Volume 13, Issue 2

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R&D Newsletter

Indian Institute of Technology Kanpur

FEATURED TECHNOLOGIES

RESEARCH HIGHLIGHT

Bhāratīya Jñāna Saritā

PI: Prof. Arnab Bhattacharya

ŚIKṢĀ: Study Centre for Indian Knowledge System for Holistic Advancement,
Dept. of Computer Science & Engineering

Sponsor: Ministry of Education

The mission of the ***Bhāratīya Jñāna Saritā*** project is to create and disseminate information on the ancient and contemporary richness of **Indian Knowledge Systems** (IKS). Its scope spans a wide spectrum of topics, including philosophy, history, civilizational sciences, social and cultural sciences, mathematics, physical sciences and engineering, astronomy, linguistics, literature, political and economic sciences, medical and health sciences, culinary, nutritional, and pharmacological sciences, agriculture, arts and sculpture, fashion and edutainment sciences, oral traditions and ancient texts of India.

Alongside articles, it also provides curated resources in the form of books, audio, and video materials, uncovering knowledge preserved in Sanskrit, Prakrit, Pali, and other classical and Indian languages.

The website is hosted at
https://bharatiya-jnana-sarita.info/

The website has a search bar to find articles, books or videos relevant to the user's needs, and can be refined using different fields.

Technology Transfer

A novel technology "**Advanced Distribution Management System (ADMS) Solution**," invented by Prof. Ankush Sharma, Prof. Abheejeet Mohapatra and his team from the Dept. of Electrical Engineering, IIT Kanpur, is licensed to **Synergy Systems & Solutions**.

The developed ADMS collects real-time data from remote terminal units and other smart electronic devices installed in different locations. Featuring interfaces with SCADA for bidirectional data exchange via polling and publish-subscribe mechanisms, it also enables flexible modelling of Electrical Distribution Networks (EDNs) in urban, semi-urban, and rural pilot projects in Kanpur, ensuring seamless SCADA/ADMS integration.

FEATURED TECHNOLOGIES

Load-limiting Device for Suspension Towers

Invented by: Prof. Chinmoy Kolay & Mr. Hironmoy Kakoty

Dept. of Civil Engineering

IPA No. 202511038820

- Prevents tower damage by absorbing shock loads from sudden conductor breakage in high-voltage transmission lines.
- Supports long-stroke energy dissipation.
- Easily integrable with both existing and new transmission line.
- Cost-effective and customizable, adaptable for other structural applications.

Hybrid Electrode Material & A Method for Synthesizing the Same

Invented by: Prof. Prakash Chandra Mondala and his team

Dept. of Chemistry

IPA No. 202511061192

- Developed by chemically bonding organic 8-Aminoquinoline with inorganic copper ferrite ($CuFe_2O_4$) nanoparticles using aryl diazonium chemistry.
- Inorganic part provides high energy storage, while the organic part enables fast charge transfer and flexibility.
- Ensures conductivity, stability, high charge capacity, and durability.
- Suitable for supercapacitors, supporting eco-friendly energy solutions.

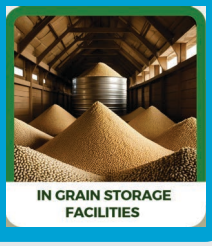
Portable Device for Non-Destructive Grain Quality Estimation

Invented by: Prof. Tushar Sandhan & his team

Dept. of Electrical Engineering

IPA No. 202411079129

- Portable, compact, and cost-effective.
- User-friendly, avoids bulky devices.
- Multi-sensor system for grain analysis.
- Checks texture, color, density, chemicals.
- Quick, non-destructive, on-the-spot results.



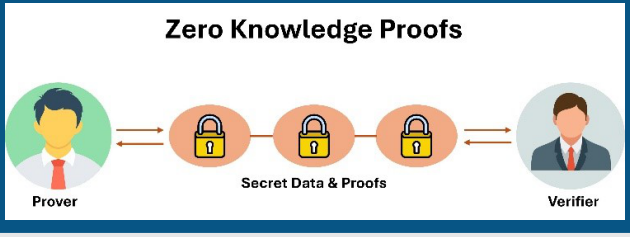
Computer-implemented System With a Lattice-based Designated Verifiable Zksnarks for Verifying Proofs And Method Thereof

Invented by: Prof. Angshuman Karmakar & his team

Dept. of Computer Science & Engineering.

IPA No. 202511059389

- Uses zkSNARKs (zero-knowledge succinct non-interactive arguments of knowledge) to prove truth without revealing underlying details.
- Prover generates a proof with secret data; DV (Designated Verifier) verifies it with a private key and can share extra info so any PV can validate without the DV's key
- Balances privacy and transparency.



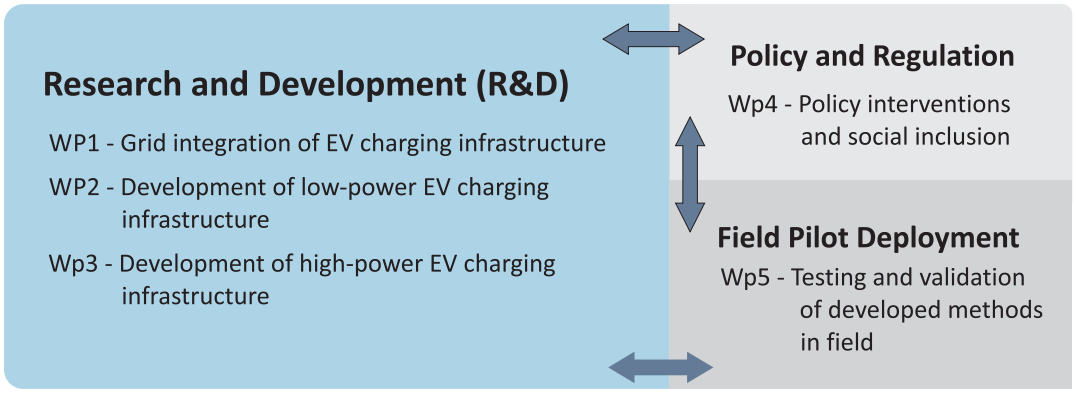
Grid Readiness for EV: Enablers & Technological Development (GREET)

Lead-PI: Prof. Saikat Chakrabarti

PIs: Professors Abheejeet Mohapatra, Ankush Sharma, Suvendu Samanta, Amarendra Edpuganti, Gururaj M. V., Piyush Kant, Swathi Battula, Ebin Cherian Mathew, Prabodh Bajpai, S. R. Sahoo, Abhilash Patel, Shiv Kumar Singh

Dept. of Electrical Engineering

Sponsor: ANRF



A massive increase in the number of EVs is expected in India in the coming years. This project aims to develop innovative solutions to the challenges posed by large-scale integration of EV-charging infrastructure into the distribution systems. Led by IIT Kanpur with a national consortium of academic and industry partners, it focuses on the following key areas: impact of large-scale grid integration of EV charging stations, development of low- and high-power wired and wireless charging infrastructure, and the required policy and social interventions. Outcomes of the project will include benchmark models, hardware prototypes, real-world pilots, and policy recommendations for a sustainable EV ecosystem in India.

Antennas for SDR and SATCOM terminal

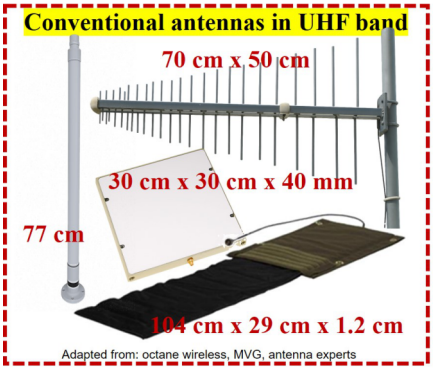
PI: Prof. R. Vijaya

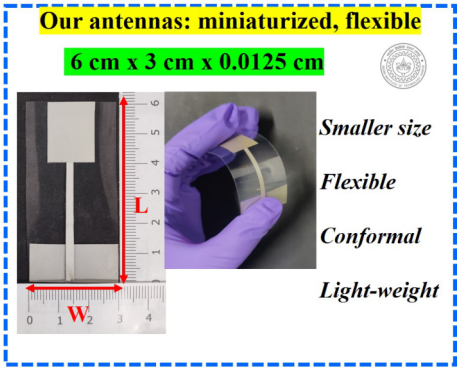
Dept. of Physics

Sponsor: DRDO Industry Academia Centre of Excellence (DIA-CoE), IIT Kanpur

Partner Lab: DEAL, Dehradun

The aim of this project is to design, fabricate and test the antennas made on flexible substrate for application in software-defined radio (**SDR**), and antennas made on conventional substrate for integrated GPS (L-band) and S-band performance in handheld terminals used for satellite communications (**SATCOM**). Conventionally, the antenna size is dependent on the frequency range of its operation, and hence antennas used in SDR are much larger in size than those meant for SATCOM.





In this project, both the types of antennas are to be miniaturized using newer techniques, without any adverse reduction in their performance metrics.

Active Tunable Electromagnetic Structure




PI: Prof. Kumar Vaibhav Srivastava
Dept. of Electrical Engineering

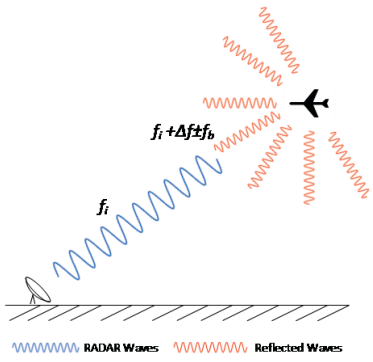
Co-PI: Prof. Raghvendra Kumar Chaudhary
Prof. Amit Verma
Dept. of Electrical Engineering
Prof. J. Ramkumar
Dept. of Design

Sponsor: DRDO Industry Academia Centre of Excellence (DIA-CoE), IIT Kanpur

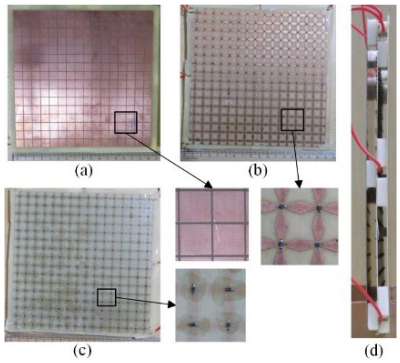
The detection capabilities of modern warfare are critical for any military mission, as the survivability of tactical assets largely hinges on how detectable they are by advanced radar sensors. Recent innovations in metamaterial (metasurface) and frequency selective surface absorbers for microwave frequencies have shown promising applications in stealth and camouflage technologies.

This project aims to fulfil defence sector demands by designing **Active Tunable Electromagnetic Structures** for stealth technology, structured around three main goals

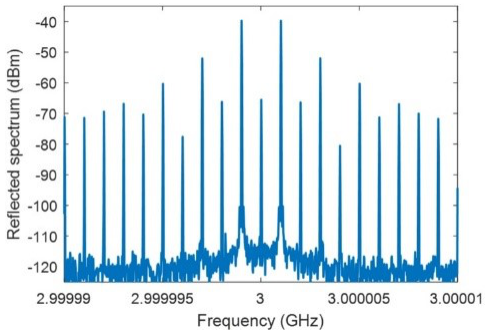
- **Time-Modulated Metasurface:** Develop a frequency-selective surface that can actively deceive radar by producing selectable harmonics and sidebands. By dynamically controlling modulation frequencies, these systems disrupt Doppler radar imaging, making target detection difficult or impossible due to the creation and suppression of multiple frequency components.
- **Reconfigurable Rasorber:** Demonstration of a rasorber that provides a transmission band within an absorption band, which can be dynamically converted to an absorption band as needed. This technology is especially useful for adaptive radome structures, which require variable electromagnetic properties for protection and RF transparency.
- **Tunable Absorber:** Design absorbers with dynamically tunable frequency bands, allowing absorption characteristics to be actively shifted across required frequency ranges, enhancing stealth capabilities against a broader set of radar systems.



(i)



(ii)



(iii)

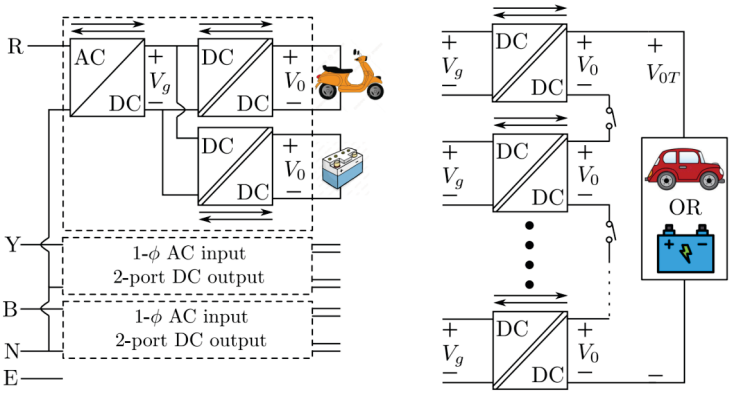
Figure: (i) Schematic of Time Modulated Metasurface for deceiving Doppler Radar (ii) Fabricated Active Metasurface (iii) Suppression of incident carrier frequency with enhanced sidebands.

Modular and Configurable Off-board Charger (G2V, V2G, V2V) for 4-, 3- and 2- wheelers

Institute PI: Prof. Utsab Kundu
Dept. of Electrical Engineering
Work-package PI: Prof. Parthasarathi Sensarma
Dept. of Electrical Engineering
Sponsor: ANRF (MAHA-EV)

Indigenous development and mass-scale deployment of off-board DC chargers are necessary for the rapid expansion of the Indian electric vehicle (EV) market. Most commercially available chargers in India are vehicle-specific and facilitate unidirectional grid-to-vehicle (G2V) power flow. Also, power outage scenarios in semi-urban and rural India necessitate fault-tolerant charger development with a battery backup feature.

This project is a part of the e-node "Empowering Research in Indigenous Development of EV Sub-systems (E-Rides)" and aims to develop a TRL-7 DC charger prototype. The proposed charger is configurable for charging multiple 2/3-wheelers or a 4-wheeler, and station batteries. The bidirectional power flow feature enables vehicle-to-grid (V2G) and vehicle-to-vehicle (V2V) operations. The system architecture is modular, which makes the solution fault-tolerant and offers significant cost benefits to the manufacturer during mass production.



Proposed modular and configurable power architecture for bidirectional off-board DC chargers. (a) Phase modular AC/DC configuration and parallel connection of DC/DC converters at the input side for 2/3-wheeler and/or 48V station battery charging, (b) Output series configuration of DC/DC converters for 4-wheeler and/or 480V station battery charging.

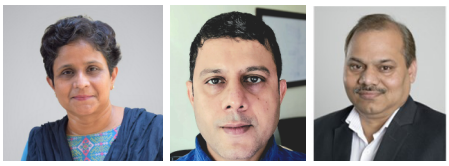
Leveraging Offline Public Data in Online Differently Private Policy Fine-Tuning

PI: Prof. Sayak Ray Chowdhury
Dept. of Computer Sciences & Engineering
Sponsor: ANRF

Modern machine learning models often train on offline data and then learn from online user interactions, raising privacy concerns—especially during fine-tuning stages that involve sensitive data. Differential Privacy (DP) mitigates these risks by adding noise to training, though this can hurt accuracy. Using offline public data helps reduce this trade-off.

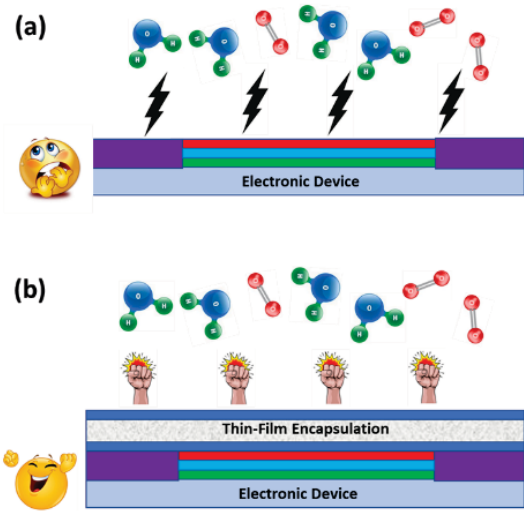
This project aims to design DP-compliant bandit and reinforcement learning algorithms using such data, with theoretical performance guarantees, and compare them to offline and online baselines. It also seeks to develop DP policy fine-tuning for aligning large language models, ultimately enabling privacy-preserving, trustworthy AI systems such as secure chatbots.

Flexible Encapsulation for Photovoltaic Devices Operating under Harsh Environments



PI: Prof. Monica Katiyar
Dept. of Materials Science and Engineering & NCFlexE
Co-PI: Dr. Ashutosh Kumar Tripathi (NCFlexE)
Dr. Sudheer Kumar (NCFlexE)

Sponsor: DRDO Industry Academia Centre of Excellence (DIA-CoE), IIT Kanpur



Fabrication of high-performance thin film encapsulation with good barrier properties against moisture and oxygen permeability is essential for packaging of thin film electronics devices. A good measure of barrier quality is water-vapor-transmission-rate (WVTR) through the barrier film. A desired WVTR of the barrier film for various electronic devices ranges from 10^{-3}g/m^2/day (e.g. for sensors, some photovoltaics) to 10^{-6}g/m^2/day (e.g. for organic light emitting diodes). Furthermore, in the field of flexible electronics, another important requirement is the reliability of these barrier films under mechanically strained conditions.

In order to meet above mentioned criteria, one needs to develop a good thin film barrier on flexible substrates, such as PET, PEN or PI. Key technology challenges in developing a high-performance barrier film is to develop a low-temperature deposition process for high quality inorganic films such as SiOx and SiNx. Low process temperature is necessary to make such films compatible with polymer substrates. Furthermore, mechanical reliability, i.e. stability under multiple bending cycle, is required in order to deploy such a barrier film on flexible electronics devices.

National Centre for Flexible Electronics at IIT Kanpur is working together with DRDO Industry Academia Centres of Excellence (DIA-CoE) to develop state-of-the-art flexible encapsulation technologies in close collaboration with DRDO labs. Technical specifications will be defined in such a way that developed encapsulation technology can be implemented in devices and applications envisaged by respective DRDO labs.

XPRIZE Grant for Innovative CO_2 Solution

Mati Carbon in collaboration with **Prof. Indra Sekhar Sen,** Department of Earth Sciences, IIT Kanpur, Yale University, and University of Sheffield, has won a ₹425 crore research grant award from **XPRIZE**. The project will scale Enhanced Rock Weathering (ERW) technology to remove CO_2 from the atmosphere across India, Tanzania, Zambia, and Southeast Asia.

Prof. Sen's team has developed a robust **Monitoring, Reporting, and Verification (MRV)** framework to ensure precise and transparent carbon crediting. This breakthrough not only addresses climate change but also promises to transform the lives of over 100 million smallholder farmers by enhancing crop yields and creating new revenue streams from carbon credits.

MoU between **Border Security Force** & IIT Kanpur was signed to enhance capabilities in Drone Forensics, Counter-UAV Technology, R&D, and Training. This collaboration marks a significant step towards strengthening national security through technological innovation and capacity building.

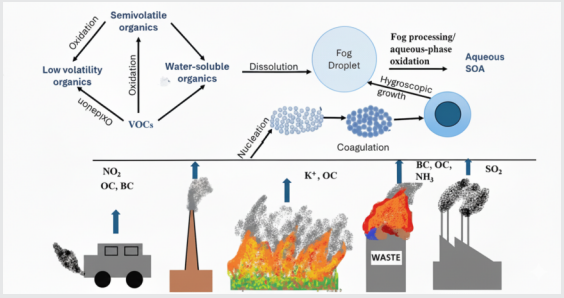
Troop Comforts Ltd. signed an MoU to collaborate in the design, development, and manufacturing of niche technology products in areas such as unmanned aerial vehicles, MSCN systems, ballistic technologies, and other advanced defense-related domains.

India Optel Limited signed an MoU to collaborate in the areas of lasers, electro-optic systems, IR optics, stabilized gimbals, and emerging technologies.

MoU with **Graymatics Inc.** to work in the areas of Video, Audio, Generative AI-based technology & solutions.

Prof. Tarun Gupta, Department of Civil Engineering, IIT Kanpur along with his former PhD student Dr. Pradhi Rajeev, has authored an invited article in the 2025 **WMO Air Quality and Climate Bulletin**, titled "***Persistence of Winter Fog in the Indo-Gangetic Plain.***" The study highlights how rising human activity, emissions, and urbanization are intensifying persistent fog events across the Indo-Gangetic plains, impacting nearly 900 million people. This global feature marks a step in taking advanced science to the wider public.

Read the article at https://lnkd.in/g3tj_TY8



Prof. Madhavi Latha Gali, Professor of Civil Engineering and Chair of the Centre for Sustainable Technologies, Indian Institute of Science (IISc), delivered an **Institute Lecture** at IIT Kanpur, on "***Chenab Bridge - Where Civil Engineering Meets the Clouds.***"

Prof. Latha, shared her extraordinary 17 years of involvement in planning, designing, and constructing the world's highest railway bridge across the Chenab River.

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