India faces critical challenges, including soil nutrient variability, delayed disease detection, and inefficient resource management. Addressing these issues, the "Bhu-Samvardhak" IoT integrated soil sensor emerges as a pioneering solution. This technology provides real-time soil health monitoring, offering precise insights for informed decision-making and minimizing resource waste. Additionally, the integration of image processing enables early disease detection, reducing yield losses and pesticide use. The solution promotes sustainability through optimized resource management, contributing to long-term food security. The soil sensor has been successfully deployed and tested in agricultural fields, engaging with end-users and forming industry partnerships. With substantial relevance to the Indian market, encompassing millions of farmers, and a projected smart soil sensor market cap of USD 101.8 million, "Bhu-Samvardhak" signifies a transformative step towards addressing agricultural challenges and ensuring a resilient future.

Present TRL: 7

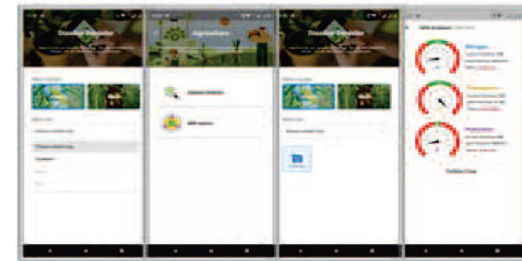


Fig. Developed IoT-enabled portable soil health monitoring system (Bhu-Samvardhak).

DS6. Triboelectric based shoe sole for energy harvesting for powering microdevices for army personnels

I. A. Palani*, Anshu Sahu*, Diksha Jaurker, Shailesh M Kohle**, Bibhuti Bhusan Padhy

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Abstract

To powerup the wearable electronics, batteries are the main source of power to make it functional. As a result, these gadgets need to be recharged frequently, which reduces their overall efficacy of the microdevices. To overcome this problem, a new solution should be needed which has longer life and does not required charging for the longer period of time. A shoe is integrated with triboelectric nanogenerator and electronic components within the shoe sole to powerup the microdevices with the human-motion. Triboelectric nanogenerators (TEGs) are devices that convert mechanical energy into electrical energy. The triboelectric nanogenerator work on the principle of electrostatic-induction between two surfaces i.e. tribopositive and tribo-negative surfaces. The triboelectric nanogenerator and electronics components are installed inside the shoe sole so that the when the person walks, the flow of charge start getting stored in the storage device. The stored energy can be used for the for powering the small micro devices in remote location.

Present TRL: TRL 6



Fig: TENG integrated shoe sole for powering wearable electronics

IN3. Wide Area-Monitoring of the Indian Electricity Grid for Enhanced Visibility

Adnan Iqbal and Trapti Jain*

Indian Institute of Technology Indore

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Abstract

The proliferation of measurement devices generates vast data, thus offering a higher level of granularity and real-time insights that were previously unavailable. Centralized information from strategically positioned monitoring devices aids load dispatch center operators in optimizing grid operations. Our Make-in-India software addresses the challenge of costly and non-customizable foreign solutions for power grid monitoring. Currently at TRL4, the solution provides a cost-effective and scalable solution. Developed in C++, it features algorithms for detecting grid events, visualisation of real-time data, along with a data historian for offline analytics. Tested at laboratory environment on a Real-time Digital Simulator, Indian Institute of Technology Indore, the technology offers concealed backend computations, an interactive GUI, and visual alarms, thus reducing the likelihood of critical grid failure events. With a focus on reducing operator cognitive load by automating grid analytics, it enhances efficiency in power grid operations, particularly benefiting rural areas prioritized during load shortages.

Present TRL:



Technology screenshot: Annotation in green.

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A Handbook of
Ideas,
Innovations &
Technologies of
IIT Indore

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