Volume 14, Issue 1

February 2026

R&D Newsletter

Indian Institute of Technology Kanpur

FOCUS

more highlight

CII Industry-Academia Partnership Award 2025

Indian Institute of Technology Kanpur has won the **PLATINUM award** in the **Academic-Public category** for outstanding achievement in securing the highest number of Intellectual Property Grants and successful commercialization through industry-academia Partnership at the **CII Industry-Academia Partnership award 2025**.

This recognition highlights IIT Kanpur's strong IP ecosystem built on years of focussed efforts in facilitating the transition from lab scale to commercial launch. Several technologies and products were listed. Among these, **Bhuparikshak** a homegrown innovation developed by Prof. Jayant K. Singh, Department of Chemical Engineering stood out for achieving notable commercial success.

The commercial success of Bhuparikshak was extensively showcased as a part of the award recognition, serving as a strong example of how research to real world application, effective IP management and strategic industry-academia collaboration can drive meaningful outcomes.

The award was received by Prof. Tarun Gupta, Dean of Research & Development, and Prof. Raja Angamuthu, Associate Dean of Research & Development IIT Kanpur, at the CII Global Summit on Industry–Academia Partnership (IAP) held on 04-06, December 2025, at the Indian Habitat Centre, New Delhi.

Marking 60 Years of the Office of Dean Research and Development

The position of the Dean of Research and Development at IIT Kanpur was established in **January 1966**, with Prof. H. K. Kesavan serving as its first Dean. Since then, the office has played a central role in strengthening the Institute's research ecosystem by supporting in-house grants, sponsored research projects, and research consultancies, thereby fostering excellence across diverse areas of science and technology.

To commemorate its Diamond Jubilee, a **coffee table book** documenting **six decades of research achievements** was released by Prof. Manindra Agrawal, Director, IIT Kanpur, on 26 January 2026, during the Institute's Republic Day celebrations.

Read the book at: *https://www.iitk.ac.in/dord/data/research_history.pdf*

Modular Aerial Manipulator System

Invented by: Prof. Nachiketa Tiwari & Mr. Anubhav Mishra

Dept. of Design

IPA No. 202511057764

The technology enables multi-copter drones to physically interact with their environment using a 4-DOF robotic arm, with a modular design that integrates seamlessly with existing platforms without any drone modifications.

Key Features

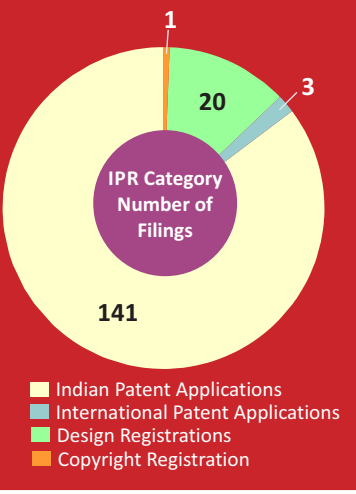
- Optimized mass distribution ensures balanced and stable flight
- Thrusters automatically adjust for real-time stability
- Dedicated control enables precise, real-time opeation
- Lightweight, modular design allows easy integration with any drone
- Handles payloads efficiently while maintaining agility and performance

Record-Breaking Innovation Milestone

2025

165 IPRs filed

118 IPRs granted



Modular System and Method for Irrigating Water in Moisture-Deficient Zones

Invented by: Prof. Amar Kumar Behera & his team

Dept. of Design

IPA No. 202511043687

A smart, sustainable solution for modern farming that integrates easily with existing sprinklers, improves water efficiency, reduces wastage, and supports healthy crop growth. It helps farmers to upgrade their irrigation set up without extensive replacement.

Key Features

- Real time moisture monitoring
- Customizable moisture thresholds
- Automated rotation control
- Low maintenance & cost-effective

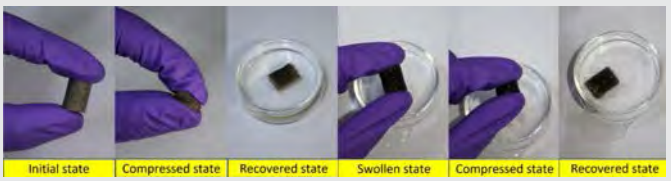
Biopolymer-Based Hemostatic Dressing for Controlling Excessive Bleeding

Invented by: Prof. Vivek Verma & his team

Dept. of Material Science & Engineering

Patent No: 534043

Hemostatic dressings for the rapid control of excessive bleeding. To make them more effective, the dressings are coated with polydopamine (PDA) and polyaniline (PANI), which help the blood to clot faster.



Key Features

- Absorb large amount of blood (40 times its own weight)
- Clot blood under 90 seconds at wound site
- Adopted to use natural polymers or non-animal origin
- Simple approach of fabrication in any shape & size
- The dressing can be part of pre-hospital kit

Green Grease : Lubrication using Microalgae

Aditya Singh[a], Bandita Rout[c], Prof. Ashwani Kumar Thakur[c], Prof. Animangsu Ghatak[ab]
Dept. of Chemical Engineering[a], Centre for Environmental Science and Engineering[b],
Dept. of Biological Sciences and Bioengineering[c]

We need lubrication for smooth movement from large mechanical assemblies to miniaturized devices, to living systems all need it. Presently, the petroleum-based lubricants are predominant, despite being non-renewable origin and adverse to environment. What if the lubricants are more eco friendly e.g. water based, soft solids based, solid-state lubrication, electric/magnetic field induced lubrication and so on.

Nature inspired solution to the problem

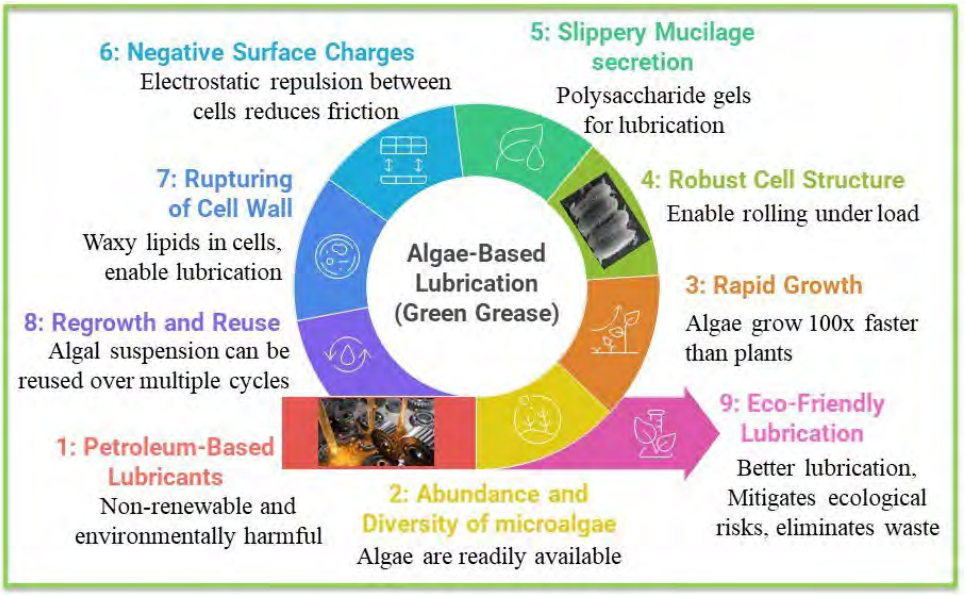
In moist environments, especially during the rainy season, brick pathways get covered with a green layer of algal micro-organisms, which generally remain highly slippery. The surface smoothness functions like a lubricant causing inadvertant fall. Can these microscopic organisms, their colonies, and/or their suspensions, be cultured in a controlled environment to be used as a living lubricant?

What makes Algae a perfect choice?

Algae are a microscopic powerhouse of the aquatic ecosystem. They are abundant and diverse, and also grow about 100 times faster than normal plants. Millions of years of evolution have turned them into highly robust organisms. Their slimy mucilage sheaths (polysaccharide gels), negative surface charges on cells, flexible cell walls with polysaccharides, silica, and waxy lipids enable rolling and deformation under stress. These properties represent a nature-tested evolutionary superpower for smooth gliding.

Algae decreases coeffecient of friction

We tried ball-on-plate friction tests on five different micro-algae species of different shapes: circular and cylindrical, and sizes: 6-25 µm. The suspension of these algae in growth media was used as the lubricant. The coefficient of friction (COF) with these lubricants decreased by more than 10 times compared to the control (lubricant-less sliding). Although this reduction in COF had multiple factors, the cell's intracellular components affected it to a limited extent; the surface charge present on the microalgae cell and on the substrate were thought to affect COF significantly. Cell surface charges were negative; the same was true for the substrate. The repulsive effect born out of their interaction could diminish friction. This hypothesis was reinforced by the finding that COF decreased with an increase in surface charges on the substrate by plasma treatment using the same lubricant.



Algae properties making it an ideal lubricant

Living Lubricant

In regard to its application, frictional stress was found to rupture only a few cells, so that the algal suspension could be regrown and reused over multiple cycles, thereby rendering it a "living lubricant". The algal suspension could mitigate ecological risks from lubricant leakage in gearboxes and drilling machines, and could probably eliminate the idea of disposal of "waste lubricants".

Bio-based Wearable Sensors for Monitoring Human Body Temperature

Dr. Gaurav Kumar and Prof. Siddhartha Panda
Materials Science Programme, Dept. of Chemical Engineering, and National Centre for Flexible Electronics

One of the easiest and most important ways to learn about our health is to keep an eye on our body temperature. Body temperature is usually the first indication that something is changing inside the body, such as when you have a fever or are recovering from an illness or surgery. However, the tools we use most of the time today, like mercury or digital thermometers, are only designed to give a one-time reading. They are hard, uncomfortable to wear for a long time, and not suitable for monitoring temperature. Our research focuses on inventing a bio-based soft, wearable body-temperature sensor that can be gently attached to the skin and precisely track human body temperature in real-time.

The motivation behind this work comes from a simple question: Can our body temperature sensing be made continuous, comfortable, safer, and more suitable for daily life?

To address this, we work with polymer gels. These are soft, jelly-like materials that are flexible and stretchable. These materials feel a lot like human skin. These gels are made using materials derived from plants. By carefully designing the composition, these gels can respond electrically to changes in temperature. When the body temperature changes, the electrical signal of the gel also changes, allowing us to measure temperature continuously. These gel-based wearable sensors can be attached to the skin comfortably and map temperature over long durations, unlike regular thermometers. Sensors like these could be helpful for babies and older people who need to have their temperature checked often, as well as for those recovering from surgery or an illness. They are also going to support future wearable healthcare technologies that want to keep an eye on several physiological signals of the human body. In a broader sense, by combining material science with healthcare needs, our research contributes to the growing field of wearable and flexible electronics and makes health monitoring more sustainable, comfortable, and accessible.

Schematic illustration of the development and application of the Bio-Wearable Temperature Sensor

Decoding Cancer - One Cell at a Time

Prof. Hamim Zafar
CoSmic Laboratory, Dept. of Computer Science & Engineering, Dept. of Biological Sciences & Bioengineering

Cancer is not just *one disease* — it's a complex crowd of different cells with different properties that lead these cells to behave in unpredictable ways. To develop better therapy for cancer, it is very important to understand what makes a tumour grow, resist treatment, spread to different organs or why cancer relapses in many patients. To search for answers to these questions, we examine cancer at its most fundamental scale—one cell at a time.

Every cell in our body carries a blueprint, in the form of genes, that dictates all its functions. In cancer, some cells go off script. They acquire mutations, random changes in the DNA which sometimes confer the cells the ability to divide uncontrollably, ignore normal checks, and form harmful masses. Cancer seems like a single mass from a distance, but up close, it is a crowd of distinct, individual cells with diverse functions - some may drive the disease while others simply follow along.

How to study this complexity within a cell?

Single-cell Sequencing: To understand this complexity, single-cell sequencing allows us to study thousands of individual cells from a tumour at once. It's like watching an orchestra not just hear the music but seeing what each musician is playing.

Computational Algorithms: We develop advanced computational models to group cells into families, or "clones," that share similar genetic changes. This helps us track how cancer evolves over time, how aggressive cells emerge, and which groups are most likely to resist treatment. It's a bit like reconstructing a family tree of cancer cells to understand where the troublemakers come from.

Spatial Omics: Cells do not live in isolation—they communicate with their surroundings and with each other. By mapping both gene activity and physical location using another cutting-edge technology called spatial transcriptomics, we can better understand how cancer cells shape their environment and how this affects disease progression.

Through these approaches our long-term goal is to move towards **more personalized cancer care**. To identify the most dangerous cell populations and the biological rules they follow, that can help doctors select treatments that target the right cells at the right time.

At **CoSmic Lab** (*https://sites.google.com/view/cosmiclab-iitk/*), we believe that combining machine learning, biology, and algorithms can unlock new ways to understand and fight cancer—starting with just one cell.

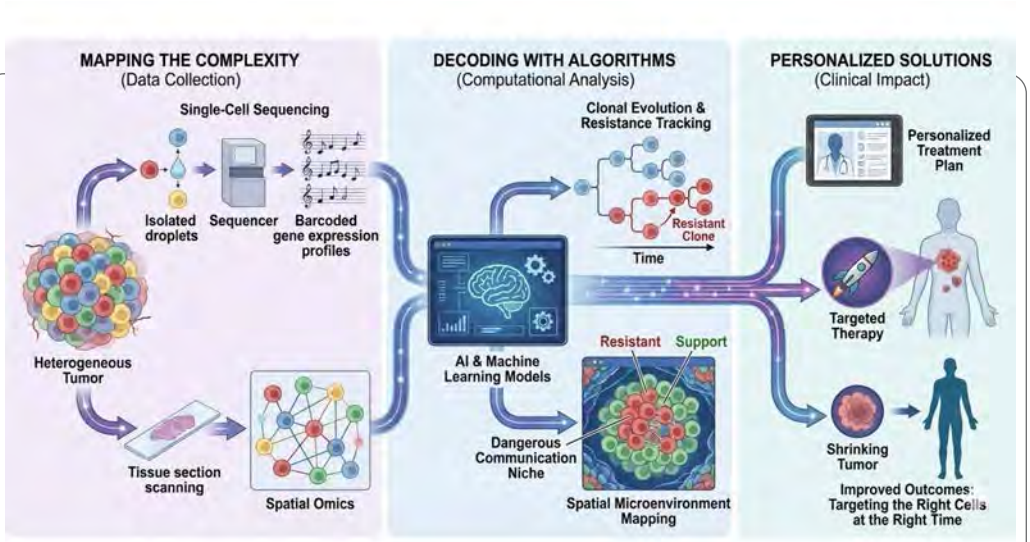


Illustration of a schematic approach in cancer studies using single cell sequencing and computational methods for personalized treatments

Multi-Sensor Fusion for Intelligent Perception and Sensing

Prof. Salil Goel
Geoinformatics Laboratory, Dept. of Civil Engineering

The core research of my lab combines multiple complementary sensors and technologies for solving the problems related to positioning, navigation, tracking, mapping and other associated areas. By "fusing" these together we create a system where one sensor's strength covers another's weakness at once. These sensors may include GNSS (Global Navigation Satellite Systems), Inertial Navigation Systems (INS), Camera, LiDAR (Light Detection and Ranging), Wi-Fi Signals, Ultra-Wide Band (UWB) etc. Specifically, our research group focuses on methods and technologies for multi-sensor calibration and fusion, exploring novel mechanisms and techniques for combining useful information from multiple sensors, and developing algorithms to intelligently make use of the fused information for various applications such as urban/forest mapping, smart-city applications, pedestrian/vehicular safety etc.

From Flying Drones to Smart Shoes

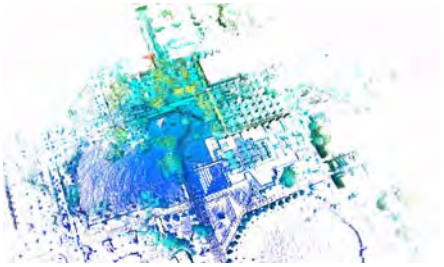
The various technological solutions resulting from such integrations could be used on various platforms including but diverse to Unmanned Aerial Vehicles (UAVs), Cars/Bikes to wearables. Most recently, our group has made significant advances in the areas of indoor positioning, navigation and mapping using a unique combination of LiDAR, INS and UWB, on three different types of platforms namely:

UAV: Drones equipped with LiDAR and INS motion sensors can fly through complex buildings to create indoor positioning and 3D maps in minutes.

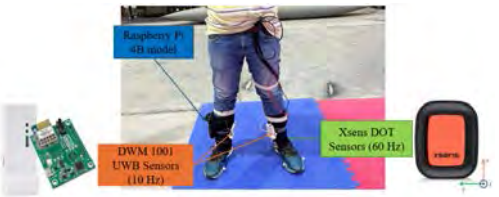
The Mapping Backpack: A wearable system that allows a person to walk and automatically generate a digital twin of the environment.

Smart Shoes: Shoe-mounted INS and UWB sensors along with heuristic model. By analysing the unique way, a person walks mapping, navigation and positioning is possible in indoor and challenging environments with incredible precision.

UAV mounted LiDAR-INS system for positioning and mapping in challenging GNSS environments



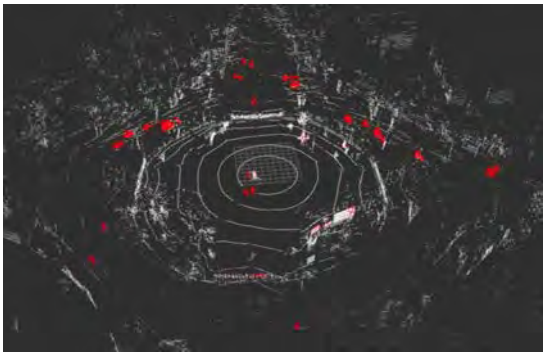
Oblique view of IITK academic area. This map is created using a backpack-based LiDAR-INS system



Foot-mounted UWB-INS system for indoor positioning and navigation

Infrastructure based LiDAR System

The intelligent algorithms here can identify all types of moving objects on the road including cars, bicycles, pedestrians, auto-rickshaws, animals etc. and thus provide enhanced perception and sensing capabilities. It's not just about collecting data; it's about making sense of it.



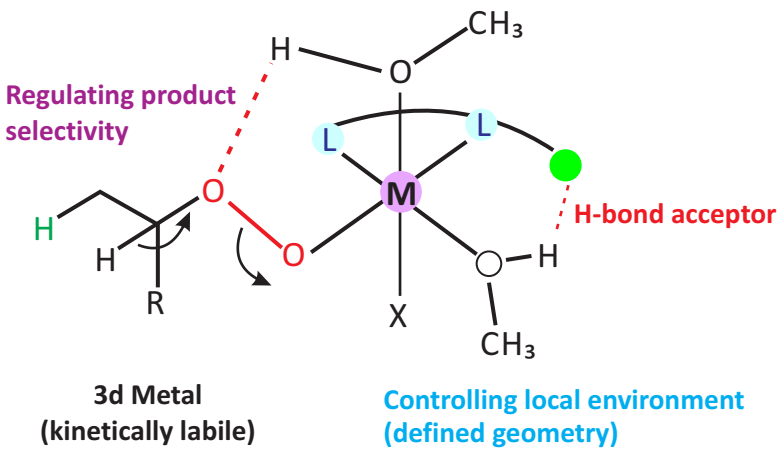
A multi-LiDAR system installed at Kargil

Secondary-Sphere Interactions for Controlling Catalytic Efficacy and Selectivity

PI: Prof. Jitendra Bera
Dept. of Chemistry

Sponsor: J C Bose Grant (ANRF, DST)

Homogeneous transition metal catalysis plays a crucial role in modern energy and chemical transformations; however, the development of highly efficient and selective catalysts remains a major challenge. Conventional catalyst design has primarily focused on the primary coordination sphere. In contrast, nature employs a more sophisticated strategy in enzymatic catalysis, harnessing secondary-sphere interactions to fine-tune catalytic behavior. These interactions, which occur beyond the immediate coordination environment of the active site, can significantly influence catalytic activity, stability, and selectivity.



Secondary coordination interaction for selective oxidation reactions

This project focuses on the rational design of catalysts featuring well-defined secondary-sphere environments to precisely control catalytic performance. By incorporating non-covalent interactions such as hydrogen bonding, electrostatic interactions, and steric effects, into the catalyst framework, the project aims to modulate reaction pathways beyond the immediate metal centre. This approach enables greater control over catalytic processes for efficient, selective, and sustainable chemical transformations.

Automated System for Cybersecurity Policies, Assessments, Audits, Ranking, and IR

PI: Prof. Amey Karkare
Dept. of Computer Science & Engineering
Co-PI: Prof. Ankush Sharma
Dept. of Electrical Engineering

Sponsor: Ministry of Electronics and Information Technology

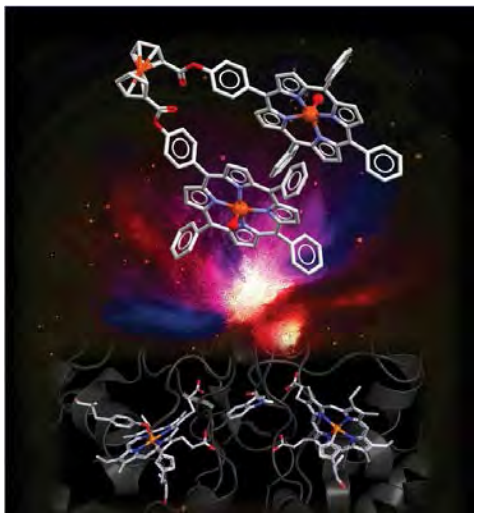
The Automated System for Cybersecurity Policies, Assessments, Audits, Ranking, and Incident Response (CcurePro) is a high-impact R&D initiative designed to strengthen cybersecurity governance for government and critical infrastructure organizations. It is architected as a connected suite of interoperable components, including CcurePolicyPro for AI-driven policy lifecycle management, CcureAssess for structured cybersecurity assessments, CcureAudit for automated audits and compliance, CcureRank for cybersecurity maturity ranking, and CcureIR for guided incident response.

CcurePro is a joint project of IIT Kanpur, IIT Mandi, NIT Jalandhar, and C-DAC Bangalore, funded by Ministry of Electronics and Information Technology.

Diheme Enzymes: Understanding Natures' Design for Cooperative Catalysis and Sustainable Development

PI: Prof. S. P. Rath
Dept. of Chemistry

Sponsor: J C Bose Grant (ANRF, DST)



The research is aimed at biomimetic study of di-heme enzymes such as cytochrome c peroxidases, rubber oxygenases and MauG and has been designed to understand the Nature's sophisticated design at the molecular level and also to reproduce the enzymatic functions in the laboratory for sustainable development and industrial applications. Di-heme enzymes are not simple heme assemblies but indeed sophisticated devices. Heme-heme interaction and cooperativity appear to be critical for high catalytic efficiency of diheme enzymes. Each heme unit behaves like a domain in multi-domain proteins and also has specific functions, including a regulatory one. Efficient catalysts will be designed to destroy the reactive oxygen species (ROS) efficiently as a sustainable solution for aging and age-related diseases. The oxidative decomposition of the rubber/polymer will also be investigated using synthetic rubber oxygenase analog, a long waited natural and sustainable solution towards environmental pollution.

Most importantly, the outcome of such investigation will also provide practical solutions for future sustainable development and industrial application.

An Experimental and Simulation Approach to Understand Shock Attenuation in Layered Heterogeneous Targets

PI: Prof. Amar Agarwal
Dept. of Earth Sciences

Sponsor: DIA-CoE

A shock wave may attenuate by (i) geometric scattering, (ii) scattering due to reflection and refractions at the heterogeneities, and (iii) deformating the target. This project aims to understand the behaviour of shock waves travelling through a heterogeneous and layered medium.

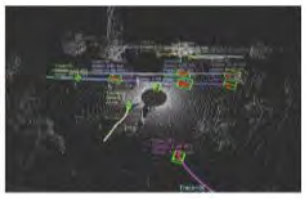
In this project 2D hydrocode simulations are being set up to understand the material deformation and behaviour of shock waves (reflections, and positive and negative superposition) at material heterogeneities and layer boundaries. Experimental verification using high velocity (~1.8 km/s) plate impacts will be used to produce parallel shock front, and the microstructural deformation, at the porosity and layer boundaries will be studied.

Proactive Safety and Mobility Assessment using LiDAR-based Traffic Monitoring

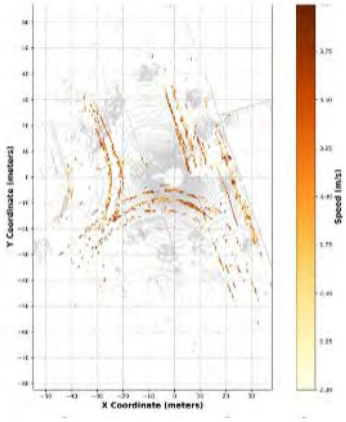
PI: Prof. Aditya Medury
Co-PI: Prof. Salil Goel
Dept. of Civil Engineering
Sponsor: AIRAWAT Research Foundation

Data Capture

Object Detection



Object Tracking



Trajectory Extraction and Traffic Parameters Calculation

This project aims to develop a portable LiDAR-based road traffic monitoring system to analyze road user movements and interactions between them. The LiDAR sensors can be used to isolate the static road environment from dynamic road users given better depth resolution and localization ability under varying visibility conditions when compared to cameras. The point clouds of dynamic road users will be further processed to automate traffic counts, speeds of vehicle trajectories, heatmaps of road utilization as well as the presence of unsafe interactions among road users (e.g., near-crashes, violations). The portable data collection setup can help aid the analysis of black spot audits as well help conduct short-term evaluation of changes in design and operational characteristics. The proposed approach is designed to be adaptable to different road settings (e.g., intersections, roundabout, midblock segments).

The analysis is expected to document a high resolution of mobility and safety metrics that can facilitate short-term assessment of road infrastructure, and complement accident-based studies. Traffic accident-based assessment of road safety relies on historical crash data, which is a reactive process. Crashes are rare events and suffer from underreporting. Consequently, any assessment of risk as well as effectiveness of safety interventions based on crashes alone requires a longer evaluation time frame. In comparison, the proposed approach is proactive in nature.

IIT Kanpur's Collaborative Achievement in Guinness World Record for Largest Electric Bicycle Delivery

IIT Kanpur has been co-featured in the **Guinness World Records for the Largest Electric Bicycle Delivery** through the E-Cycle program, in collaboration with EMotorad, Kuppam Area Development Authority (KADA), District Collectorate of Chittoor, and the Government of Andhra Pradesh. The Guinness World Records certificate was presented to Hon'ble Chief Minister Shri N. Chandrababu Naidu, with representation from the Institute by Principal Investigators Prof. Manoj Kumar Tiwari and Prof. Rajeev Jindal. Two IIT Kanpur alumni: Mr. Hari Shankar Consultant to the Kuppam Net Zero Constituency Project, and Mr. Vikas Marmat (IAS), Project Director, Kuppam Area Development Authority, played a key role in coordinating and supporting the initiative. This is a significant milestone in IIT Kanpur's journey toward sustainability-driven innovation and impactful public-sector collaboration.

Application of Kirigami-based Metamaterials for Interfacial Effects

PI: Prof. Animangsu Ghatak
Dept. of Chemical Engineering
Sponsor: Anusandhan National Research Foundation (ANRF)

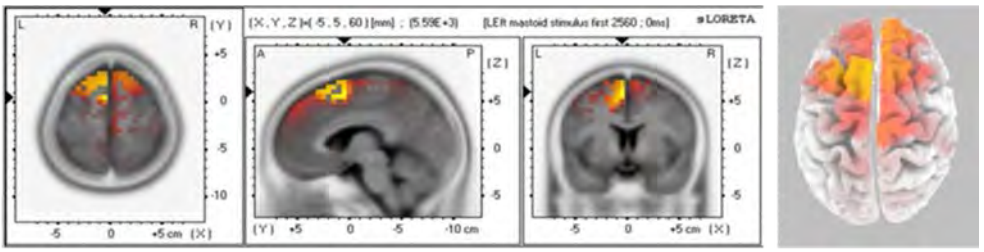
Kirigami, is a Japanesse art, that involves introducing strategic cuts into a thin two-dimensional sheet to transform it into stretchable, three-dimensional, auxetic structures upon mechanical loading. Such kirigami-inspired designs have enabled lightweight, strong structures, tunable optical materials, enhanced heat transfer systems, and robotic skins. However, their integration with surface and interfacial phenomena remains largely unexplored. Existing studies, on this field primarily exploit mechanical flexibility rather than modifying interfacial behaviour itself. Integrating kirigami with soft-matter interfacial effects—such as wetting, elastocapillarity, surface instabilities, and nucleation—offers opportunities to dynamically control liquid motion, adhesion, heat and mass transfer. Addressing this gap motivates the proposed research.

Design & Development of an Array of Electroencephalogram (EEG) / Functional Near Infrared Spectroscopy (FNIRS) integrated with Multi-modal Sensory System to Capture Analysis and Classify the Emotion of Consumers

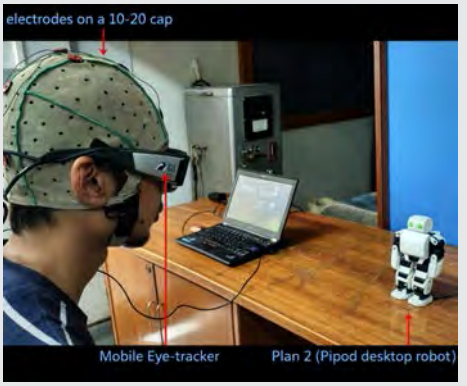
PI: Prof. Bishakh Bhattacharya
Dept. of Mechanical Engineering
Sponsor: Hindustan Unilever Limited

The project explores the use of EEG based and other physiological measurements to understand how people naturally respond during product interactions. By observing response across diverse participants the work aims to generate objective insights that complement traditional feedback based methods.

This approach coupled with new development in artificial intelligence is designed to strengthen how new ideas are evaluated and support consumer centric innovations.



Pronounced frontal midline theta



Mobile eye-tracker & EEG

An MoU was signed with **Telecommunication Engineering Centre (TEC)**, Department of Telecommunications, Government of India to strengthen national efforts in standardization, research, and innovation in telecom and ICT.

IIT Kanpur signed an MoU with **Power Foundation of India (PFI)**. This partnership marks an important step towards sustainable development and the decarbonisation of the power sector.

New Age Education and Skills Foundation (NAMTECH) and IIT Kanpur signed an MoU to mutually explore opportunities for joint initiatives, including internships, action research projects, faculty capacity development, consultancy assignments, guest lectures, and outreach activities such as conferences and symposia.

A Strategic Advisor Agreement was signed with **Helium Smart Air Private Limited** . Under this collaboration, Prof. Umesh Madanan will serve as a strategic advisor, providing advisory support to Helium Smart Air on air-conditioning technology, HVAC innovation, research & development, academic-industry partnerships, and related areas.

DICUL AM Private Limited (LUCID Implants) and IIT Kanpur signed an MoU to start collaborative partnership in the areas of 3D printed/machinable interbody spacers/spinal cages and biodegradable/ non-degradable implants.

IIT Kanpur signed an MoU with **Axiro Semiconductor Private Limited** to collaborate in the areas of semiconductor design, development, and related technologies.

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