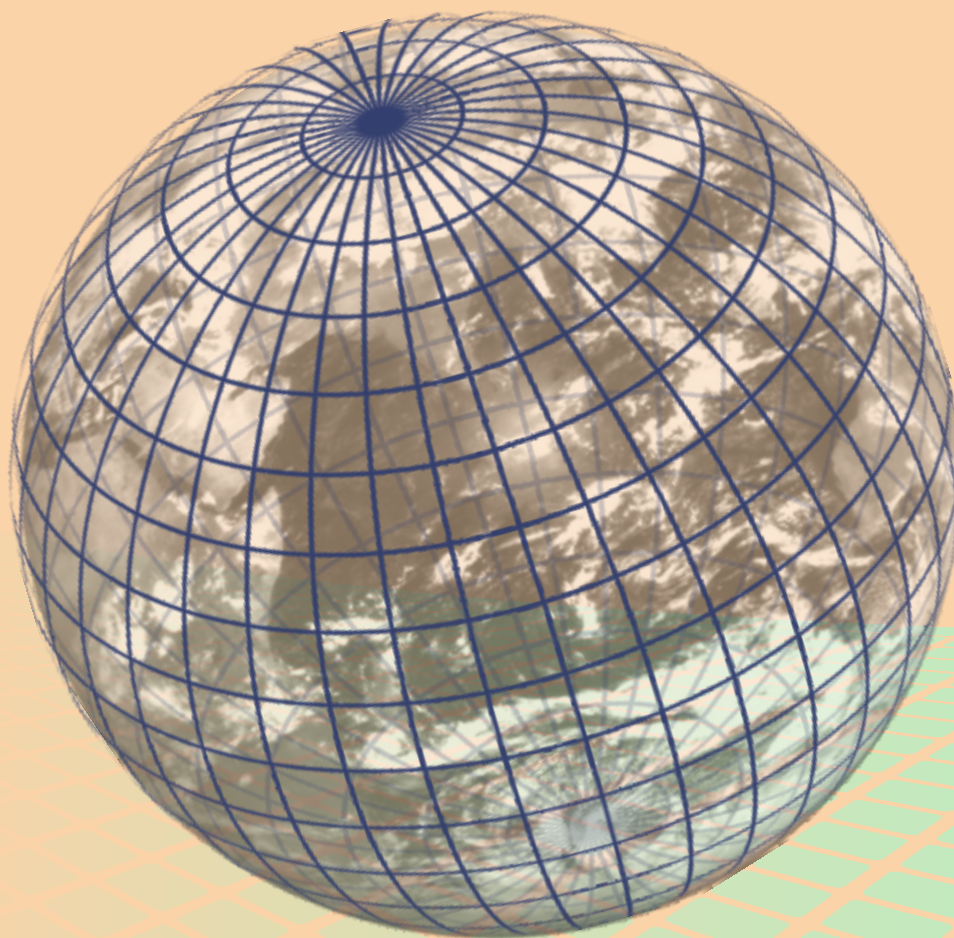




# R&D Newsletter

Indian Institute of Technology Kanpur



IITK to set up  
National Centre of  
Excellence in Geodesy .....5

**IIT Kanpur** signed an MoU with the **Bureau of Indian Standards (BIS)** for collaboration in standards education, standards based research and contributions to national & international standards. The MoU was signed by Prof. Abhay Karandikar Director, IIT Kanpur and Smt. Surina Rajan, Director General, BIS.



An MoU was signed between **IIT Kanpur** and **UP Police** to do research on data analytics, AI, Drones and Surveillance technologies. This will help to address the problems of policing.



**IIT Kanpur** signed an MoU with **Prasar Bharti** for setting up a center of excellence in next generation broadcast and broadband. Other areas of collaboration include setting up AI Incubator, manpower training & capacity building and policy, regulation and standardization studies. Prasar Bharati CEO, Shashi Shekhar Vempati exchanged the MoU with Director, IIT Kanpur, Prof. Abhay Karandikar in New Delhi on July 10, 2019.



## Success Stories of Incubated Companies

### Kritsnam Technologies

Winner of Smart Cities Technology Showcase and received LoI from New Delhi Municipal Council (NDMC)

Winner of Pitch Session at Smart Cities India Expo 2019

### Saptkritshi

Selected at the Nepal Innovation Challenge (Agritech) by the UN Capital Development Fund

### CD Space Robotics

Received appreciation from Amitabh Kant for first of its kind blood samples transportation using UAV with Tehri District Administration

### KrishiHub

Selected for sponsored participation at Facebook Developer Conference & Global Startup Summit

Cofounder Jyotiska was selected for the prestigious Forbes 30 under 30 Asia list

### Garv Toilet

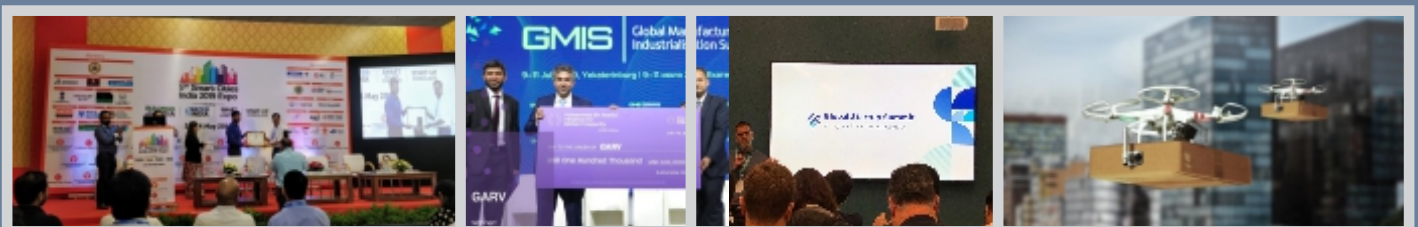
Garv Toilets wins in the 'Sustainable Cities' category of the Global Maker Challenge.

### BioScan Research

Semifinalist in the Lufthansa Runway Season 5

### HelpUsGreen

Appreciated by Sachin Tendulkar on World Environment Day initiative of DBS Bank



# Institute Lecture (April 2019 - July 2019)



## Shri Ajit Kumar Seth

Former Cabinet Secretary, Government of India

*Title: The Challenge of Climate Change and India's response*



## Prof. Tooraj Jamasb

Durham University Business School

*Title: Energy Systems Integration: Economics of a "Network of Networks"*



## Prof. Debraj Ray

New York University

*Title: Similarity, Difference, and Social Conflict*

## National Technology Day Celebration

National Technology Day is celebrated in India to mark the technological advancement in the country. Like every year, IIT Kanpur celebrated National Technology Day on May 11 2019. This year the event was coordinated by Space Technology Cell (STC). The theme of National Technology Day for year 2019 was "Space Technologies & ISRO." In keeping with this theme, STC invited two well-known scientists in the field of space technology for presentation. The first talk was delivered by Dr. B.S Munjal, Space Applications Centre (SAC), ISRO. Dr. Munjal spoke on "Technology Applications in Space/Ground Segment of SATCOM Domain". This was followed by a talk by Dr. Mehul R Pandya, SAC, ISRO, who spoke on "Eye in Space for Earth and Planetary Observations".



It was followed by the demonstration/display of technologies developed at IIT Kanpur. A group of school children from the city participated in the event.

### Development and Demonstration of a Fibre-Optic Sensor-based System for Aircraft Loads and Usage Monitoring

PI: Prof. G.M. Kamath (gmkamath@iitk.ac.in)  
Co-PI: Prof. P.D. Mangalgi (pdmngiri@iitk.ac.in),  
Department of Aerospace Engineering

Sponsor: Science & Engineering Research Board



Health monitoring of critical assets such as aircraft is becoming a reality. This is achieved by installing a network of sensors within the structure not unlike the human nervous system. A health monitoring system provides enhanced awareness of structural integrity. One approach is to monitor actual loads on the structure to estimate deterioration due to fatigue and thereby calculate remaining useful life. This is especially useful for making rational decisions regarding retirement of aging aircraft. In practice, strains are measured and monitored at some chosen locations, and the loads estimated using regression-based or machine learning-based techniques. However, only a few locations can be monitored due to the cumbersome wiring and instrumentation associated with conventional strain gages. Fibre-optic sensors, on the other hand, provide a more efficient solution, since an optical fibre can carry several strain sensors in a single fibre.



*Hansa-3 Aircraft, Flight Laboratory, IIT Kanpur*

This project will develop a fibre-optic system comprising Fibre Bragg Grating (FBG) sensors, sensor instrumentation combined with load-monitoring algorithms. The system will be demonstrated first with ground tests. Subsequently, subject to the approval of the certification authority DGCA, the system would be used for flight trials using the Hansa aircraft (see pic above) of the Flight Laboratory, IIT Kanpur. This project is being carried out in collaboration with CSIR-National Aerospace Laboratories, Bangalore.

### Towards Realization of Additive Manufacturing of Aerospace Structural Component in India

PI: Prof. Arvind Kumar (arvindkr@iitk.ac.in)

Department of Mechanical Engineering

Sponsor: Science & Engineering Research Board (IMPRINT II scheme)



This project will develop a robust platform for process design, development and optimization for metal additive manufacturing (AM) of aerospace structural components by integrating design with process physics, structure and defects formation, based on a validated integrated numerical-experimental analysis. The manufacturing of industry-standard aerospace products via AM remains a challenge unlike the established conventional processes. Considering the limited data for process design and characterization, it becomes vital to establish the

technology for aerospace structural components by addressing the underlying processing issues. Significant challenges relating to process parameters and build quality are critical to understand and overcome.

The demonstration of proof of concept to additive manufacture aerospace structural components using the design/process developed in this project will lay the foundation for technology and manufacturing maturation.

### Structural Basis of Activation, Signaling and Regulation of the Human Complement Receptor, C5ar1: A Gpcr Drug Target In Sepsis And Inflammation

PI: Prof. Arun K. Shukla (arshukla@iitk.ac.in)

Department of Biological Sciences & Bioengineering

Sponsor: Department of BioTechnology (DBT)

When deadly pathogens attack human body, the first line of defense known as the “innate immune system” comes to the rescue. A key component of this protective mechanism is known as the “complement system”. The complement system generates several peptides which trigger many different signaling cascades in cells leading to clearance of pathogens.

A major component of the complement system is “C5a” which is a highly potent pro-inflammatory mediator and it plays a central role in clearing the exogenous pathogens from the body. C5a activates an integral membrane receptor known as C5aR1 which belongs to the superfamily of G protein-coupled receptors (GPCRs), the largest class of drug targets in the human genome.

This project aims to capture and visualize a signaling complex consisting of C5a, C5aR1 and the heterotrimeric G-protein at atomic resolution using cryo-electron microscopy (cryo-EM). We anticipate that such information will provide a currently lacking framework to design novel therapeutics against various inflammatory disorders.



*cryo-EM based structure of the calcitonin receptor (a GPCR) in complex with its signaling partner heterotrimeric G-protein. The image is reproduced from a previous research publication of our collaborators on this project (Nature. 2017 Jun 1;546(7656):118-123) (EMD-8623).*

### National Centre of Excellence in Geodesy

PI: Prof. Onkar Dikshit (onkar@itk.ac.in)

Co-PI: Prof. Balaji Devaraju (dbalaji@iitk.ac.in)

Department of Civil Engineering

Sponsor: Department of Science & Technology



The Department of Science & Technology has approved the **National Centre of Excellence in Geodesy** at IIT Kanpur starting from July 1, 2019 for five years with a budgetary support of Rs. 21.14 Crores.

Geodesy is the science of measuring the size and shape of the earth including its gravity field and their temporal variations. **The objective of the Centre is to nucleate and strengthen education, capacity building and R&D activities in Geodesy by imparting regular training programmes through various courses and by supporting masters and doctoral programs with fellowships to researchers working in Geodesy.**

The Centre will act as a hub for extending laboratory and resource support for students and researchers from universities and institutions and advise state/central government departments on issues related to Geodesy.

The Centre will take up R&D projects in the entire spectrum of geodesy, viz., geoid modelling, height reference system, polar motion, estimating total water storage and crustal deformation. The Centre will also establish a network of permanent GNSS stations including one IGS station along with automatic weather and meteorological sensors.

## Automated Synthesis of Motion Plans for Large Scale Multi-Robot Systems from Complex Specifications

PI: Prof. Indranil Saha (isaha@cse.iitk.ac.in)

Department of Computer Science & Engineering

Sponsor: Defence Research and Development Organization (DRDO)

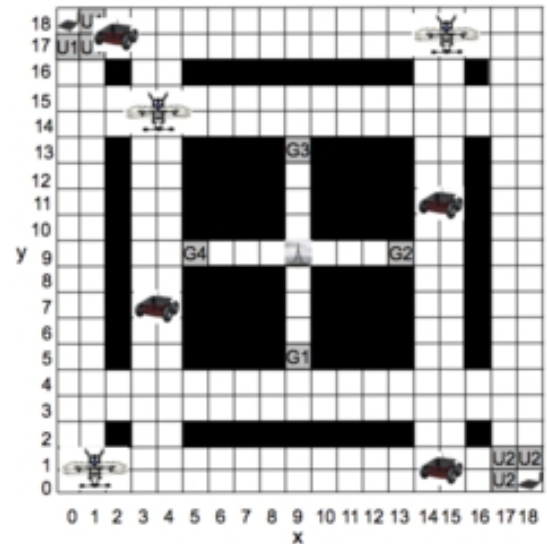


Numerous applications such as monitoring, surveillance, and disaster response involve tasks that are performed better by a team of robots rather than by a single robot. Collision-free motion planning for such systems is a fundamental problem in robotics. Though the problem of motion plan synthesis is being studied for decades, the available algorithms are not mature enough to be applicable to systems consisting of a large number of robots and having a complex logical specification.

This project aims at progressing the state of the art for multi-robot systems in the following dimensions:

- Complexity in the specifications
- Complexity in the dynamics of the robots and
- The scale of the multi-robot system

Apart from the above aspects, the project would also contribute to the robotics domain by adopting a system-oriented approach supported by formal methods. The software system developed in this project will be able to produce motion plans that are provably correct with respect to the specification, and also can be installed in the robotic systems easily in the form of embedded software. In this project, the research team at IIT Kanpur is collaborating with the researchers at the Center of Artificial Intelligence and Robotics, DRDO, Bangalore.



Ground robots and UAVs participating in surveillance activities

## Centre for Technology for Sustainable Development

The Board of Governors (BoG) IIT Kanpur has approved the proposal for the creation of a **Centre for Technology for Sustainable Development** at IIT Kanpur. The Center will leverage its research strength in key areas to address selected Sustainable Development Goals (SDGs) from the UN Charter to allow for development of technologies or solutions for UP/Indian Government.

In particular, it is possible to provide leadership in the following areas of SDG mandate:

- Intervention for healthy lives and well-being
- Quality education and outreach
- Clean, accessible water and sanitation
- Sustainable and modern energy solutions
- Industries, innovation and infrastructure
- Climate action

Various departments at IIT Kanpur will be involved for achieving success and for creating impact in addressing challenges concerning Technology for Sustainable Development.

## Development of Solid-state Thermoelectric Power Generator for Electricity Generation from Waste Heat in Steel Plant

PI: Prof. Tanmoy Maiti (tmaiti@iitk.ac.in)

Co-PI: Prof. Dipak Mazumdar (dipak@iitk.ac.in)

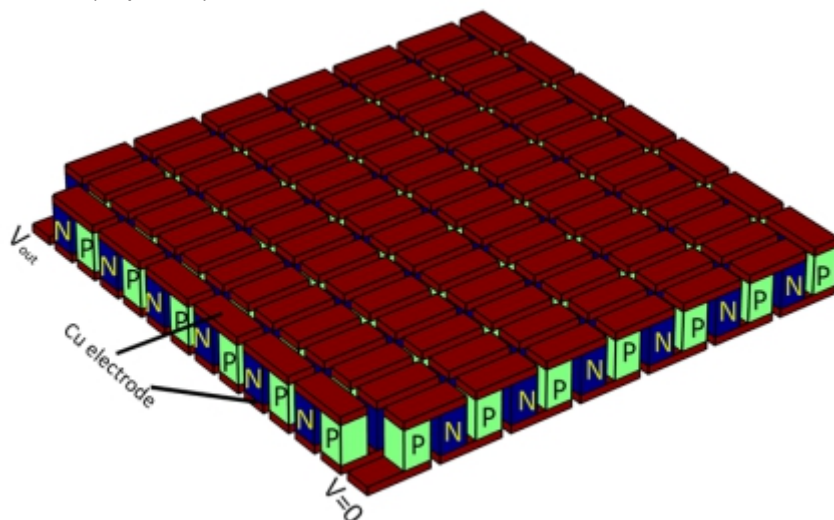
Department of Materials Science & Engineering

Sponsor: Science and Engineering Research Board, DST (Imprint-II)



The Aim of this project is to design, fabricate and test thermoelectric (TE) modules for electricity generation from waste heat in Steel plant. In order to tap huge amount of waste heat generated in steel plant, it is required to develop a highly efficient TE materials, which are stable chemically as well as thermally above 1000 K.

The project intends to use the recently developed novel perovskites-based oxides and nanocomposites to design TE generator. Furthermore, finite element modeling will be performed to optimize the size, geometry and other design parameters of TE legs in order to reduce energy loss for maximizing power output and efficiency. A state-of-the-art testing facility will be developed to evaluate the performance of TE generator especially at high temperature.



## Development of Energy Harvesting Device with Giant Power Density (~10 mW/cm<sup>2</sup>) using Thin-Film Multiferroic Composites

PI: Prof. Ashish Garg (ashishg@iitk.ac.in)

Department of Materials Science & Engineering

Sponsor: Science and Engineering Research Board, DST (Imprint-II)

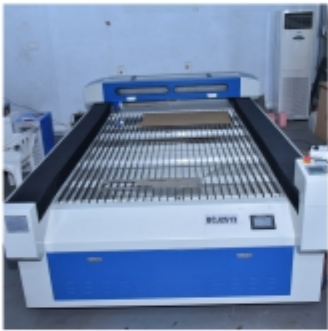


Development of energy harvesting devices is a very research active area due to their potential to utilize the energy available in the ambient, which is usually wasted. These devices are needed to support a wide variety of wireless applications including internet of things as well as plethora of other low power applications where alternative to batteries is essential.

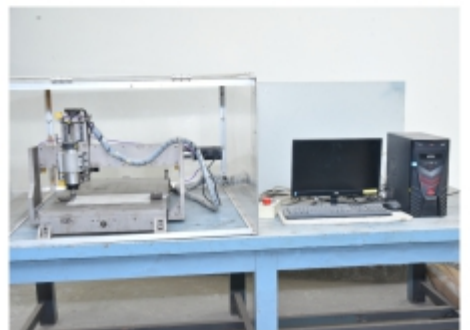
materials to fabricate flexible energy harvestors.

The project will be in collaboration with Jadavpur University and CGCRI Kolkata.

The project is aimed at achieving this objective by developing composites using magnetic and ferroelectric



## Glimpses from Imagineering Lab



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### R&D Profile at a glance

<http://www.iitk.ac.in/dord/data/R&D-profile-flyer-2019-16-08-19.pdf>

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