RESEARCH GROUPS @ BIT-MESRA

Chief Patron

Shri CK Birla
Chancellor

Patron

Prof. Indranil Manna
Vice Chancellor

Editor-in-Chief

Prof. Raju Poddar
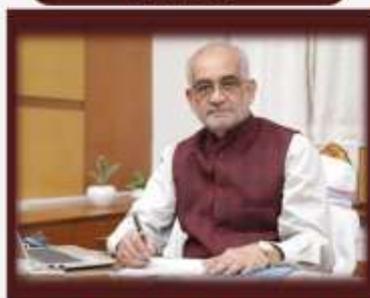Dean-Research, Innovation & Entrepreneurship

Editors

Dr. Anand Prasad Sinha
Associate Dean
Research, Innovation &
Entrepreneurship

Dr. Biswatrish Sarkar
Associate Professor
Department of Pharmaceutical
Sciences and Technology

Technical Assistant

Mrs. Sejal Shah
Senior Technical Superindent

BIRLA INSTITUTE OF TECHNOLOGY

MESRA - 835215, RANCHI (JHARKHAND), INDIA

Prof Indranil Manna
Vice-Chancellor
प्रो. इन्द्रनील मन्ना
कुलपति

बिरला प्रौधौगिकी संस्थान
मेसरा - 835215, रांची (झारखण्ड), भारत

दुरभास/*Phone* : 0651-2275402
फैक्स/*Fax* : 0651-2275401
ई-मेल/*E-mail* : vc@bitmesra.ac.in

11ᵗʰ July, 2025

MESSAGE

Advancing the frontiers of knowledge through research and innovation is a fundamental responsibility of any institution of higher learning. At Birla Institute of Technology, Mesra, we are committed to nurturing a vibrant and inclusive research environment that addresses contemporary challenges and contributes to national development and global progress.

The compendium of *Institute Research Groups* is a commendable initiative that brings together the diverse and high-quality research being pursued across departments and centres. It not only showcases the expertise of our faculty and scholars but also reflects the strategic direction in which BIT's research capabilities are evolving—toward interdisciplinary collaboration, translational outcomes, and real-world relevance.

We are actively advancing this vision through several parallel efforts: the revamp of the R&D Cell website, launch of a Research Newsletter, creation of short videos on research breakthroughs, and streamlined dissemination of funding opportunities. These platforms will serve as catalysts to amplify the visibility and impact of our research, enhance stakeholder engagement, and foster new partnerships.

This compilation highlights critical information from each research group, including thematic areas, schematic overviews, key publications and patents, recent funded projects, industry-academia collaborations, and visual documentation of research practices and outcomes. It is a reflection of the excellence, originality, and hard work that defines our research culture.

I extend my heartfelt appreciation to all faculty members, research group leaders, and scholars for their dedication and contributions. I am confident that this collective effort will reinforce BIT Mesra's standing as a research-driven institution and open new avenues for recognition, collaboration, and innovation at the national and global level.

(Indranil Manna)   11.07.2025

Message from the Dean – Research, Innovation & Entrepreneurship

At BIT Mesra, research is central to our identity as a leading institution committed to innovation, societal impact, and academic excellence. The *Institute Research Groups Book* is a significant initiative that highlights the depth and diversity of research being carried out across departments, showcasing the vibrant ecosystem of knowledge creation that defines our campus.

As part of our continuous effort to strengthen visibility and outreach, we are in the process of updating and enriching the R&D Cell website, publishing a periodic *Research Newsletter*, producing a *'Short Video Series' on Research Highlights*, and compiling *funding opportunities* for faculty and scholars. These efforts aim to reflect the latest advancements, specializations, projects, and national/international collaborations taking place at the Institute.

This document captures essential aspects of each research group, including:

- Research Theme and Broad Area of Focus
- Scope and Targeted Applications
- Graphical Abstracts and Schematic Representations
- Group Publications and Patents
- Sponsored Projects
- Visual Content (photos, fieldwork, product designs, lab setups, etc.)
- Industry and Academia Collaborations

I extend my sincere thanks to all Research Group Leaders and members for your enthusiastic participation. Your contributions are invaluable in effectively presenting the innovative work of BIT Mesra to the wider academic, industrial, and funding communities.

I am confident that this collective effort will significantly enhance the visibility of our research output and foster greater engagement and recognition at national and international levels.

Prof. RAJU PODDAR

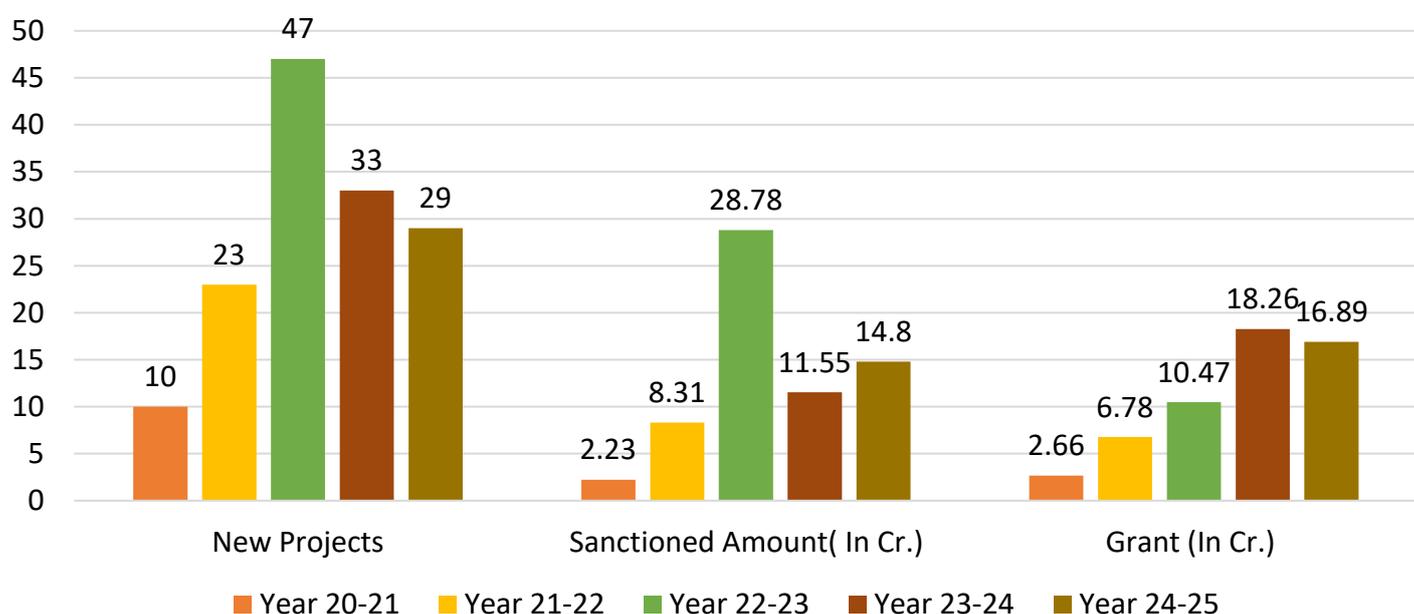Dean – Research, Innovation & Entrepreneurship

Birla Institute of Technology, Mesra

R&D Sponsored Project / Grant Details
2020-2025

Sponsored Project Details

Sponsored Research Projects and Grants

	New Projects	Sanctioned Amount (In Cr.)	Grant (In Cr.)
Year 20-21	10	2.23	2.66
Year 21-22	23	8.31	6.78
Year 22-23	47	28.78	10.47
Year 23-24	33	11.55	18.26
Year 24-25	29	14.8	16.89

FY 2020-2021

New Projects: **10 (+6)**
Sanctioned Amount: **2.23Cr**
Total Grant Received: **2.66Cr**
TEQIP-III Grant Received: **5.68 Cr**

FY 2022-2023

New Projects: **47 (+ 21)**
Sanctioned Amount: **28.78*Cr**
Total Grant Received: **10.47Cr**

FY 2024-2025

New Projects: **29 (+26)**
Sanctioned Amount: **14.8 Cr**
Total Grant Received:**16.89Cr**

FY 2021-2022

New Projects: **23 (+13)**
Sanctioned Amount: **8.31Cr**
Total Grant Received: **6.78Cr**
TEQIP-III Grant Received: **1.57 Cr**

FY 2023-2024

New Projects: **33 (+20)**
Sanctioned Amount: **11.55 Cr**
Total Grant Received: **18.26 Cr**

FY 2020-2025

Total Projects: **283**
Sanctioned Amount: **65.67 Cr**
Total Grant Received: **120.73 Cr**

DST FIST (4) + PURSE (1): 14.44 Cr
Fund Split: 75:25

R&D Consultancy/ Patent/ Seed Fund Details
2021-2025

Patent Details

Category	2021	2022	2023	2024	Total
Number of Patents Published	11	11	40	37	99
Number of Patents granted	2	4	5	7 + 19(US)	37

Consultancy Details

In Lakhs

Category	2021 -2022	2022-2023	2023-2024	2024-2025	Total
Number of Consultancy Projects	56	23	12	11	102
Total Cost	24.80	124.53	75.40	54.20	278.93

BIT Support for CIF USE

In Lakhs

Category	2021 -2022	2022-2023	2023-2024	2024-2025	Total
External Fund Generated from CIF	7.24	10.06	10.97	9.51	37.78
Internal Support by CIF	54.82	91.53	124.27	372.86	643.48

Seed Fund for New Faculty

In Lakhs

Category	2021 -2022	2022-2023	2023-2024	2024-2025	Total
Fund Allotted	90	30	40	52	212

Indexing

Birla Institute of Technology Mesra, Ranchi

Research Groups @ BIT Mesra Ranchi

Research and Development Cell (RDC) is responsible for the implementation of the institute's overall research, innovation and entrepreneurship programs which are focused towards advancement of human knowledge and development of society. Research efforts are directed towards solving complex problems, delivering social benefits and driving economic prosperity, nationally as well as globally. The RDC aims (a) to provide needed administrative support to all faculty in proposing and executing their research /consultancy projects, (b) to improve research culture in the institute through various training program and seed grant schemes, (c) to promote innovation and entrepreneurship amongst students and faculty, (d) to assess the research related SWOT and provide needed intervention.

DEPARTMENT OF ARCHITECTURE & PLANNING

Research Group - Planning, Development & Economics

- **Name of Principal Investigator/ Group Leader**: **Dr. Satyaki Sarkar**
- **Research Theme**: Urban Planning, Development Management, Economic Development
- **Broad Area of Research and Scope:**

➢ Urban and regional planning - inclusive planning; sectoral planning.
➢ Sustainable planning - approach to growth and human development, sustainable habitat.
➢ Development Management - managing the complex and distributed development of products.
➢ Economic development - involves using the tools of economics to analyse urban issues.

Schematic Representation of Broad Area of Research:

- **Total Number of Publications by the group:**
- **Top 5 Article with impact factor: (Vancouver Style)**

1. Sneh Prabha, Sarkar Satyaki., & Roy Supriyo. (2025), *Review of the Indicators for Assessing Socio-Economic Development, Social Innovation and Entrepreneurship Development in small heritage town: Approaching Sustainability*, in Social System Reforms to Achieve Global Sustainability, IGI Global. ISBN: 979-833-73-1280-4 (Accepted – in press) (SCOPUS)

2. Varsha V., Sarkar Satyaki., & Roy Supriyo. (2024). *An Overview of key indicators and evaluation tools for assessing economic value of heritage towns – A literature review,* Journal of The Institution of Engineers (India): Series A, [ISSN 2250-2149] (Springer) (SCOPUS) (Accepted – in press) DOI: 10.1007/s40030-024-00807-3

3. Nag A., & Sarkar S. (2024). *Integrating Choice Freedom, Economic Health, and Transportation Infrastructure to Forecast Tourism Demand: A Case Study of Bishnupur and its Alignment with Sustainable Development Goals,* Transport Policy (ScienceDirect), 147, 198-214, [ISSN 0967-070X] (SCI IF:6.8) DOI/10.1016/j.tranpol.2024.01.001.

4. Sarkar S., Kumari K., & Prasad P. (2024). *Approaching Planning for new areas based on Environmental Suitability and Accessibility - A Study of Navi Mumbai, India*, Journal of Urban Planning and Development (ASCE), 150(1), (SCIE; IF: 2.5) [ISSN: 1943-5444/0733-9488] DOI:10.1061/JUPDDM/UPENG-4335

5. Swarup Mukherjee, Anupam Dey & *Supriyo Roy** (2025). Service Quality Management under Risk Prioritization and Imprecise Information: A Hybrid Fuzzy Approach. **Accepted for Publication**, **The TQM Journal, Emerald, Q1, I.F: 9.1** (ABDC/WOS/SCOPUS) 1754-2731, DOI 10.1108/TQM-07-2024-0245

6. Swarup Mukherjee, Anupam Dey and **Supriyo Roy** (2025). Risk prioritization in enterprise supply chains: application of fuzzy analytic hierarchy process. Accepted for Publication, **Business Process Management, Emerald,** I.F : 8.8, Q1 (ABDC/WOS/SCOPUS), In Earlycite.

Patents by the group: NIL

Research Projects:

Sl. No.	Project Title	PI / Co- PI/	Funding Agency	Year of Sanction	Sanctioned Amount	Project Duration
1	Interrelationship Between Socio-Economic Development, Social Innovation and Entrepreneurship Development: An Empirical Study on Small Heritage Town	Project Director – Dr. Satyaki Sarkar, Co-Director – Dr. Supriyo Roy	Indian Council of Social Science Research	2023	Rs 8.06 L	2 years - Ongoing
2	Heritage Consultation of Heritage Byelaws of 08 Centrally Protected Monuments & Protected Areas" In Bihar & Jharkhand	Co-PI – Dr. Satyaki Sarkar	National Monuments Authority Ministry of Culture, Government of India	2022	Rs 7.27 L	6 months - completed
3	Upgradation of MUP Lab to 3D City Engine lab under MODROBS	PI – Dr. Satyaki Sarkar	AICTE	2021	Rs. 8.00 L	2 years - ongoing
4	Preparation of Gram Panchayat Spatial Development Plan / Master Plan for Neori (Ranchi district) and Kanrra (Bokaro District)	PI – Dr. Satyaki Sarkar	Ministry of Panchayati Raj, Government of India	July 2020	Rs. 5.00 L	6 months - Completed

Industry/Academia Collaborations: NIL

Targeted Application Area: Urban Development**,** Socio-Economic Development, and Entrepreneurship Development

Achievements:

Brief Description of Projects :

Problem Statement:	Applications:

Problem Statement:

Ensuring Quality Drinking Water Access in Jharkhand Coal Mining Areas: Issues and Challenges

Heavy coal mining activities severely contaminate groundwater with harmful chemicals and metals, making access to safe drinking water extremely difficult. The absence of clean drinking water in mine settlements often results in various health problems, particularly waterborne diseases. The situation worsens during dry seasons, intensifying water scarcity. Therefore, it is crucial to improve groundwater collection and sharing mechanisms in these mining communities to ensure sustainable and safe water access for all. All these require significant attention.

Applications:

1. The primary design is directed at ensuring drinking water access and identifying the pertinent factors by:

- Understanding the drinking water issues under broad areas of water resource management. For this, we will propose Trend Analysis to observe the percentage changes over time in the selected data.
- Identifying the factors affecting drinking water quality (from the possible factors). We may explore Factor Analysis or use Q-sort Analysis.

Strategy/ Approach/ Technique/ Experiments used to solve
   a. The first stage of the proposed trend analysis uses secondary data.
   b. For the second stage, we proposed that the research is survey-based and empirical. For that, we framed a questionnaire to collect primary data. Framing a questionnaire after exploring the maximum possible issues related to the quality of drinking water is one of the areas of contribution of this study. Here, the population is the residents staying in the rural region of the Rajrappa coal belt.
   c. Sampling Plan: We plan to identify the Blocks as Strata. We use a stratified sampling scheme to choose the blocks. The adults residing in each block are considered a sub-population. Now, from each block, we randomly select sample adults as respondents.
   d. Samples: Our target samples are 400+. We choose blocks and collect samples from each block. These raw samples will be scrutinized for data analysis.
   e. Pre-Pilot and Pilot Study: We take 10% samples for the pre-pilot and 15-20% for the pilot study. After checking with statistical analyses, we proceeded with large-scale data analysis.
   f. The third stage is the identifying the factors. For this, we propose Factor Analysis.
   g. The last stage is ranking (prioritization), which identifies factors.

Group Members

DEPARTMENT OF BIOENGINEERING AND BIOTECHNOLOGY

Research Group - Systems Biology

- **Name of Principal Investigator/ Group Leader**: Dr. Anjana Dwivedi
- **Research Theme**: Cancer Systems Biology, Biosignal analysis in health and disease
- **Broad Area of Research and Scope:**
  - Systems Biology
  - Biomedical Instrumentation

Schematic Representation of Broad Area of Research:
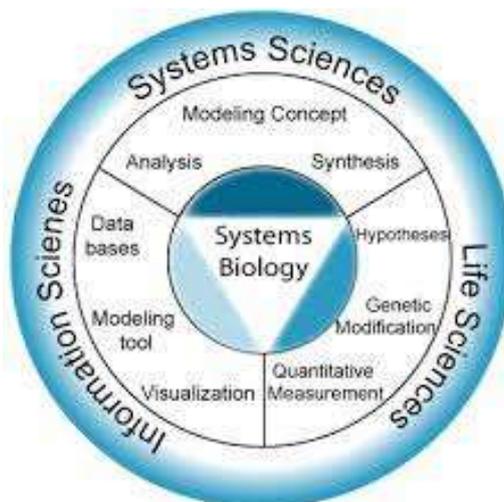
Total Number of Publications by the group: 15

Top 5 Article with impact factor: (Vancouver Style)

1. Roy, A., Pandey, D. M. and **Dwivedi, A**. (2025 Accepted). A review on modeling approaches for the transcriptional regulatory network intricacies of circadian clock genes in plants, *Planta*

2. Singh, A., & **Dwivedi, A.** (2024). Network dynamics investigation of omics-data-driven circadian-hypoxia crosstalk logical model in gallbladder cancer reveals key therapeutic target combinations. *Integrative Biology*, 16, zyae018, https://doi.org/10.1093/intbio/zyae018

3. Singh, A., & **Dwivedi, A.** (2022). Circulating miRNA and cell-free DNA as a potential diagnostic tool in early detection of biliary tract cancer: a meta-analysis. *Biomarkers*, *27*(5), 399-406, DOI: 10.1080/1354750X.2022.2064551

4. Singh A, & **Dwivedi A.** (2025). A systems pharmacology based ADME profiling and molecular docking analysis unveils the potential role of baicalein as the natural drug candidate for gallbladder cancer. *International Journal of Biomedical Engineering and Technology*. 47(4), pp 287-307, **DOI:** 10.1504/ijbet.2024.10067441 .

5. Anusha., & **Dwivedi, A.** (2022). Hand grip strength and Electromyogram data acquisition and analysis pre and post grounding in healthy young adults. *Journal of Physics*, 2318 (2022) 012027, doi:10.1088/1742-6596/2318/1/012027

Patents by the group:

Sl. No.	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	A Computational System for Identifying Drug Target Combinations to Inhibit Colon Cancer Progression, And Method Thereof.	202531003757, January 16, 2025	Published

Research Projects: Recent 5 in chronological

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Investigating the circadian crosstalk pathways in cancer: A systems biology approach	PI	SEED MONEY, BIT, MESRA	3.2	2 years

Industry/Academia Collaborations: Dr. Rajendra Kumar, RIMS, Ranchi

Targeted Application Area: Drug Target Identification and Therapeutic Development

Achievements:

Investigating the circadian crosstalk pathways in cancer: A systems biology approach

Problem Statement:

With cancer cells becoming resistant to chemotherapy, there is a pressing need to identify effective therapeutic targets. Identification of common dysregulated genes and studying crosstalk among important pathways can lead to screening genes/combinations as therapeutic targets

Applications:

- Cancer Diagnostics and Biomarker Discovery
- Understanding Tumor Heterogeneity
- Drug Target Identification and Therapeutic Development
- Personalized and Precision Oncology
- Modeling Cancer Progression and Metastasis
- Tumor Microenvironment (TME) Analysis
- Resistance Mechanism Elucidation
- Synthetic Biology and Cancer Therapy
- Cancer Epidemiology and Population-Based Modeling

Strategy/ Approach/ Technique/ Experiments used to solve	Graphical Abstract
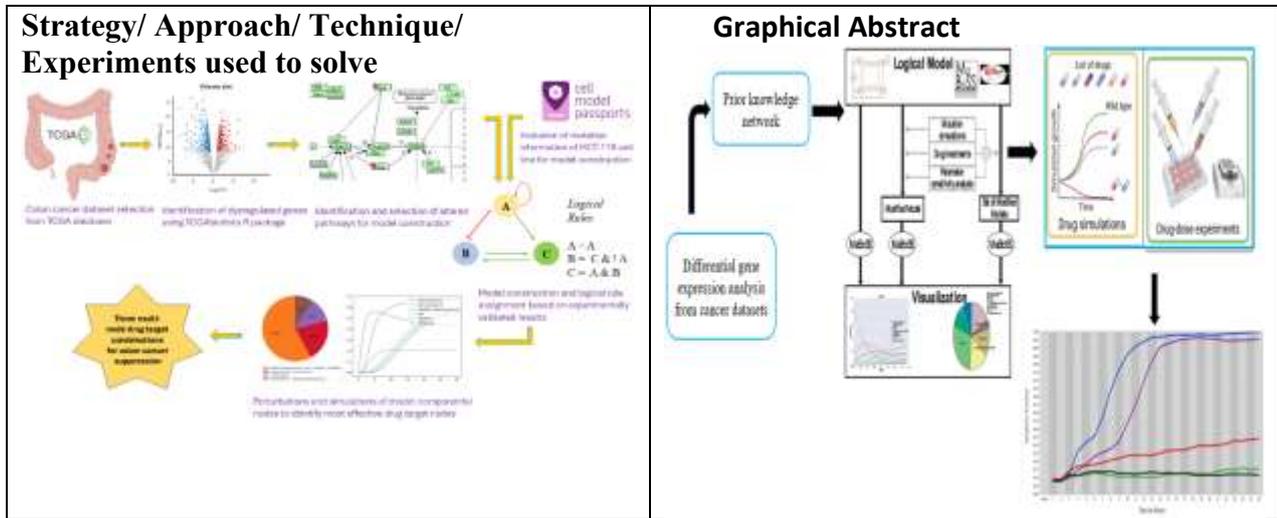
Group Members

Research Group -B³R Lab

- **Name of Principal Investigator/ Group Leader**: Dr. Soham Chattopadhyay
- **Research Theme**: Biosensors, Biofilms, & Bioremediation
- **Broad Area of Research and Scope:**
  - Development of Biosensors for Triglycerides detection in a sample
  - Use of Biofilm for the degradation of heavy metals and toxic dyes in water

Schematic Representation of Broad Area of Research
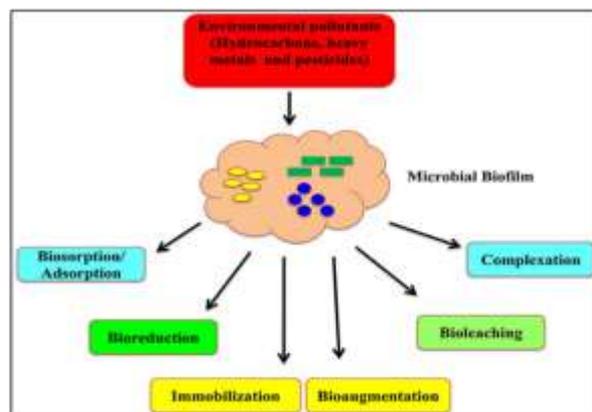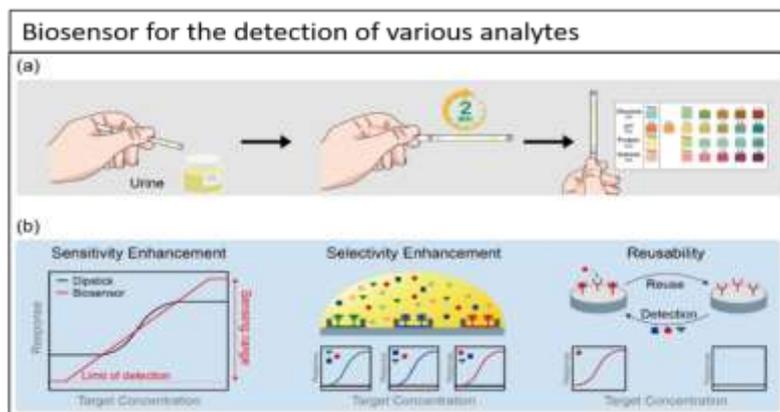
- **Total Number of Publications by the group: 13**
- **Top 5 Articles with impact factor: (Vancouver Style)**
  1. Iyer MB, Shreshtha I, Baradia H, Chattopadhyay S. Challenges and opportunities of using immobilized lipase as biosensor. Biotechnol Genet Eng Rev. 2022;38(1):87-110. https://doi.org/10.1080/02648725.2022.2050499. (IF: 6.5).
  2. Iyer MB, Chattopadhyay S. Colourimetric detection of triglycerides using porcine pancreatic lipase immobilized nanocomposite biosensor. Biomass Conversion and Biorefinery. 2023;13:1-10. https://doi.org/10.1007/s13399-023-04458-5 (IF: 3.5)
  3. Mehra A, Das P, Chattopadhyay S. Analyzing the Growth and Characteristics of *Pseudomonas aeruginosa* Biofilm and Estimating its Cr (VI) Removing Potential from Water. Water, Air, & Soil Pollution. 2024;235(11):721—37. https://doi.org/10.1007/s11270-024-07548-w (IF: 3.8)
  4. Das P, Mehra A, Sachan SG, Chattopadhyay S. Screening different solid supports for *Pseudomonas aeruginosa* biofilm formation and determining its efficiency for decolorization and degradation of Congo red. Archives of Microbiology. 2024 Oct;206(10):402—15. https://doi.org/10.1007/s00203-024-04125-x (IF: 2.3)
  5. Iyer MB, Baradia H, Chattopadhyay S. Graphene Oxide Enabled Colorimetric Detection of Triglyceride. BioNanoScience. 2024;14(5):5044-54. https://doi.org/10.1007/s12668-024-01493-y (IF: 3.0)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Iyer M., Chattopadhyay S., A Nanoparticle-Based Method for Determining Fatty Acid In Sample	**E-12/5/2025/KOL**	Published

Industry/Academia Collaborations: Dr. Janmejay Pandey, Central University of Rajasthan, India
Targeted Application Area: Blood TG detection, Pesticide detection and remediation, Biofilm-based Dye degradation **.**

Achievements:

Developing pH-resolved colorimetric paper biosensor using immobilized enzyme-nanoconjugate for detection and quantification (smartphone-based) of Triglycerides
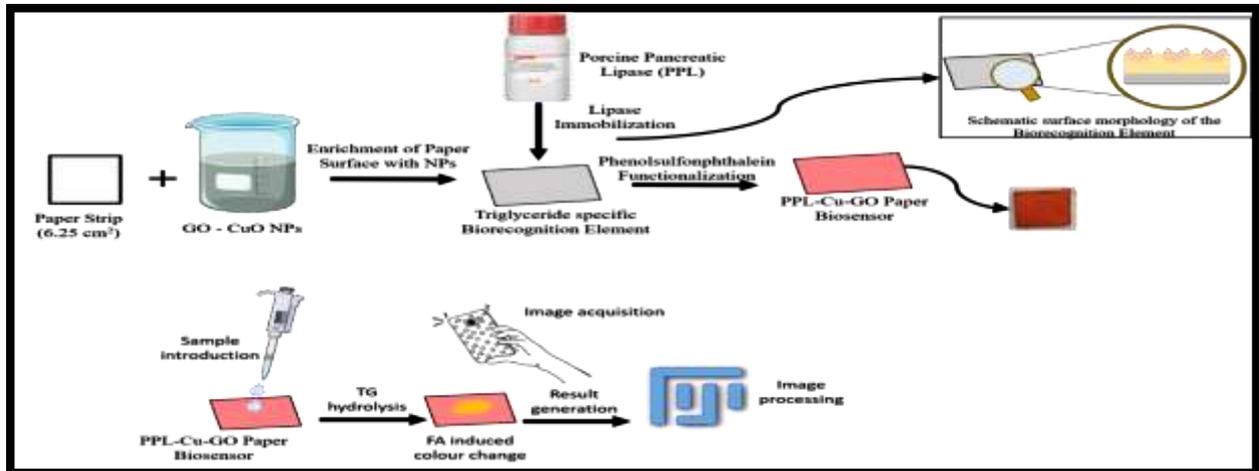
2. Bioremediation of toxic dyes using Biofilm producing bacteria isolated from industrial wastes
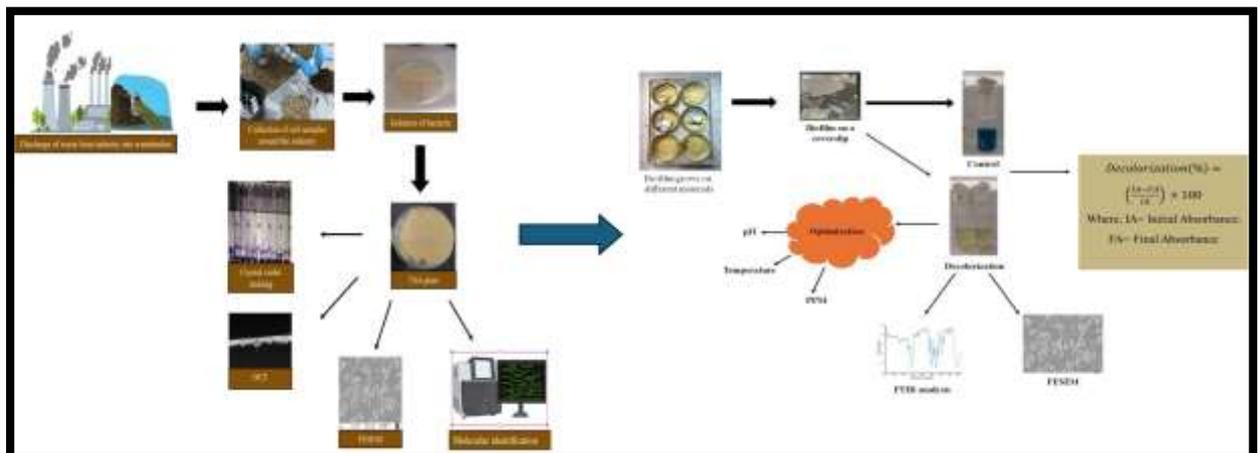
Group Members

Research Group -Biophotonics

- **Name of Principal Investigator/ Group Leader**: Prof. (Dr.) Raju Poddar
- **Research Theme**: Biomedical device, Optics, Spectroscopy
- **Broad Area of Research and Scope:**
  - Indigenous development of multiple non-invasive biomedical devices
  - Nano-thernostics through up conversion nanoparticles and magnetic nanoparticle
  - Label free high contrast Bioimaging

Schematic Representation of Broad Area of Research:
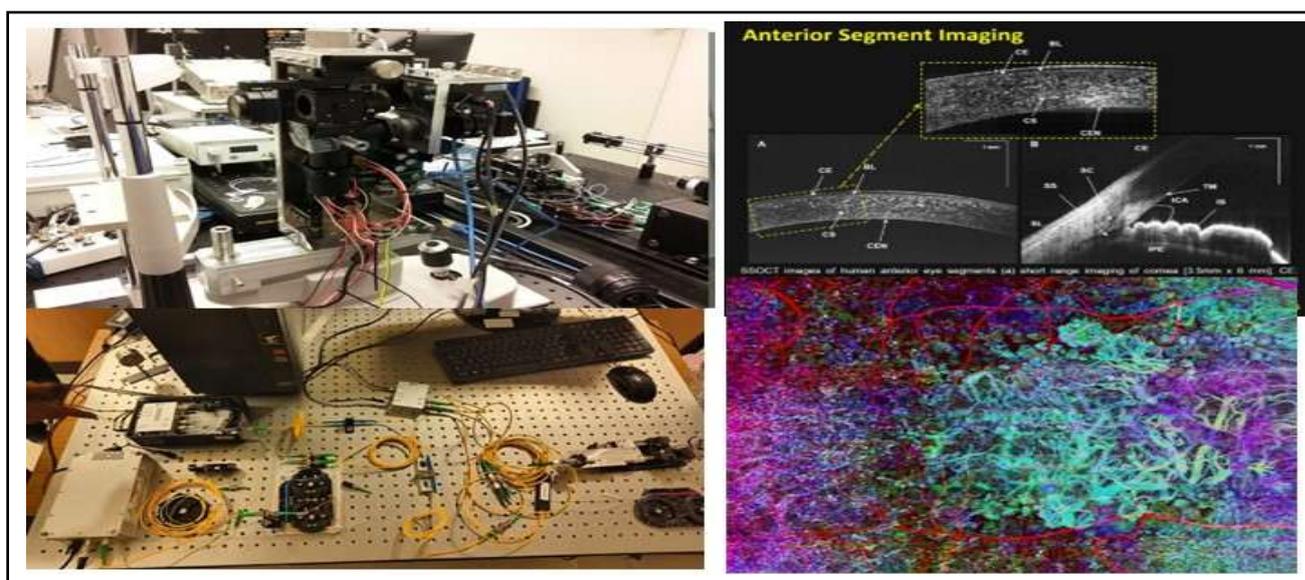
- **Total Number of Publications by the group: 126+**
- **Top 5 Article with impact factor: (Vancouver Style)**

1. Mohan M, Poddar R*. Polymerically engineered upconversion nanoparticles (UCNPs) as contrast agent for functionally modified optical coherence tomography (OCT). Materials Science and Engineering: C. 2021 Feb 1;121:111841.
   https://doi.org/10.1016/j.msec.2020.111841 (IF - 8.4)

2. Alam Z, Poddar R*. Assessing silver nanoparticle uptake dynamics in young zebrafish using swept source optical coherence tomography to mography. Optics & Laser Technology. 2024 May 1;172:110481. https://doi.org/10.1016/j.optlastec.2023.110481 (IF - 4.6)

3. Asani PC, Alam Z, Poddar R*. Exploring the impact of PVC and PVA microplastics on zebrafish tissue using multi-spectral imaging, Optical Coherence Tomography (OCT) and bio-speckle OCT (bOCT). Chemosphere. 2023 Nov 1;341:140088. https://doi.org/10.1016/j.chemosphere.2023.140088 (IF - 8.9)

4. Alam Z, Poddar R*. An in-vivo depth-resolved imaging of developing zebrafish microstructure and microvasculature using swept-source optical coherence tomography angiography. Optics and Lasers in Engineering. 2022 Sep 1;156:107087. https://doi.org/10.1016/j.optlaseng.2022.107087 (IF - 3.9)

5. **Indoliya A, Dhar D, Mohan M, Poddar R***. In-vivo analysis of iron-gold composite nanoparticles as potential exogenous contrast agents for magnetomotive optical coherence tomography (MMOCT). Journal of Magnetism and Magnetic Materials. 2020 Nov 15;514:167211. https://doi.org/10.1016/j.jmmm.2020.167211 (IF - 3.8)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	A red-reflux imaging system for detecting retinal defects, and method thereof, Raju Poddar*, Abhishek Banerjee, Shreekant Pandey and Pratyush Pallav	202531003239	Published
2	A method and apparatus for imaging of vasculature of human eyes adapting an intensity disparity field subtraction, Raju Poddar	E-1/39303/2019-KOL	Granted
3	A portable multispectral imaging system for detection of disease in plants in method thereof, Pooja C Asani, Mamta Kumari and Raju Poddar*	202331057916	Published
4	A confocal scanning laser ophthalmoscope system, Raju Poddar* and Sweta Satpathy	202311090140	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Towards development of a novel high resolution and high contrast in-vivo imaging technique based on Swept Source Optical Coherence Tomography (SSOCT) and unique Upconversion Nanoparticles (UCNPs)	PI	DST-SERB, CRG	37.06	2017-2021
To Study the Structure and Blood Flow of Chorioretinal Complex in Human Using Optical Coherence Angiography	PI	5/20/21 (Bio)/2014 -ITR-I	43.42	2017-2020
Indigenous development of low-cost AI enabled portable multispectral camera system for rapid early detection of plant diseases and other stress based morphological changes	PI	DST-SERB, CRG	31.46	2023-2025
Indigenous development of novel biomaterial for laser tissue soldering process and real-time monitoring with optical coherence tomography/angiography system	PI	DST-NMICPS; TIH – ISI	7.8	2023-2026
Indigenous development of low-cost optical imaging system for early detection of Retinoblastoma in child	PI	DHR-ICMR	30.81	2023-2026

Industry/Academia Collaborations: IIT-Indore, IIT-ISM Dhanbad, UC Davis, USA

Targeted Application Area: Biomedical instrumentation, Photonics, Imaging, diagnosis of tumour

Achievements:

Member National Academy of Sciences, Research Professor UC Davis, USA, Postdocs NTU Singapore, University of Tsukuba, Japan and Stanford University.

Brief Description of Projects

Designed and developed advanced Swept-Source Optical Coherence Tomography (SSOCT) and Optical Coherence Angiography (OCTA), MMOCT and FD OCT systems for high-resolution, high-contrast in-vivo imaging. Introduced for the study of a novel high-resolution and high-contrast in-vivo imaging technique, funded by DST-SERB (EMR/2015/001757), Structure and Blood Flow of chorioretinal complex in human, (ICMR-EMR (5/20/21(Bio)/2014-ITR-I), noninvasive imaging of posterior segment of the animal eye (DST-IDP/MED/10/2010) posterior segment of human eye with high resolution scattering optical coherence angiography BT/PR3309/MED/32/185/ 2011), next generation high speed data acquisition and processing system for ophthalmic SSOCT (MRP-MAJOR-INST-2013-23798).Using custom-built MMOCT and PTOCT combined with laser therapy, real-time monitoring of cancerous tumours in rat models demonstrated a significant reduction in tumour size, highlighting the potential of this approach for advancing cancer treatment strategies.

Applications:

- ➢ Medical devices
- ➢ Healthcare
- ➢ Nano thernostics
- ➢ Tumour detection
- ➢ Ophthalmology

Graphical Abstract
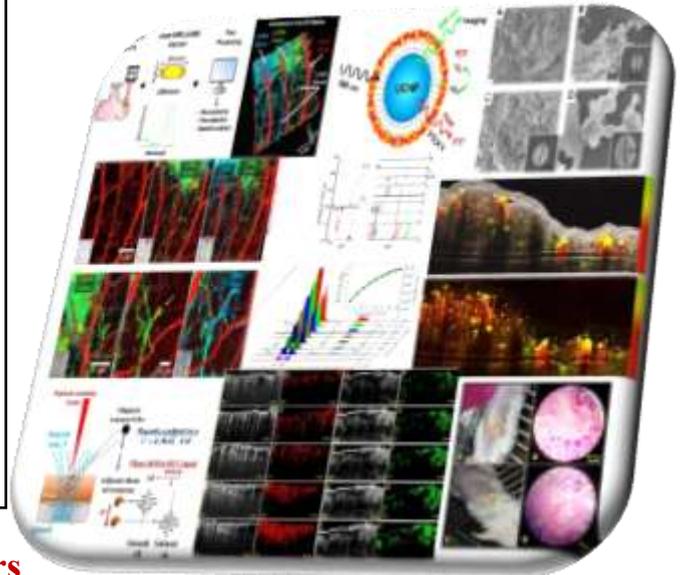
Group Members

Research Group -Process Technology

- **Name of Principal Investigator/ Group Leader**: Dr. Vinod Kumar Nigam
- **Research Theme**: Bioprospecting for metal recovery & Enzyme-catalysis
- **Broad Area of Research and Scope: Process Technology**
  - Recovery of valuable metals through biological route
  - Biodegradation of Polystyrene and Polyethylene
  - Bioleaching of Lithium and heavy metals
  - Synthesis of nanoparticles for improving the yield of pectinase

Schematic Representation of Broad Area of Research
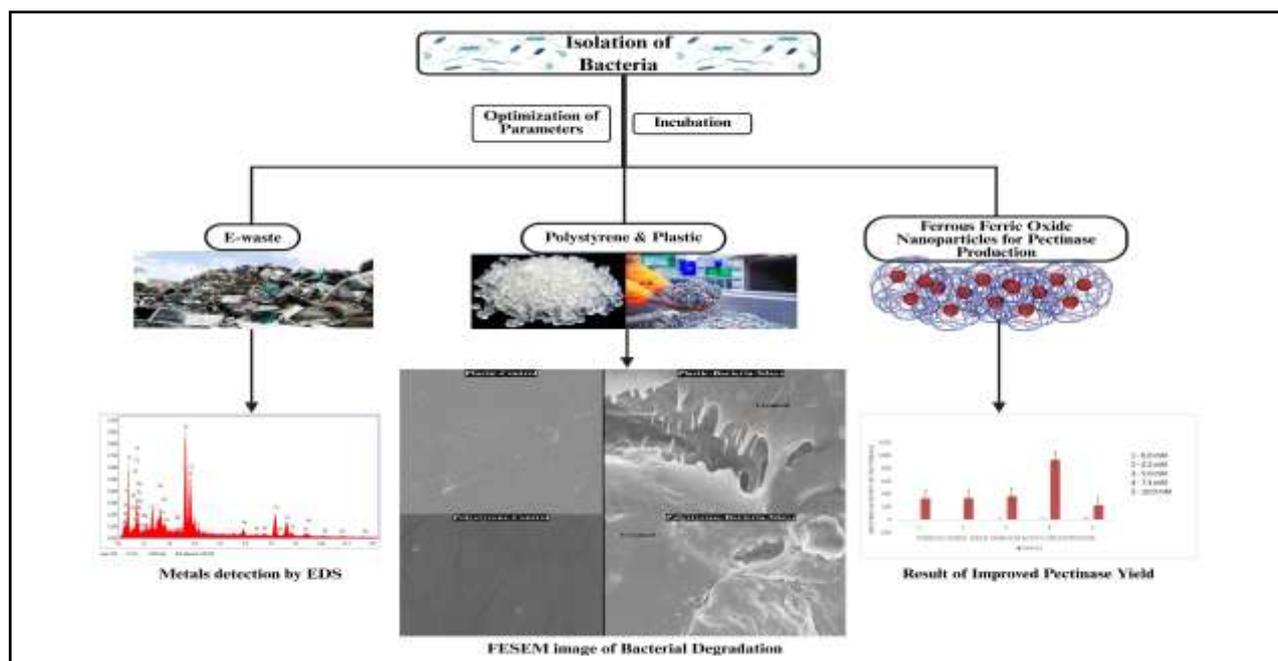
- **Total Number of Publications by the group: 223**
- **Top 5 Article with impact factor: (Vancouver Style)**
  1. Shreya S, Nigam VK, Sampath MK. Biorecovery of Metals from E-waste: An Elaborate Study. InExtraction of Precious Metals from Industrial Waste Using Microbial Technology 2025 Mar 14 (pp. 69-86). Cham: Springer Nature Switzerland. (Book Chapter)
  2. Patade CL, Sharma AR, Nigam VK, Sampath MK. Recovery of lithium and lead ions from battery industry wastes using advanced separation techniques. InMetal Value Recovery from Industrial Waste Using Advanced Physicochemical Treatment Technologies 2025 Jan 1 (pp. 235-259). Elsevier. (Book Chapter)
  3. Satpathy A, Mukherjee K, Nigam VK. Improved production of thermostable pectinase from novel Bacillus siamensis (BIOSMNF45) using computational-conventional approach. Scientific Reports. 2025 Apr 3;15(1):11489.
  4. Kumari G, Nigam VK, Pandey DM. Mutational analysis of flavonol synthase of M. pinnata towards enhancement of binding affinity: A computational approach. Journal of Biomolecular Structure and Dynamics. 2024 Nov 1;42(16):8574-87.
  5. Dutta B, Panja AS, Nigam VK, Nanjappan SK, Ravichandiran V, Bandopadhyay R. Computational and biochemical characterization of the immobilized esterase of Salinicoccus roseus for pesticide degradation. Scientific Reports. 2024 Dec 28;14(1):30661.

Patents by the group

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	A method for efficient metal recovery from a potent metal source *Shristy Shreya, Muthu Kumar S, Vinod Kumar Nigam*	202331084815; 12-12-2023	Published
2.	A method for time-efficient production of microbial natural product using minimal media *Usha Lakra, Shubha Rani Sharma, Vinod Kumar Nigam*	202431002003 10-01-2024	Published
3.	A method for efficient production of microbial natural product for wound care *Usha Lakra, Vinod Kumar Nigam, Shubha Rani Sharma*	202331081605 30-11-2023	Published
4.	A method for isolating extremophilic bacterial microflora from a semi digested food sample and a biocatalyst formulation thereof *Sugandha Jaiswal, Rakesh Kumar Sinha, Vinod Kumar Nigam*	202431006964 01-02-2024	Published
5.	A method for formulating biomolecule-metabolizing microbial consortia *Vinod Kumar Nigam, Abhimanyu Kumar, Anushka Satpathy Vishaka Verma*	202431035650 17-05-2024	Published
6.	ANNZYMIX: A Machine Learning-Based System For Predicting And Optimizing Pectinase Enzyme Activity *Ashish Kumar, Koel Mukherjee, Anushka Satpathy, Vinod Kumar Nigam*	202531006309 25-01-2025	Published
7.	Process Development for Bioleaching Toxic Metals Using a Novel Bacterium *Arthrobacter gandavensis* From Printed Circuit Boards (PCBs) *Banhi Halder, Muthu Kumar S, Vinod Kumar Nigam*	--	Filed
7.	Biodegradation of polystyrene (PS) by Bacillus cereus *Komal Singh, Banhi Halder, Vinod Kumar Nigam*	--	Filed
8.	Studies on the enhancement effect of nanocatalyst on pectinase production *Pragnya Biswas, Anushka Satpathy, Koel Mukherjee, Vinod Kumar Nigam*	--	Filed

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Bioleaching process for the recovery of precious metals (Cu, Ag) from electronic waste: Towards circular economy	Dr. M. K. Sampath (PI) Dr. V. K. Nigam (Co-PI)	SERB	29.51	3 years
Optimization of Production and commercial application of Xylanase from thermophilic bacteria from Suraj Kund hot spring.	Dr. V. K. Nigam (Co-PI)	CSIR	24.45	3 years
Nanorobotics drug delivery system and LAB-ON-CHIP platform development	Dr. K. Mukherjee (PI)	IHFC-IIT Delhi	45.88	3 years

Achievements

Problem Statement:

- E-waste causes environmental & health risks due to toxic metals.

- E-waste contains valuable metals, and to restore them, the conventional methods are costly and not eco-friendly.

- Hydrometallurgical is a very tedious and economically non-viable process.

- In the paper and pulp industry, chemical bleaching is a costly as well as environmentally toxic process.

Applications:

➢ Bioleaching is an economical, practical, and ecological technique for recovering valuable metals from low-grade ores
➢ Reduced toxicity from e-waste.
➢ Bioleaching reduces the production cost up to 47% compared to the hydrometallurgical process.
➢ The Bio bleaching process will be used in different industries, which will be cost-effective as well as process-effective compared to the chemical bleaching process.
➢ Xylanase as a biopolishing agent can be eco-

Strategy/ Approach/ Technique/ Experiments used to solve

In this bioleaching project, microorganisms were used to recover metals from e-waste without chemical pretreatment or added nutrients. The strategy focused on direct bioleaching under optimized conditions such as pH, temperature, and e-waste concentration. Experiments showed high metal recovery efficiency, highlighting the strain's potential for eco-friendly e-waste remediation and supporting circular economy goals. Few novel isolates like *Exiguobacterium himgiriensis, Arthrobacter gandavensis, Bacillus cereus* etc. have been used for bioleaching study.

The idea of sustainable development has created the need for isolation of cost-effective biocatalysts that are stable at a wide range of temperatures and pH, which can be implemented in various industrial uses, which has led to the extraction of bacteria capable of producing thermozymes extracted from natural habitats and isolated through standard lab protocols. One such isolate *Geobacillus* was isolated and been under investigation for production of xylanase with improved shelf-life and biocatalytic action.

One more application of study, we carried out was to develop nano-catalyst based pectinase synthesis with high

Group Members
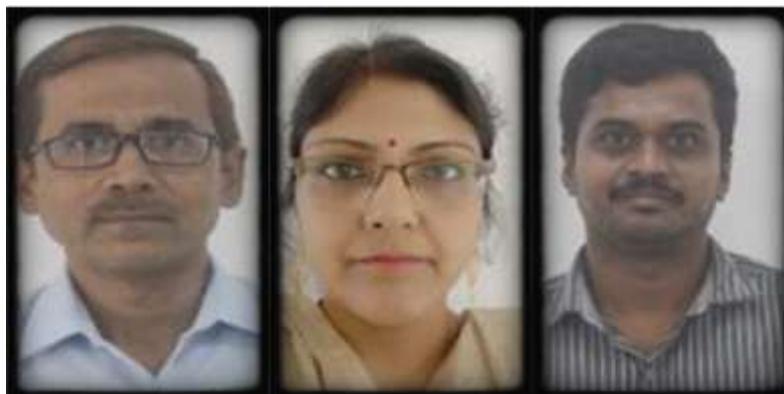
Research Group -Nano-Bio Labs

- **Name of Principal Investigator/ Group Leader**: Dr. Sneha Singh
- **Research Theme**: Designing Functionalized Biomaterials and Nanomaterials for Advanced Tissue Engineering Solutions.
- **Broad Area of Research and Scope:**
  - Synthesizing nanomaterials for the ranostics, wound healing, and tissue regeneration.
  - Phytomedicine focuses on harnessing phytobioactives for targeted and controlled therapies
  - Developing multifunctional biomaterials for smart therapeutics and regenerative applications
  - Tissue engineering by utilizing the therapeutic potential of bio-nanocomposites and phytomedicines.

Schematic Representation of Broad Area of Research
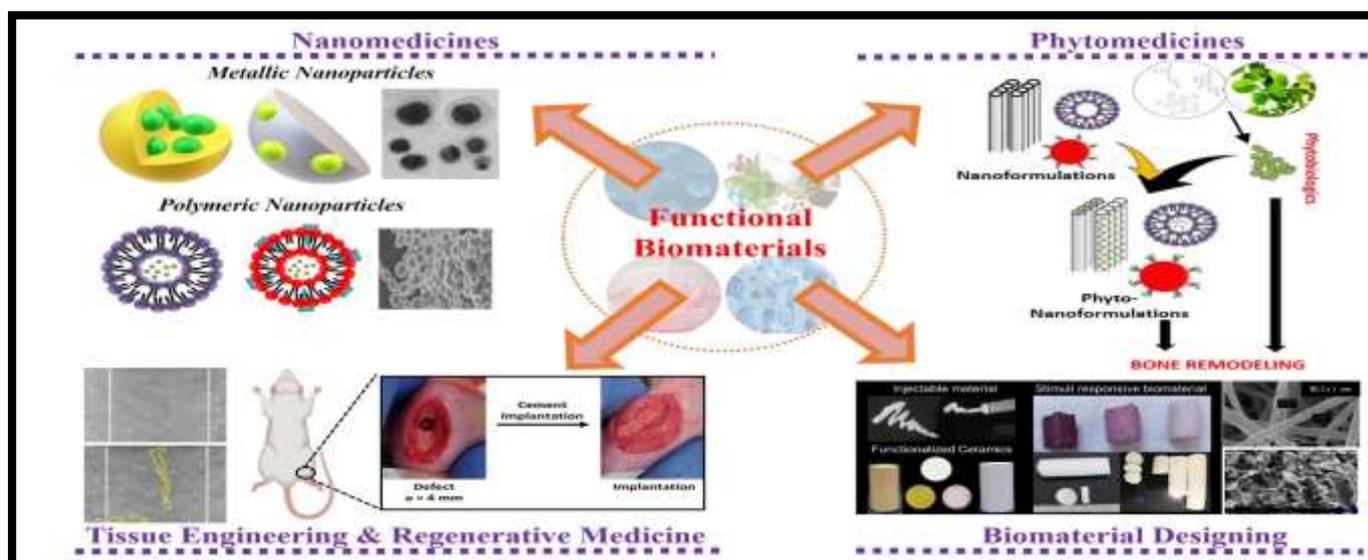
- **Total Number of Publications by the group:** 23
- **Top 5 Article with impact factor:**
  1. Gupta A, Madhyastha H, Kumar A, Singh S. Osteo-modulatory potential of biologically synthesized cis-resveratrol passivated gold nanoparticles. International Journal of Pharmaceutics. 2024 Oct 25;664:124637. **[IF=5.3]**
  2. Gupta A, Mehta SK, Kumar A, Singh S. Advent of phytobiologics and nano-interventions for bone remodeling: a comprehensive review. Critical Reviews in Biotechnology. 2023 Jan 2;43(1):142-69. **[IF=9.0]**
  3. Gupta S, Qayoom I, Gupta P, Gupta A, Singh P, Singh S, Kumar A. Exosome-functionalized, drug-laden bone substitute along with an antioxidant herbal membrane for bone and periosteum regeneration in bone sarcoma. ACS Applied Materials & Interfaces. 2023 Feb 7;15(7):8824-39. **[IF=8.3]**
  4. Gupta A, Singh S. Multimodal potentials of gold nanoparticles for bone tissue engineering and regenerative medicine: avenues and prospects. Small. 2022 Jul;18(29):2201462. **[IF=15.153]**
  5. Singh P, Gupta A, Qayoom I, Singh S, Kumar A. Orthobiologics with phytobioactive cues: A paradigm in bone regeneration. Biomedicine & Pharmacotherapy. 2020 Oct 1;130:110754. **[IF=7.419]**

<h1 align="center">Patents by the group:</h1>

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	A Biocomposite Delivery System for Phytobioactives in Bone Healing Inventors- Ashok Kumar, Sneha Singh, Archita Gupta, Prerna Singh, Sneha Gupta, Sanjay Kumar Mehta	202211024100 & April 19, 2023	Published
2.	Nano-scaffold Loaded with trans-Resveratrol Stabilized Gold Nanoparticles for Enhanced Bone Regeneration and Applications Thereof Inventors- Sneha Singh, Archita Gupta, Ashok Kumar	202331031960 & May 4, 2023	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of multi-functional nano-HAP bone substitute for effective bone regeneration in critical defects	PI	DST (Nanomission)	Rs. 1,13,25,480/-	2019-2022
Self-fitting 4D-printed smart scaffolds with efficient bone regenerative potential	PI	SERB (CRG)	Rs. 70,56,808/-	2021-Present

Industry/Academia Collaborations:

1. Department of Biological Sciences and Bioengineering, Indian Institute of Technology Kanpur, India
2. Manipal School of Life Sciences, MAHE, Manipal, India
3. Faculty of Medicine, University of Miyazaki, Japan
4. Institute of Tissue Regeneration Engineering, Dankook University, Korea

Targeted Application Area: Nanobiotechnology, Biomaterials & Tissue Engineering, Phytomedicines, Antimicrobials and Regenerative medicine

Achievements:

The developed bone substitute are first of their kind product which will be available and ready to use in the clinical setting for bone regeneration and healing providing better and cost-effective solutions for orthopedics problems, especially for the Indian population.

Brief Description of Projects :

Problem Statement:

Critical-sized and complex bone defects present significant challenges in orthopedic treatment due to the need for effective bone regeneration, which often involves high medical costs and prolonged recovery periods. Consequently, there is an urgent need for bioactive and resorbable bone substitutes that can address both regular and irregular shape bone defect, providing proper structural and biological support to enhance bone regeneration and integration.

Applications:

- Orthopedic implants and trauma care industry
- Dental biomaterials and oral surgery
- Oncology-related bone reconstruction
- Veterinary healthcare and animal prosthetics
- Regenerative therapies
- Drug delivery systems

Strategy/ Approach/ Technique/ Experiments used to solve

A nano-hydroxyapatite (nHAP)-based ceramic bone substitute was developed for the localized and sustained delivery of osteogenic phytobioactives from *Cissus quadrangularis*. This approach enhanced bioavailability at the defect site and showed promising potential for promoting neo-bone formation in critical defects.

Graphical Abstract
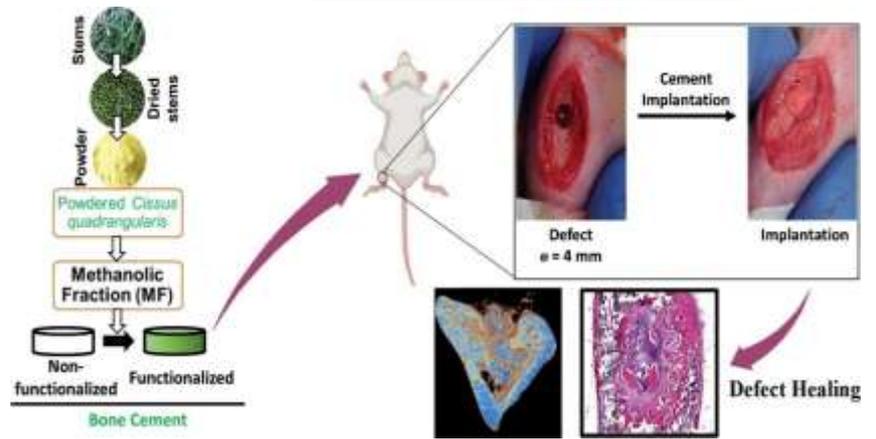
Group Members

Research Group -Therapeutic Micro Innovations

- **Name of Principal Investigator/ Group Leader**: Dr. Shubha Rani Sharma
- **Research Theme**: Medical science, Therapeutics & Environmental Microbiology
- **Broad Area of Research and Scope:**
  - Gallstone, pancreatic stones & Gallbladder Cancer Research
  - Thermophile Research

Schematic Representation of Broad Area of Research

- **Total Number of Publications by the group: 25**
- **Top 5 Article with impact factor:**

1. Sharma B, Shukla R, Nagar A, Ekka N, Kapoor VK, Behari A, **Sharma SR**. A comparative analysis of gallstones from gallbladder cancer patients and cholelithiasis patients unveiling the association between gallstones and gallbladder cancer. Med Oncol 2025;42(3):65. doi: 10.1007/s12032-025-02614-7. **[IF:2.8]**

2. Sharma B, Sethi B, Kumar S, Poddar R, Prashad A, **Sharma SR**. Exploration of molecular interactions between Scoparone and associated compounds with Constitutive androstane receptor (CAR) leading to gallstone prevention: An In-silico investigation. Journal of Biomolecular Structure and Dynamics. 2023; 42(2): 960–976. **[IF: 5.235]**

3. Soy S, Lakra U, Prakash P, Suravajhala P, Nigam VK, **Sharma SR**, Bayal N. 2023. Exploring microbial diversity in hot springs of Surajkund, India through 16S rRNA analysis and thermozyme characterization from endogenous isolates. Scientific Reports 13,14221. **[IF: 4.6]**

4. Sharma B, **Sharma SR**. Microstructural and heavy metal analysis of gallstones prevalent in Jharkhand and its implications in the treatment. Postgraduate Medicine. 2022 8:1-6. **[IF:4.379]**

Research, Innovation & Entrepreneurship Cell
RESEARCH GROUPS @ BIT-MESRA

5. Lakra U, Kumar V, Dhan, S., Nigam, V. K., & Sharma, S. R. (2024). Characterization and evaluation of biosurfactant produced from a the rmophilc bacillus licheniformis. Bioremediation Journal, 29(1), 25-41. **[IF:2.4]**

<div align="center">

Patents by the group:

</div>

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	A method for efficient production of microbial natural product for wound care **Usha Lakra, VK Nigam, SR Sharma**	Application no.: 202331081605, Ref. :PAT199/045/23	Published
2.	A method for time-efficient production of microbial natural product using minimal media **Usha Lakra, VK Nigam, SR Sharma**	Application no.: 202431002003 Ref. :PAT199/083/23	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Optimization of Production and Commercial Application of Xylanase from Thermophilic Bacteria of Surajkund Hotspring	PI	CSIR	24 lakhs	28/09/2023 - 27/09/2026
The role of oxysterol in gallbladder cancer development	PI from India	Indo Japan Project funded by Japanese funding Agency JSPS	Rs. 11725057.20 Crore	05/03/2023 - 04/03/2027

Industry/Academia Collaborations:

1. Dr Dharam Singh, Principal Scientist, CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur, Himachal Pradesh and together obtained a CSIR project in 2023.

2. Dr. Rupjyoti Talukdar, Director, Pancreatology, Clinical Pancreatologist (Fellowship, Mayo Clinic, Rochester, USA), Asian Institute of Gastroenterology,Head, Pancreas Research Group & Division of Gut Microbiome Research, Asian Healthcare Foundation,Hyderabad, India.- Topic of collaboration- Microbiome of gallbladder and gallbladder cancer. We both are guiding Sneha Kumari in her PhD work (Guide: Dr Shubha Rani Sharma, Co. Guide: Dr. Rupjyoti Talukdar). Together we have Submiited ICMR small project 2024

3. Dr V K. Kapoor, Professor and Head of the Department, Pro-Vice Chancellor, Mahatma Gandhi Medical College & Hospital (MGMCH), Jaipur INDIA – Working on Gallstones and gallbladder cancer since 2018. Together we have Submiited ICMR intermediate project 2024

4. Dr Usha Dutta, Professor and Head Postgraduate Institute of Medical Education and Research, Chandigarh (PGIMER), India - Gallbladder Motality and gallbladder cancer Together we have Submiited ICMR intermediate project 2024

5. Dr Arun Kumar Senior Scientist in Mahavir Cancer Sansthan & Research Centre, Patna, Bihar, India

International collaboration

1. Dr Takao Asai, Dr Yasuo Tsuchia from Nigata University, Japan for the research topic - The role of oxysterol in gallbladder cancer development an Indo Japan Project funded by Japanese funding Agency JSPS.

2. Dr. Jill Koshiol, Ph.D. Infections and Immunoepidemiology Branch Division of Cancer Epidemiology and Genetics National Cancer Institute, National Institutes of Health 9609 Medical Center Drive, Room 6-E212 Rockville, MD 20850 E-mail: koshiolj@mail.nih.gov- Metal in gallstones & gallbladder cancer.

3. Dr. Khelifa Bouacem, Associate professor at Laboratory of Cellular and Molecular Biology, Microbiology Team, Faculty of Biological Sciences at University of Mouloud Mammeri, Tizi Ouzou, Algeria.

Achievements

Optimization of Production and Commercial Application of Xylanase from Thermophilic Bacteria of Surajkund Hotspring

Problem Statement:

As only isolation and identification of thermophilic bacteria has been reported and no work on thermozymes has yet been reported from Surajkund Hotspring till date, we are the first to initiate the work on the enzymology of thermozymes from this particular Niche. There have been many reports of thermophilic xylanase but most of the paper have stated fungal strain as an effective xylanase secreting source. In our work, not only the isolate obtained is at 70 °C but the screening showed xylanolytic activity at 70 °C. The crude enzyme has shown stability at 70 °C. There have been few reported works on crude xylanase which has exhibited activity at temperature higher than 60 °C, most of them being recombinant xylanase. We need to probe into the thermozymes like xylanase from the thermophiles isolated from the unexplored Surajkund and to characterize them so as to achieve novel results pertaining to thermostable xylanase for industrial applications.

Applications:

➢ Paper & pulp industry
➢ Food and Beverage Industry
➢ Animal Feed:
➢ Biorefineries:
➢ Textile Industry
➢ Pharmaceutical Industry

Strategy/ Approach/ Technique/ Experiments used to solve

From the isolated and screened thermophiles, four best xylanase producing thermophiles will be further assessed for xylanase production by optimizing culture media conditions using One Factor at a Time (OFAT) approach. The best isolate producing xylanase enzyme will be selected for further investigation. The characterization of crude xylanase will be also done. The xylanase activity will be determined by Nelson-Somogyi method. The whole genome analysis to understand the genomic information will also be carried out. The potential application of xylanase enzyme in bio-bleaching of pulp and de-inking process will also be investigated.

Graphical Abstract
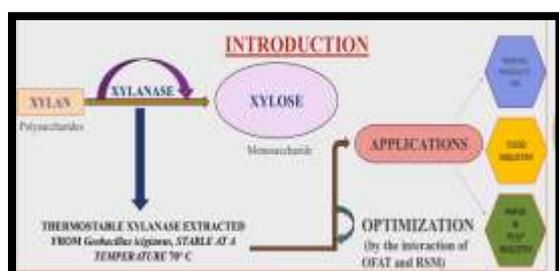
The role of oxysterol in gallbladder cancer development

Problem Statement:

The aim of this study is to determine whether gallstones and oxysterols in bile are associated with gallbladder cancer development, following reports that oxysterols, an oxidised derivative of cholesterol, stimulate biliary cancer cell growth in vitro. Although gallstones are considered a strong risk factor for gallbladder cancer, the incidence of gallbladder cancer is generally very low in relation to the prevalence of gallstones, and it has not been concluded that a correlation exists between the possession of gallstones and the occurrence of gallbladder cancer. However, it was reported that the incidence of gallbladder cancer with respect to the possession of gallstones is higher in Indians than in American Caucasians (Dutta et al. Chin Clin Oncol 2019) (Figure 4), suggesting that the influence of region-specific risk factors contributing to the development of gallbladder cancer may be more significantly observed possible implications.

Applications:

➢ Biochemical analysis of oxysterols for finding the relation of oxysterol in gallbladder cancer development

Strategy/ Approach/ Technique/ Experiments used to solve

The study will be based at Mahatma Gandhi Medical College & Hospital (Jaipur, India) and Sharda Hospital (Greater Noida, India) and will include 100 patients with gallbladder cancer (cases), 100 patients with gallstone disease (controls) and 100 healthy subjects (controls). 100 cases. Cases and controls will be matched for sex and age. The study collaborators at each hospital will explain the purpose of the study to the subjects and obtain informed consent. The study will be initiated after obtaining approval from the Ethics Committees of each hospital in India and J Year 2024 2) Sample and data collection Samples (gallstones, bile, blood) and data to be collected for analysis as variables. Gallstones: Gallstones removed from patients with gallbladder cancer and cholelithiasis are collected. After collection, the gallstones are washed, lyophilised and stored frozen (-20°C). Bile: 1 mL of bile is collected from patients with gallbladder cancer or cholelithiasis who have undergone cholecystectomy. After collection, add dibutylhydroxytoluene to prevent spontaneous oxidation and store frozen (-20°C). Blood: 3 mL of blood is collected from patients with gallbladder cancer, cholelithiasis and healthy subjects early in the morning on an empty stomach. The blood is partly centrifuged to obtain serum and stored frozen (-20 °C). Data on gender, age, BMI, medical history (cholelithiasis, diabetes, chronic hepatitis), drug prescription history (e.g. history of statins, fibrates, contraceptives containing oestrogen or oestrogen replacement therapy), smoking history and alcohol consumption frequency will be collected based on medical records.

Graphical Abstract

Cancerous gallbladder

Blood

Bile

Gallstones

Sample preparation

GCMS analysis for oxysterols

Analysis of presence and concentration of oxysterols in the samples of normal gallbladder and cancerous gallbladder to correlate the role of oxysterols in gallbladder cancer development

Normal gallbladder
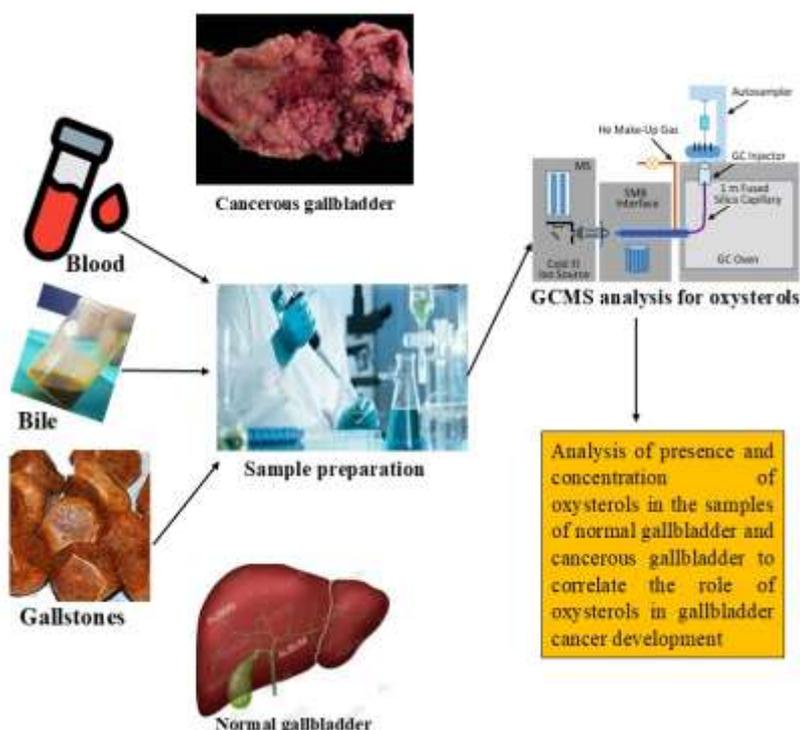
Group Members :

Research Group- Microbial Biotechnology

- **Name of Principal Investigator/ Group Leader**: Dr. Shashwati Ghosh Sachan
- **Research Theme**: Microbial and Environmental Biotechnology
- **Broad Area of Research and Scope:**
  - Bioremediation
  - Production of value-added compounds (fish mucus/microbes)

Schematic Representation of Broad Area of Research:
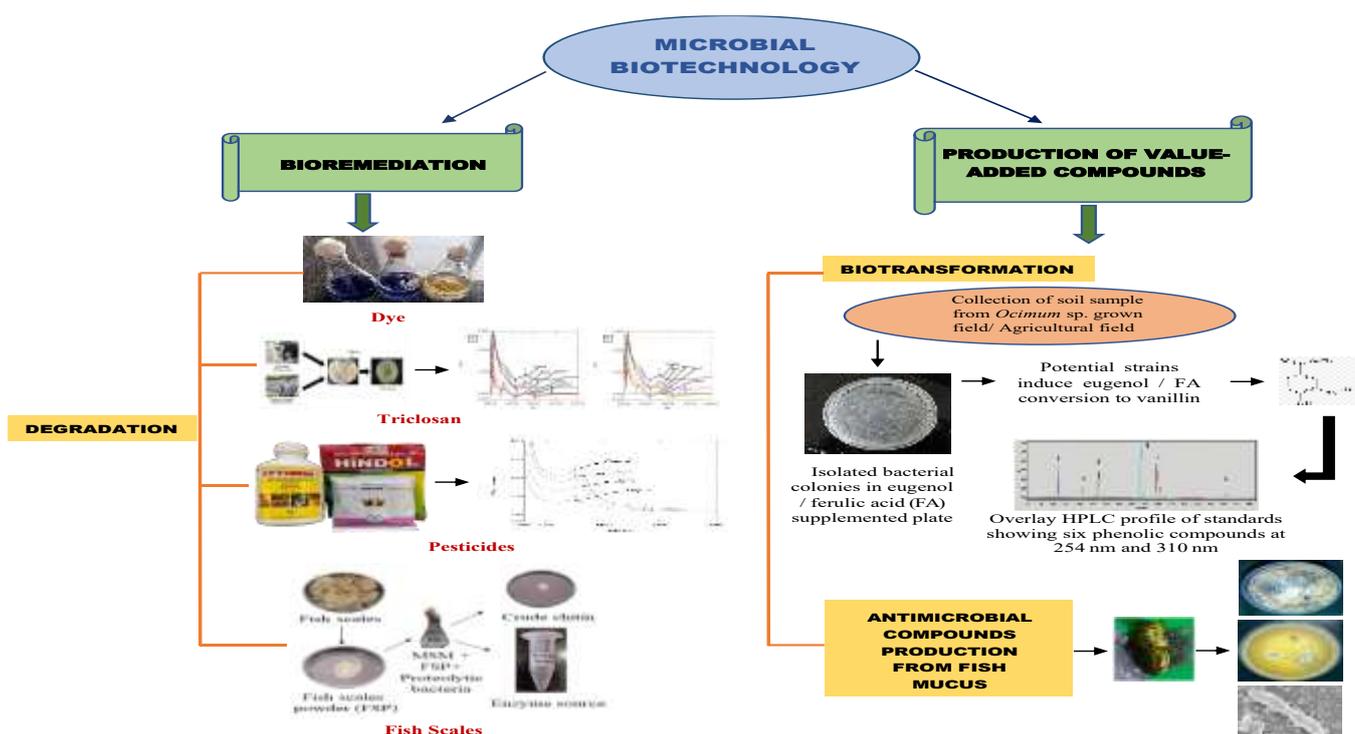
- **Total Number of Publications by the group: 39**
- **Top 5 Article with impact factor: (Vancouver Style)**
  1. Sunanda, Ghosh Sachan S. Development and validation of a spectrophotometric method for microbial degradation study of chlorpyrifos. Int. J. Environ. Anal. Chem. 2025; https://doi.org/10.1080/03067319.2025.2471391 (SCI; I.F- 2.6)
  2. Hussain A, Kumar M, Mukhopadhyay K, Dutta A, Ghosh Sachan S. Antimicrobial peptides in *Clarias batrachus* epidermal mucus: Characterization and therapeutic potential. Fish Shellfish Immunol. 2025; 159:110191 (SCIE; I.F- 4.1)
  3. Singh A, Mukhopadhyay K, Ghosh Sachan S. Enhanced vanillin production from eugenol by *Bacillus cereus* NCIM-5727. Bioprocess Biosyst Eng. 2022;45:1811-24 (SCI; I.F- 3.3)
  4. Kumari R, Ghosh Sachan S. Bioconversion of toxic micropollutant triclosan to 2,4-dichlorophenol using a wastewater isolate *Pseudomonas aeruginosa* KS2002. Int. J. Environ. Sci. Technol. 2019;16:7663-72 (SCIE; IF: 3.1)
  5. Mishra S, Sachan A, Vidyarthi AS, Ghosh Sachan S. Transformation of ferulic acid to 4-vinyl guaiacol as a major metabolite: a microbial approach, Rev. Environ. Sci. Biotechnol. 2014;13: 377-85. (SCIE; IF: 12.3)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted
1.	Title: A method for preparing Clarias mucus-based antimicrobial composition Ahmed Hussain, Shashwati Ghosh Sachan	Application no.: 202431045706 (06-09-2024)	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Production of natural flavour compounds from ferulic acid by microbial transformation (No. 37-115/2009(SR)	PI	UGC	9.44	2009-2012 (Ext. upto Jul 2013)
Biotransformation of Eugenol into value added methoxyphenols (No. SB/YS/LS-308/2013)	PI	DST-SERB	24.2	2014-2017 (Ext. upto Mar 2018)
Bioprocess Development for efficient Triclosan Degradation (No. 24(0340)/16/EMR-II)	Co-PI	CSIR, GOI	10.53	2016-2019

Industry/Academia Collaborations (as External Guide for PhD Scholars):

1. Dr Anil Kumar Saxena, former Director, ICAR- National Bureau of Agriculturally Important Microorganisms, Mau and former Head, Division of Microbiology, IARI
2. Dr Debashis Chakraborty, Department of Chemistry, IIT Madras
3. Dr Ashish Sachan, Department of Life Sciences, Central University of Jharkhand
4. mixture. FRIN. 2012;49(2):641–7.

Achievements:

Brief Description of Project 1 : Bioremediation

Problem Statement:

One of the research interests of the group focus upon microbial bioremediation of toxic compounds (dyes, pesticides, triclosan, plastic in mulch films) released in environment.

Applications:

➢ Environmental clean-up
➢ Pollutant degradation and treatment in an eco-friendly way

Strategy/ Approach/ Technique/ Experiments used to solve

A couple of research works focused on developing innovative processes for the decolorization and degradation of azo dyes, a major pollutant in textile effluents and triclosan. They emphasized microbial bioremediation techniques, optimizing conditions for effective dye/triclosan removal, and minimizing environmental impact.

Isolation and screening of microorganisms capable of degrading acephate and chlorpyrifos from contaminated soil in Jharkhand has been pursued. Further through optimization and pathway elucidation using spectrophotometer, HPLC, LC-MS, and GC-MS, it seeks efficient bioremediation strategies to ensure non-toxic degradation, promoting environmental safety and sustainable agriculture.

Brief Description of Projects 2 : Production of value-added compounds (fish mucus/microbes)

Problem Statement:

The research interests of the group focus upon microbial production of bioactive molecules (flavour compounds, enzymes) from wastes (agro-residues, fish waste). The antimicrobial efficacy of bioactive compounds present in fish epidermal mucus have also been explored. Medicinal plants of Jharkhand region with possible antimicrobial and antibiofilm properties are being explored to combat the rise of antimicrobial resistance.

Applications:

➢ Food industry
➢ Pharmaceutical industry
➢ Detergent, Leather & Textile industries

Strategy/ Approach/ Technique/ Experiments used to solve

One research study addressed the global demand for biovanillin by developing a sustainable microbial transformation method to convert eugenol into vanillin. It demonstrated stable vanillin accumulation, explored industrial scalability, and introduced a novel UPLC analytical method for metabolite detection. Another study reported the production of flavour compounds upon microbial biotransformation of ferulic acid found in agricultural wastes.

Identifying efficient microbes responsible for fish scale leading to the production of valuable compounds like protease enzyme and chitin is also being explored which could be applied in industries such as cosmetics, pharmaceuticals, and food.

Another study investigated the antimicrobial potential of epidermal mucus from *Channa punctatus* and *Clarias batrachus*. The mucus demonstrated significant antibacterial and antifungal activity. Protein analysis revealed antimicrobial peptides, suggesting fish mucus as a promising source for novel therapeutics to combat antimicrobial resistance.

Group Members

Research Group-Advanced BioComputing (ABC) Lab

- **Name of Principal Investigator/ Group Leader**: **Dr. Alok Jain**
- **Research Theme**: Computational Biology: Functional Applications in Disease Mechanisms and Biomaterial Design
- **Broad Area of Research and Scope:**
  - o Smart peptide-based biomaterials, next-gen regenerative medicine
  - o AI-powered cancer therapeutics, precision medicine for Alzheimer's
  - o Network-driven disease decoding, Computational disease modelling

Schematic Representation of Broad Area of Research:
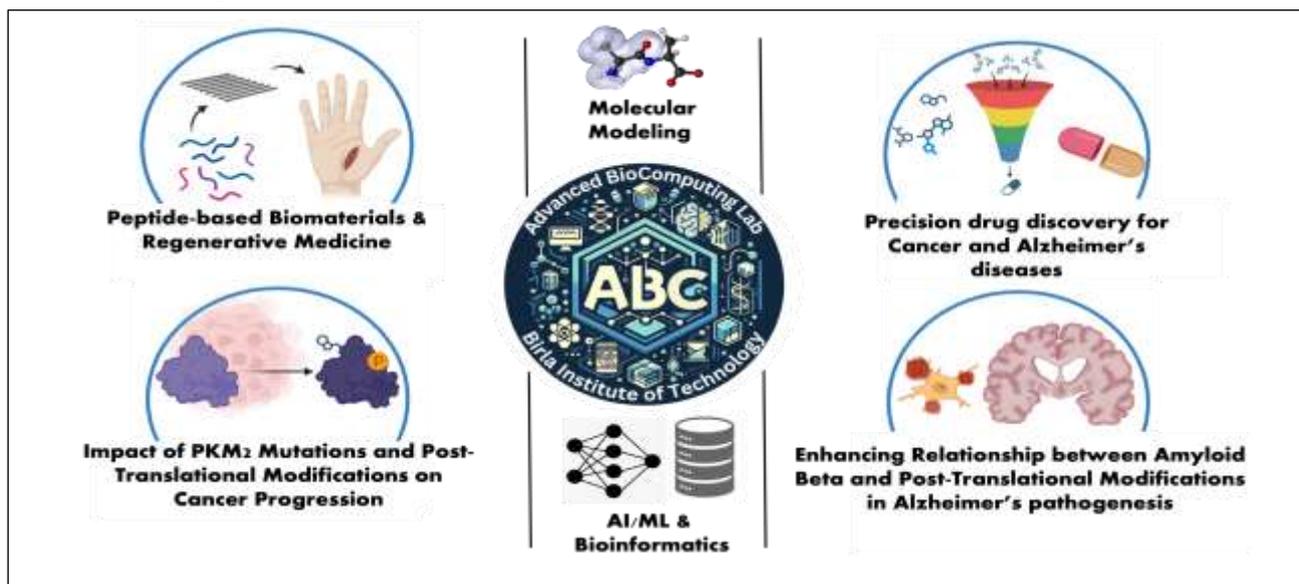
- **Total Number of Publications by the group:** 46

- **Top 5 Article:**

  1. Chaudhary AS, Modak C, Gayakvad B, Biswas I, **Jain A***. Design and characterization of pH-responsive DGEA-derived peptide scaffolds: a comprehensive molecular dynamics simulation study. *ACS Appl Bio Mater.* 2025;8:2459–68. **IF: 4.7.**

  2. Tiwari A, Singh R, Kumar S, Sunkaria A, **Jain A***. From plant to pathway: molecular mechanisms of ruscogenin in preventing amyloid-beta aggregation through computational and experimental approaches. *ACS Chem Neurosci.* 2025;16(3):500–3. **IF: 5.0.**

  3. Singla P, **Jain A***. Deciphering the complex landscape of post-translational modifications on PKM2: implications in head and neck cancer pathogenesis. *Life Sci.* 2024;349:122719. **IF: 6.1.**

  4. Jaiswal E, Globisch C, **Jain A***. Knowledge-driven design and optimization of potent symmetric anticancer molecules: a case study on PKM2 activators. *Comput Biol Med.* 2022;151:106313. **IF: 7.7.**

  5. Contractor D, Globisch C, Swaroop S, **Jain A***. Structural basis of Omicron immune evasion: a comparative computational study. *Comput Biol Med.* 2022;147:105758. **IF: 7.7.**

- **Industry/Academia Collaborations:** University of Konstanz Germany, IIT Kanpur, AIIMS Bhopal, NIT Rourkela, NIPER Ahmedabad, GNDU Amritsar and many more.
- **Targeted Application Area:** Smart Solutions for Drug Design, Biomarker Discovery, and Next-Gen Functional Biomaterials
- **Research Projects:**

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
1. A Multi-scale Simulation-based Approach to Design, Characterize and Optimize the Peptide Based Scaffold for Tissue Engineering Applications.	PI	DST-SERB	29.8 Lakhs	2022-2024
2. Anti-viral drug repurposing to inhibit the CoV-2 entry: A molecular modeling approach targeting ACE-2 and TMPRSS2.	PI	IIT Delhi (HPC-COVID19 call)	Equivalent to 7.6 Lakhs	2021-2021
3. In-silico design and validation of boronic acid-based molecules for the treatment of colorectal cancer: Computer aided hit to lead discovery.	PI	DBT	113.6 Lakhs	2019-2024
4. Molecular simulations of biological systems.	PI	HPC facility BW state, Germany	3.5 million core hours	2015-2017

Key Achievements:
- **Elected Member, National Academy of Sciences, India (NASI)** – Recognized in 2025 for impactful contributions to interdisciplinary research.
- **Editorial Board Member, *Scientific Reports* (2024)** – Invited to join one of Nature Portfolio's leading journals.
- **Awardee, Vishnu Ji Ram Memorial Award (2022)** – Conferred by the Indian Society of Chemists and Biologists for outstanding contributions in chemical biology.
- **Recipient, Ramalingaswami Re-entry Fellowship (2019)** – A prestigious fellowship awarded by DBT for advanced research in the field of biotechnology.
- **International Recognition** – Awarded the *Biophysical Society-USA Travel Award* in 2010 for excellence in computational biophysics.

Project-1: Smart, self-assembling peptide scaffolds designed in silico, tailored for real-world biomedical impact.

Problem Statement	Selected Publication
Conventional ECM-derived peptides lack the self-assembly and environmental responsiveness needed for real-world biomedical applications limiting their translational potential in regenerative medicine and targeted therapies.	Chaudhary AS, Modak C, Gayakvad B, Biswas I, **Jain A***. Design and characterization of pH-responsive DGEA-derived peptide scaffolds: a comprehensive molecular dynamics simulation study. *ACS Appl Bio Mater.* 2025;8:2459–68.

Strategy

Using a structure-guided, multi-scale simulation platform, we bioengineered a library of short collagen-mimetic peptides. Strategic incorporation of hydrophobic, amphiphilic, and salt-bridge-forming motifs enabled the design of self-assembling, pH-responsive scaffolds with preserved functional activity.

Applications

These customizable peptide scaffolds are cost-effective, injectable, and bioprinting-compatible making them well-suited for tissue engineering, wound healing, and localized therapeutic delivery.

Simulation-Guided Design of pH-Responsive Peptide Scaffolds for Biomedical Applications

In silico-designed, pH-responsive scaffolds—ready for translational biomedical use
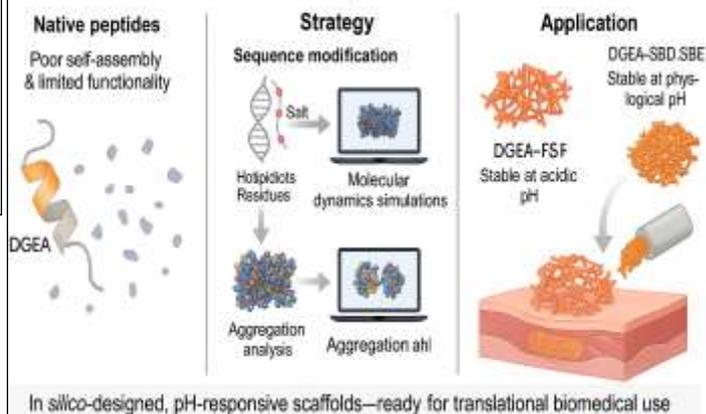
Project-2: Reprogramming cancer metabolism with simulation-driven PKM2 modulators designed for precision, built for translation.

Problem Statement

Unstable tetramerization of PKM2—driven by cancer-associated mutations and post-translational modifications—limits the efficacy of conventional inhibitors in metabolic oncology.

Strategy

Leveraging a structure-guided, simulation-integrated pipeline, we designed few modulators that selectively restore PKM2 tetramer stability even under mutation and PTM stress using ADMET filtering, all-atom simulations, and bioactivity-guided in vitro validation.

Applications

Our lead candidates exhibit precision reactivation of PKM2 in mutant tumors, opening new avenues for targeted therapeutics in colorectal and head & neck cancers. The platform sets a scalable model for industry-focused hit-to-lead optimization against allosteric protein targets.

Selected Publications

1. Singla P, **Jain A***, *Life Sci.* 2024;349:122719.
2. Jaiswal E, Globisch C, **Jain A***, *Comput Biol Med.* 2022;151:106313.
3. Patel S, Globisch C, Pulugu P, Kumar P, **Jain A***, Shard A*, *Eur J Pharm Sci.* 2022;170:106112.

Group Members:

31
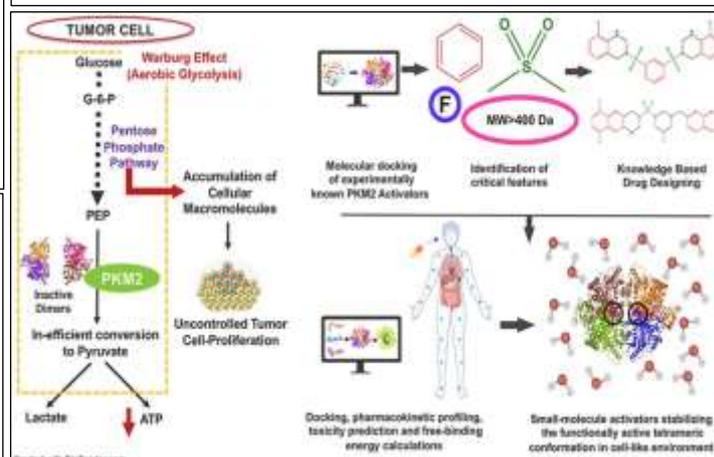
RESEARCH GROUP- NUCLEIC ACID BIOSENSING LAB (NABL)

Name of Principal Investigator   Dr. Dinesh Prasad

Research Theme: Innovative Biosensing Technologies for Health, Food Safety, and Environmental Monitoring.

Broad Area of Research:
- Biosensor Development and Nanobiotechnology
- Nucleic Acid Technologies and Point-of-care Sensor
- Functional Genomics and Plant Biotechnology
- Genome editing (CRISPR/Cas system) and RNAi
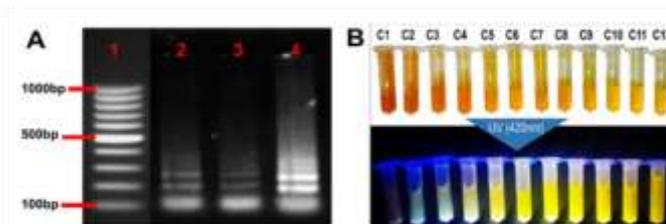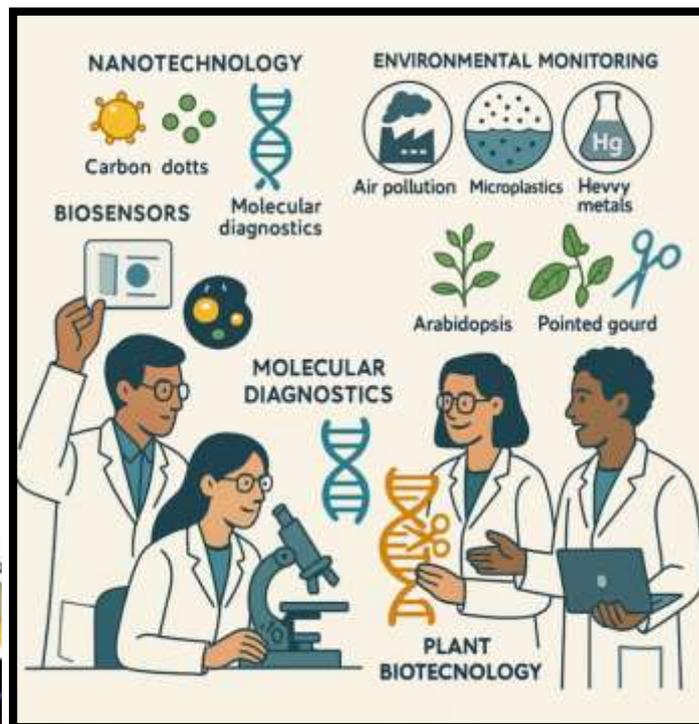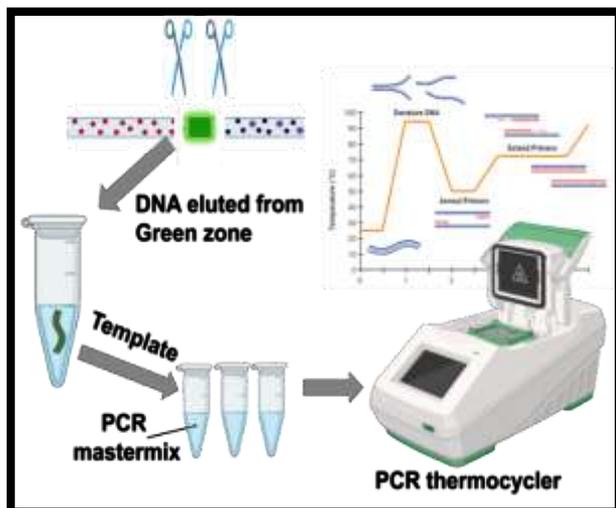
- **Total Number of Publications by the group: 28**
- **Top 5 Article:**

1. Garg R, Prasad D. Enhanced pyrophosphate detection: Utilizing oPD-derived carbon dots and Fe3+ interactions in a paper strip biosensor. Biochemical and Biophysical Research Communications. 2024 Dec 20;739:150577.
2. Garg R, Maurya A, Mani NK, Prasad D. Thread-powered cell lysis and isotachophoresis: unlocking microbial DNA for diverse molecular applications. World Journal of Microbiology and Biotechnology. 2024 Mar;40(3):97.
3. Sudarsan S, Prabhu A, Prasad D, Mani NK. DNA compaction enhances the sensitivity of fluorescence-based nucleic acid assays: a game changer in point of care sensors?. Analyst. 2023;148(10):2295-307.

4. Giaretta S, Prasad D, Forieri I, Vamerali T, Trentin AR, Wirtz M, Hell R, Masi A. Apoplastic gamma-glutamyl transferase activity encoded by GGT1 and GGT2 is important for vegetative and generative development. Plant Physiology and Biochemistry. 2017 Jun 1;115:44-56.
5. Prasad D, Shankaracharya, Vidyarthi AS. Gold nanoparticles-based colorimetric assay for rapid detection of Salmonella species in food samples. World Journal of Microbiology and Biotechnology. 2011 Sep;27(9):2227-30.

▪ **Patents by the group:**

Sl. No	Title and Inventors	Application No. & Date	Status
1.	A method and device for nucleic acid extraction and purification.	App. No: 202431007428; Ref. No: TEMP/E-1/8520/2024-KOL	Published
2.	A polymer sheet for determining nucleic acid and method of use thereof.	App. No: 202431038910; Ref. No: TEMP/E-1/45432/2024-KOL	Published

▪ **Research Projects:**

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of LAMP based dipstick format biosensor for sensitive and specific DNA detection.	PI	DST SERB	14.85	3Y
A RNAi approach to induce parthenocarpy in *Trichosanthes dioica Roxb*. By regulating phytohormones	PI	UGC BSR	6.0	3Y

Brief Description of Projects : The project uses NGS to identify hormone-regulating genes in *Trichosanthes dioica*. RNAi constructs silence these genes via Agrobacterium-mediated transformation. Transgenic plants are screened and validated through qRT-PCR and phenotypic analysis for seedless fruit development without fertilization.

Problem Statement:
Trichosanthes dioica (pointed gourd) is a dioecious cucurbit with limited fruit set due to its dependence on pollination and fertilization, often resulting in low yield and seasonal productivity. Additionally, the presence of seeds in fruits reduces consumer appeal and processing value. There is a need for a biotechnological approach to induce seedless (parthenocarpic) fruit development independent of pollination, which can enhance yield, fruit quality, and marketability. However, the molecular mechanisms and regulatory genes involved in hormonal control of fruit development in *T. dioica* remain poorly understood. Addressing this gap through gene silencing strategies like RNA interference (RNAi) could offer a sustainable solution for improving fruit production in this economically important crop.

Applications
➢ Seedless Fruit Production: Enhances consumer appeal and processing efficiency
➢ Increased Yield: Promotes fruit development without fertilization, leading to higher yields.
➢ Off-Season Cultivation: Enables fruit set independent of pollinators, controlled-environment cultivation.
➢ Improved Market Value
➢ Biotechnological Advancement: Provides a model for applying RNAi to induce parthenocarpy in other dioecious crops.
➢
➢ Reduced Dependency on Pollinators: Minimizes the impact of declining pollinator populations on crop productivity.

Strategy/ Approach/ Technique/ Experiments used to solve
The project uses NGS to identify hormone-regulating genes in Trichosanthes dioica. RNAi constructs silence these genes via Agrobacterium-mediated transformation. Transgenic plants are screened and validated through qRT-PCR and phenotypic analysis for seedless fruit development without fertilization.

A RNAi approach to induce parthenocarpy in *Trichosanthes dioica* by regulating phytohormones

33
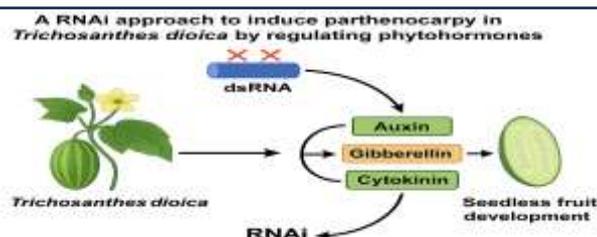
Brief Description of Projects : This project aims to develop a Loop-Mediated Isothermal Amplification (LAMP)-based dipstick biosensor for rapid, sensitive, and specific DNA detection. The portable format enables visual readout without sophisticated instruments, making it suitable for point-of-care diagnostics and field-level molecular testing.

Problem Statement:

Conventional DNA detection methods are time-consuming, require expensive instruments, and lack portability. There is a need for a rapid, cost-effective, and field-deployable solution. A LAMP-based dipstick biosensor addresses this by enabling sensitive and specific DNA detection without complex equipment.

Strategy/ Approach/ Technique/ Experiments used to solve:
The project involves selecting a specific target DNA sequence and designing LAMP primers for high specificity. The LAMP reaction is optimized to enable rapid isothermal amplification. A dipstick format is developed, incorporating labelled primers or probes (e.g., biotin, FITC) to allow visual detection of amplified DNA. The biosensor is validated for sensitivity and specificity using known samples and further tested in real-world conditions such as clinical, food, and environmental samples.

Applications:
- **Point-of-Care Diagnostics**: Rapid detection of pathogens in clinical settings without advanced lab infrastructure.
- **Food Safety Testing**: On-site detection of foodborne pathogens
- **Environmental Monitoring**: Detect microbial contamination in water or soil.
- **Agricultural Disease Surveillance**: Early detection of plant pathogens in crops.
- **Forensic and Biodiversity Studies**: Quick identification of genetic material in field conditions.
- **Resource-Limited Settings**: Ideal for rural or remote areas lacking lab facilities.
- Reduced Dependency on Pollinators: Minimizes the impact of declining pollinator populations on crop productivity.

Publication/patent:
- Isothermal nucleic acid amplification and its uses in modern diagnostic technologies. 3 Biotech, 13(6), 200.
- Quantitative estimation of Pyrophosphate ions released during Loop-Mediated Isothermal Amplification. Indian Journal of Biochemistry and Biophysics Accepted

Development of LAMP-based Dipstick Format Biosensor for Sensitive and Specific DNA Detection

Target DNA Selection → LAMP → Dipstick Development → DNA Detection
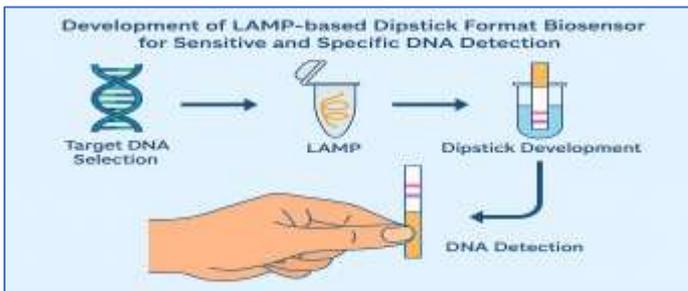
Group Members

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Research Group -Environmental Monitoring and Remediation

- **Name of Principal Investigator/ Group Leader: Dr. Sukalyan Chakraborty**
  Research Theme: Monitoring and Remediation of Environmental Contaminants
- **Broad Area of Research and Scope:**
  - Comprehensive analysis of microplastics in environmental matrices
  - Green Synthesis of Biochar-based metallic nano composites and their application for remediation of emerging contaminants like synthetic dye, antibiotics, heavy metals
  - Heavy metal biogeochemistry in the environment and its phytoremediation
  - Environmental pollution study in mining areas and their ecological impacts

Schematic Representation of Broad Area of Research:
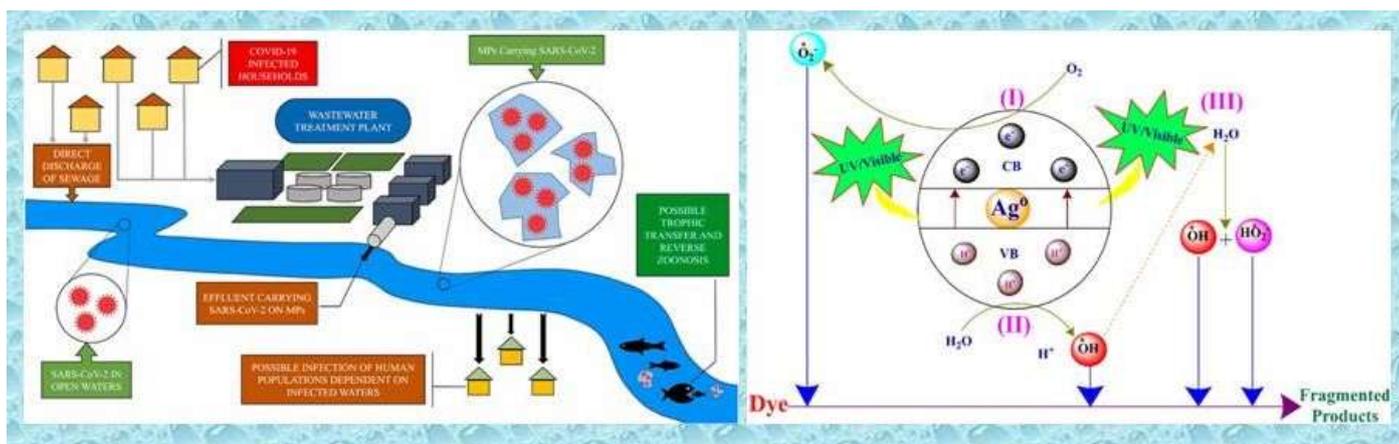
- **Total Number of Publications by the group: 73**
- **Top 5 Article with impact factor: (Vancouver Style)**

1. Jha AK, Chakraborty S, Biswas JK. Green synthesis of low-cost graphene oxide-nano zerovalent iron composite from solid waste for photocatalytic removal of antibiotics. *iScience*. 2024;27(12):111486. https://doi.org/10.1016/j.isci.2024.111486 **Impact Factor (2023): 6.3**

2. Shaikh WA, Chakraborty S, Kumar A, Biswas JK, Jha AK, Bhattacharya T, Vithanage M, Ansar S, Hossain N. Tailor-made biochar-based nanocomposite for enhancing aqueous phase antibiotic removal. *J Water Process Eng*.2023;55:104215.https://doi.org/10.1016/j.jwpe.2023.104215 **Impact Factor (2023): 6.1**

3. Shaikh WA, Kumar A, Chakraborty S, Naushad M, Islam RU, Bhattacharya T, Datta S. Removal of toxic dye from dye-laden wastewater using a new nanocomposite material: Isotherm, kinetics and adsorption mechanism. *Chemosphere*. 2022;308(Pt 2):136413. https://doi.org/10.1016/j.chemosphere.2022.136413 **Impact Factor (2023): 9.8**

4. Shaikh WA, Islam RU, Chakraborty S. Stable silver nanoparticle doped mesoporous biochar-based nanocomposite for efficient removal of toxic dyes. *J Environ Chem Eng*. 2021;9(1):104982. https://doi.org/10.1016/j.jece.2020.104982 **Impact Factor (2023): 6.4**

5. Shaikh WA, Alam MA, Alam MO, Chakraborty S, Owens G, Bhattacharya T, Mondal NK. Enhanced aqueous phase arsenic removal by a biochar based iron nanocomposite. *Environ Technol Innov*. 020;18:100936. https://doi.org/10.1016/j.eti.2020.100936, **Impact Factor (2023): 7.1**

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Source Apportionment, Hydrodynamic Study and Environmental Fate Assessment of Micro-Plastics in Drinking Water Supplying Reservoirs of Ranchi, Jharkhand	Principal Investigat	ANRF	38.5	3 years
Strengthening Research in Monitoring and Remediation of Chemical Contaminants of Emerging Concern for clean and potable water.	Co-Principal Investigat	DST-FIST	94	5 years
Arsenic enrichment in agricultural soils with potential impacts on crops and food security of Sahibganj, Jharkhand, India	Principal Investigat	DST-SERB	19	3 years
Environmental Consequences and Reclamation Options for coal mining Activities in Charhi& Kuju of Jharkhand, India	Principal Investigat	UGC Start-up Grant	06	2 years
"Marine benthic algae as Metal Biomarker in selected areas of Gulf of Kutch	Principal Investigat or	UGC Minor	1.8	2 years

Industry/Academia Collaborations:

- Research collaboration with National Institute of Oceanography, India, IIT, Indore, Calcutta University on Microplastic study.
- Research collaboration with University of Texas at Dallas on Environmental impacts of Underground fire in Jharia coal belt (Fulbright specialist grant).
- Collaborating with University of South Australia on heavy metal biogeochemistry studies

Targeted Application Area:

- **Safe Drinking Water** – Developing advanced treatment technologies to ensure the removal of contaminants from drinking water sources.
- **Wastewater Remediation** – Designing low-cost, eco-friendly nanomaterials for treating industrial and domestic wastewater containing dyes, antibiotics, and heavy metals.
- **Contaminated Site Rehabilitation** – Applying phytoremediation and biogeochemical analysis for the cleanup of heavy metal-contaminated soils and sediments.
- **Pollution Monitoring in Mining Zones** – Assessing environmental degradation due to mining and proposing strategies for ecological restoration and risk reduction.
- **Microplastic Pollution Management** – Investigating the sources and fate of microplastics in freshwater systems to inform environmental policy and cleanup.

Achievements:

Brief Description of Projects : **(**Source Apportionment, Hydrodynamic Study and Environmental Fate Assessment of Micro-Plastics in Drinking Water Supplying

Problem Statement:

Microplastics are emerging pollutants in freshwater systems, including drinking water sources. Their small size allows them to persist and transport toxic chemicals, posing ecological and health risks. Limited data on their distribution, sources, and impacts hampers effective monitoring and management, especially in developing countries like India.issues.

Applications:

Findings support safer drinking water practices, enhance pollution monitoring, inform environmental regulations, and promote waste management. The research also helps understand microplastic interactions with aquatic organisms, providing insights for biodiversity protection and public health policies in urban and rural watershed areas.

Strategy/ Approach/ Technique/ Experiments used to solve

The study involves water and sediment sampling from reservoirs, microplastic isolation via density separation, and identification through microscopy and FTIR spectroscopy. Source apportionment uses GIS and statistical models. Ecological risk is assessed using risk indices to evaluate potential harm to aquatic ecosystems and public health.

Group Members

38

Achievements:

Brief Description of Projects : Arsenic enrichment in agricultural soils with potential impacts on crops and food security of Sahibganj, Jharkhand, India

Problem Statement:

Arsenic contamination in agricultural soils of Sahibganj, Jharkhand, is emerging as a critical concern, likely due to natural geogenic sources and anthropogenic activities such as irrigation with contaminated groundwater. This contamination poses serious threats to crop health, productivity, and ultimately to the food security and health of local farming communities.

Applications:

- **Safe Crop Cultivation**: Identifying arsenic levels helps select low-uptake crops and safe cultivation zones.
- **Food Safety**: Minimizes arsenic accumulation in food crops, protecting human health.
- **Policy Guidance**: Assists in developing land-use plans and groundwater usage strategies.
- **Sustainable Agriculture**: Supports long-term agricultural productivity in arsenic-prone regions.

Strategy/ Approach/ Technique/ Experiments used to solve

Soil samples are collected across agricultural fields in Sahibganj and analyzed for arsenic content using AAS or ICP-MS. GIS mapping visualizes contamination hotspots. Arsenic uptake in various crop species is studied. Risk assessment models estimate potential threats to food safety and suggest management strategies like crop rotation and soil amendments.

Group Members

Research Group -Groundwater quality and Watershed Management

- ▪ **Name of Principal Investigator/ Group Leader**: Dr. Neeta Kumari
- ▪ **Research Theme**: Heavy metals and emerging contaminant in surface water, Groundwater fluoride management
- ▪ **Broad Area of Research and Scope:**
  - ➢ Surface water management
  - ➢ Groundwater quality management
  - ➢ Watershed management
  - ➢ Ecomodeling using ANN

Schematic Representation of Broad Area of Research:
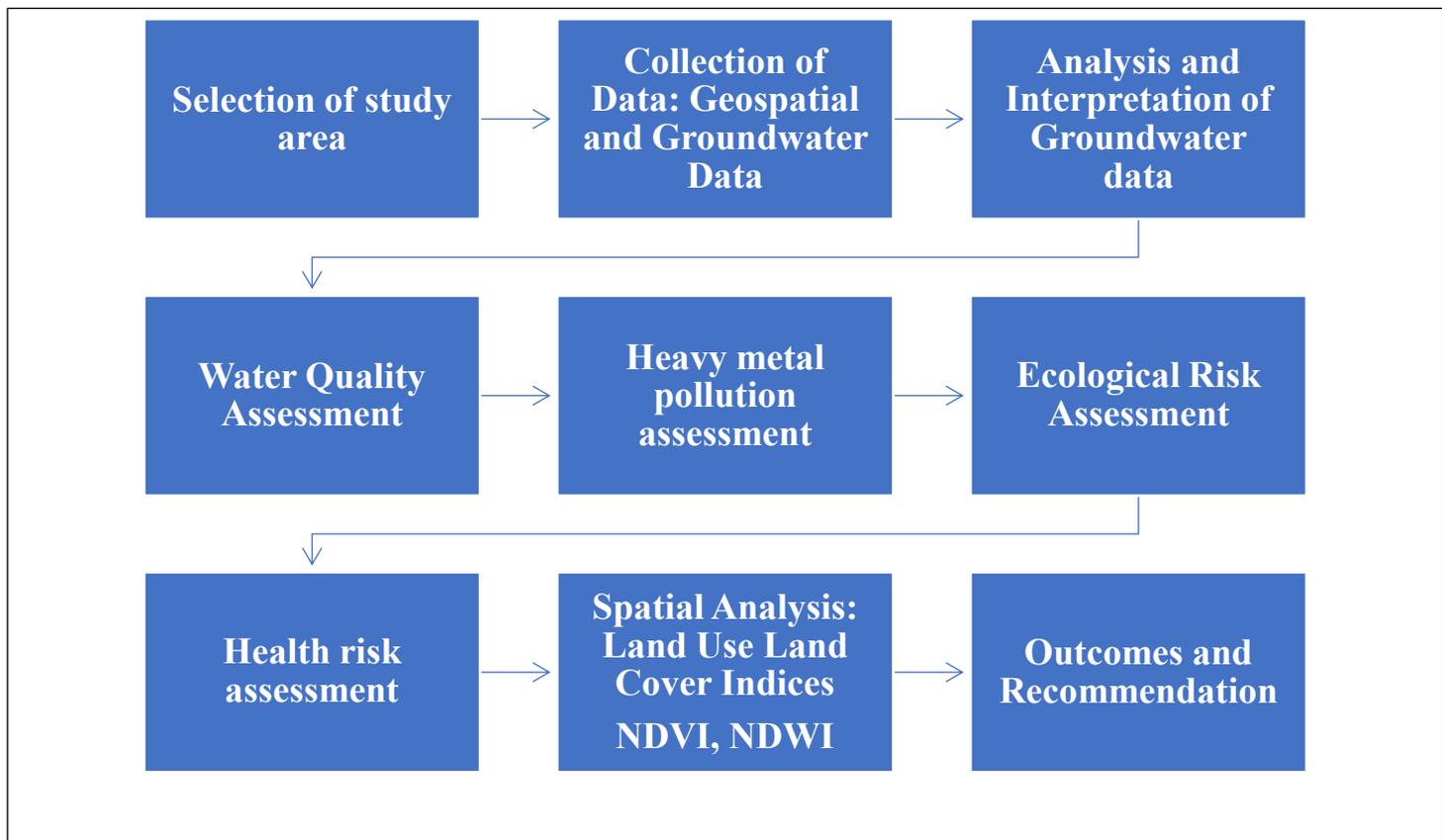
Selection of study area	→	Collection of Data: Geospatial and Groundwater Data	→	Analysis and Interpretation of Groundwater data
Water Quality Assessment	→	**Heavy metal pollution assessment**	→	**Ecological Risk Assessment**
Health risk assessment	→	**Spatial Analysis: Land Use Land Cover Indices NDVI, NDWI**	→	**Outcomes and Recommendation**

- ▪ **Total Number of Publications by the group: 15**
- ▪ **Top 5 Article with impact factor: (Vancouver Style)**

1. Singhal, A., Kumar, M., Bhattacharya, M., Kumari, N., Jha, P.K., Chauhan, D.K. and Thakur, I.S., 2018. Pretreatment of Leucaena leucocephala wood by acidified glycerol: optimization, severity index and correlation analysis. *Bioresource technology*, *265*, pp.214-223. (SCI indexed)

2. Kumari, N., Garg, S., Singhal, A., Kumar, M., Bhattacharya, M., Jha, P.K., Chauhan, D.K. and Thakur, I.S., 2019. Optimizing pretreatment of Leucaena leucocephala using artificial neural networks (ANNs). *Bioresource Technology Reports*, *7*, p.100289. (SCOPUS indexed)

3. Singhal, A., Kumari, N., Ghosh, P., Singh, Y., Garg, S., Shah, M.P., Jha, P.K. and Chauhan, D.K., 2022. Optimizing cellulase production from Aspergillus flavus using response surface methodology and machine learning models. *Environmental Technology & Innovation*, p.102805. (SCI indexed)

4. Pandey, S. and Kumari, N., 2023. Prediction and monitoring of LULC shift using cellular automata-artificial neural network in Jumar watershed of Ranchi District, Jharkhand. *Environmental Monitoring and Assessment*, *195*(1), p.130. https://doi.org/10.1007/s10661-022-10623-6 (SCI indexed)

5. Pandey, S., Kumari, N. and Al Nawajish, S. 2023. Land Use Land Cover (LULC) and Surface Water Quality Assessment in and around Selected Dams of Jharkhand using Water Quality Index (WQI) and Geographic Information System (GIS). J Geol Soc India 99, 205–218. https://doi.org/10.1007/s12594-023-2288-y (SCI indexed)

6. Kadave, K.P. and Kumari, N., 2023. Assessment of seasonal water quality and land use land cover change in Subarnarekha watershed of Ranchi stretch in Jharkhand. *Environmental Science and Pollution Research*, pp.1-16. (SCI indexed)

Targeted Application Area: *Watershed management, Groundwater quality management in coal mining areas Groundwater fluoride management using biochar*

Group Members

Research Group -Slope Stability

- **Name of Principal Investigator/ Group Leader**: Dr. Siddhartha Sengupta
- **Research Theme**: Slope stability of road cuts and embankments
- **Broad Area of Research and Scope:**
  - Slope stability by geosynthetics
  - Slope stability using retaining walls
  - Slope stability soil nailing
  - Seismic slope stability

Schematic Representation of Broad Area of Research:
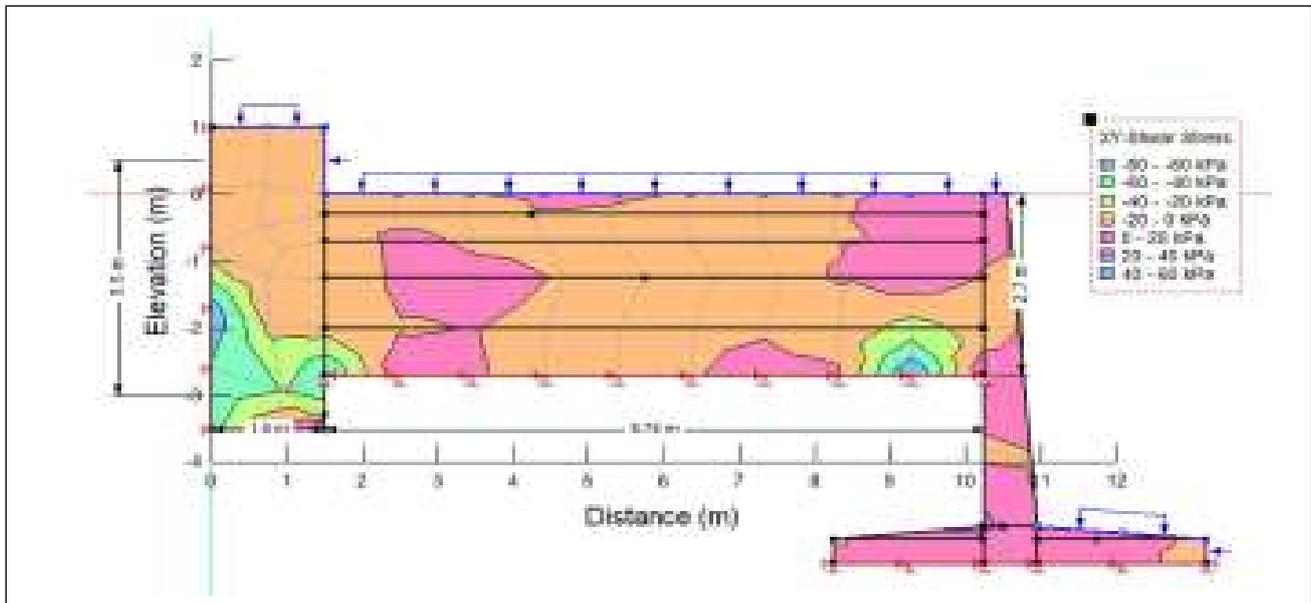
- **Total Number of Publications by the group: 05**
- **Top 5 Article with impact factor:**
  1. Azim U, Sengupta S. Dynamic response of retaining wall optimizing stress distribution and stability of reinforced highway embankments in seismic prone area. Iranian Journal of Science and Technology, Transactions of Civil Engineering 2025 https://doi.org/10.1007/s40996-025-01843-0
  2. Azim U, Sengupta S. Prediction of slope stability with comparative study between unstable slopes reinforced with breast wall and soil nailing using kNN and least square regression analysis. Innovative Infrastructure Solutions, 2024, 9:431. https://doi.org/10.1007/s41062-024-01749-2
  3. Das S, Chakraborty S, Sengupta S. Soil Quality Assessment and Future Agricultural Land Use Potential of a Municipal Dumpsite (Jharkhand, India). *Accepted in* Soil and Sediment Contamination 2025 https://doi.org/10.1080/15320383.2025.2509738
  4. Patnaik A.K.**,** Chaulia S., Bhuyan P.K. Roundabout entry capacity models: Genetic programming approach. *Proceedings of the Institution of Civil Engineers-Transport, ICE Publishing, 2021,* 174 (3), 182-196, https://doi.org/10.1680/jtran.17.00089
  5. Patnaik A.K.**,** Agarwal, A., Panda, M., Bhuyan, P.K. Entry capacity modelling of signalized roundabouts under heterogeneous traffic conditions" *Transportation Letters: The International Journal of Transportation Research, Taylor & Francis 2020* 12 (2), 100-112, https://doi.org/10.1080/19427867.2018.1533160

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount	Duration
Effect of blasting on opencast mine dump and development of relationship between blast induced vibration and dump design	Dr. Ashish Kumar Patnaik (PI) Dr. Siddhartha Sengupta (Co-PI) Dr. Mani Mohan (Co-PI) Dr. Indrajit Roy (Advisor)	CIL	33 lakh	2 years

Industry/Academia Collaborations: Industry like L&T, HCC, Gammon India would be interested in the result of the project.

Targeted Application Area: Slope stability of roads/ embankments

Group Members

DEPARTMENT OF CHEMICAL ENGINEERING

Research Group -High Performance Polymer Blends and Composites

- **Name of Principal Investigator/ Group Leader**: **Prof. Akhil Kumar Sen**
- **Research Theme**: Polymer Blends and Composites
- **Broad Area of Research and Scope:**
  - Polymer blends and composites
  - High-performance polymer nanocomposites for defence application
  - Fire retardant filler for polymer composites

Schematic Representation of Broad Area of Research:

a) **Polymer Blends and composites**
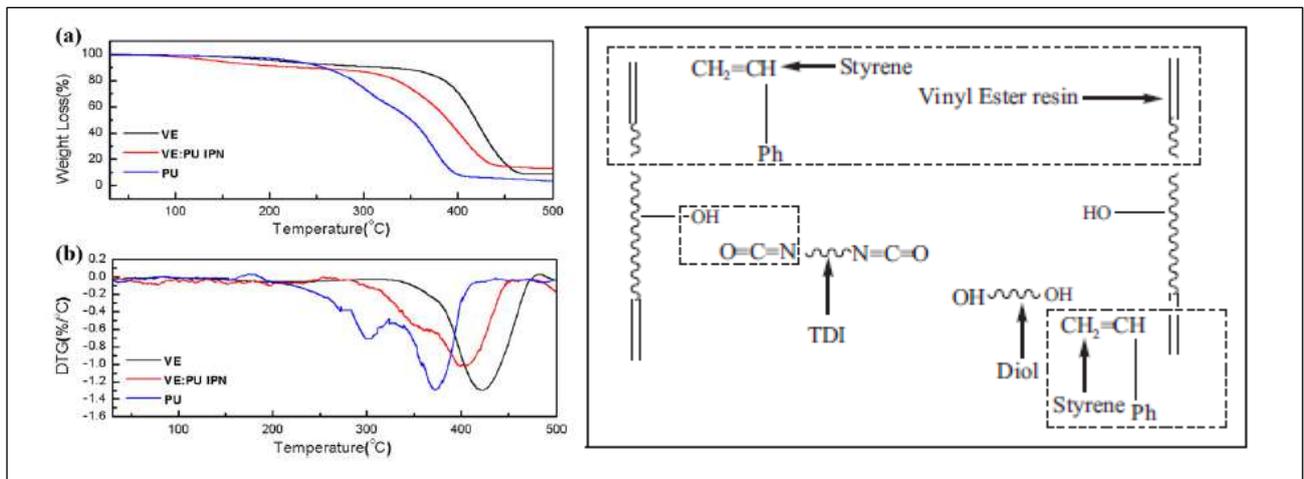
- **Stretched acrylates for high strength applications**
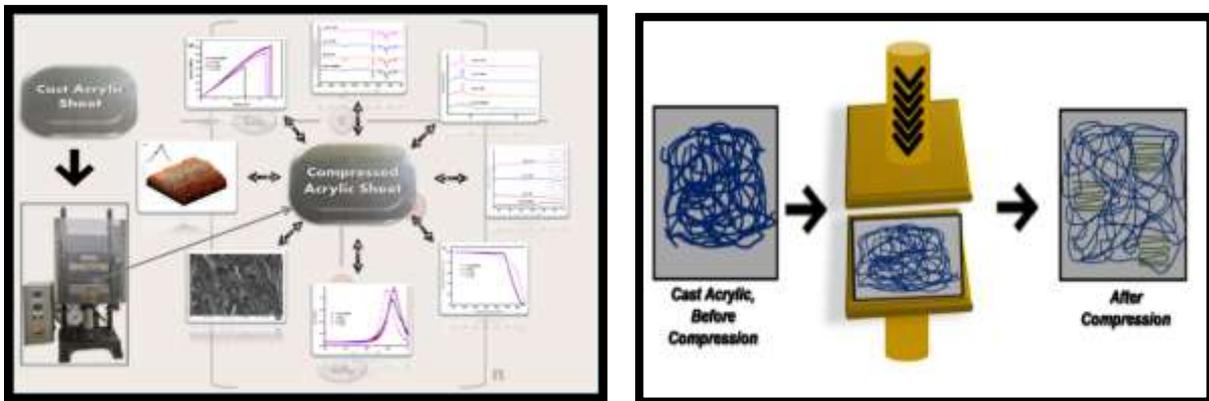
- **Synthesis of nanoparticles and its applications for H2O2 sensors**
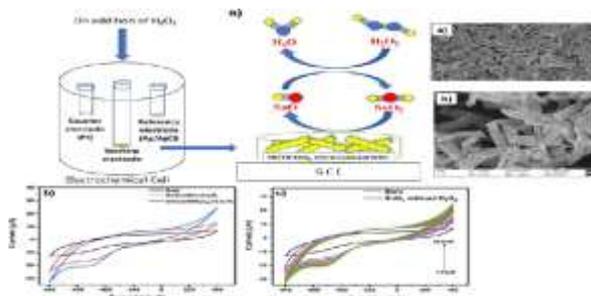
- **High-performance polymer nanocomposites for defence application**
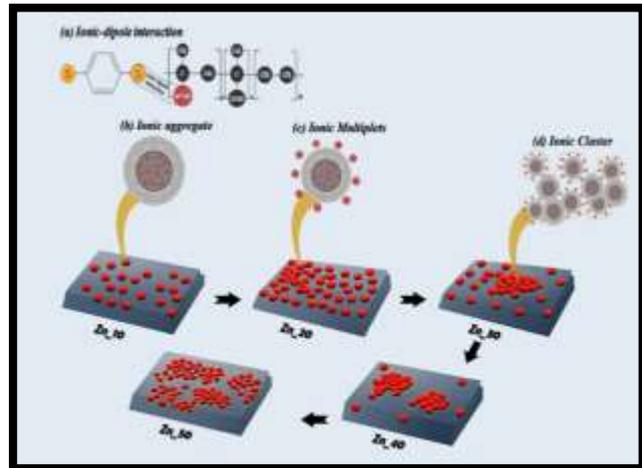
- **Fire retardant filler for polymer composites**
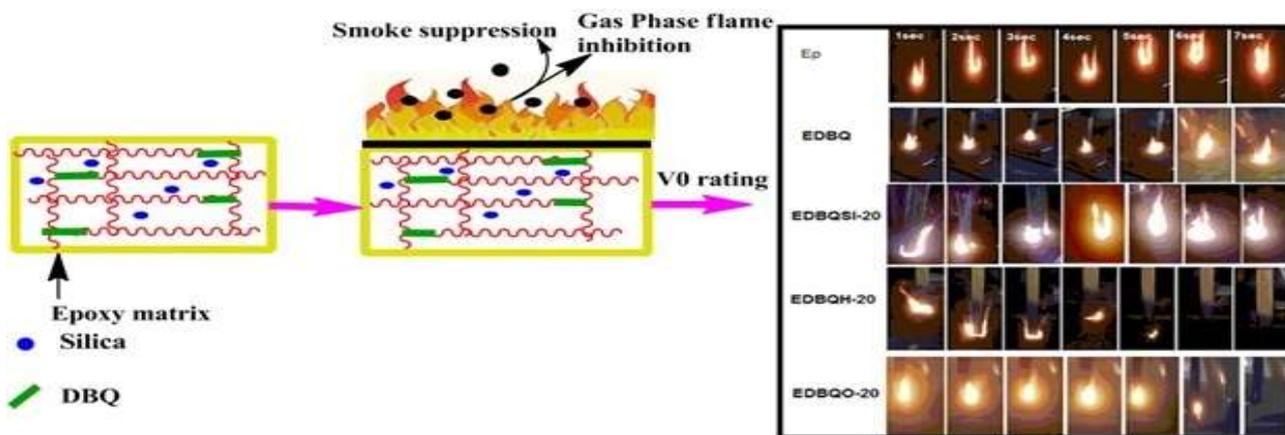
- **Total Number of Publications by the group: 90**
- **Top 5 Article with impact factor:**
    - A.M. Kundu, D.S. Bag, A. Choudhury, G. Sarkhel, Compression induced molecular orientation and crystallization: Enhancing the thermal and mechanical properties of PMMA for aircraft interiors, Polymer (Guildf) 319 (2025) 128009. https://doi.org/10.1016/j.polymer.2024.128009, *IF. 4.1.*
    - S. Pethaperumal, G T Mohanraj, K. Vediappan, K. Kavibharathy, Nano-Micro 2D/3D SnO2 Semiconductor Ultrahigh Sensitive Sensors for Electrochemical Sensing of Hydrogen peroxide, Sensors and Actuators A: Physical, 370 (2024) 115212. https://doi.org/10.1016/j.sna.2024.115212 I.F. = 4.1
    - R. Rangarajan and P. Datta, "Comprehensive Study of Polyphenylene Sulfide (<scp>PPS</scp>)/Na-Ionomer Blend System on Morphological, Thermal, Mechanical, Thermo-Mechanical, and Flame Retardance Behavior," Polym. Adv. Technol., vol. 36, no. 1, Jan. 2025, doi: 10.1002/pat.70058. *IF. 3.1*
    - Sen A.K., Basu S., Ratna D., "Use of a combination of phosphorous-containing epoxy resin and silica fillers for development of flame retardant thermoset polymer composites", *J.Vinyl Add. Tech.* 2023, 29 (1), 130-143, Print ISSN: 1083-5601. Impact Factor 2.367.
    - Effect of variation of biobased phenolic resin content in natural rubber blend on rheological, thermal and tribological properties, Akish E. Kujur, Sudipta Goswami, **Journal of Elastomers and Plastics, SAGE,** vol., 2025, DOI:10.1177/00952443251317115 (IF1.8).

Patents by the group:

Sl. N	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Biaxial Stretching Unit for Acrylates in the name of Defence Research & Development Organisation (DRDO) **Gautam Sarkhel, Anwar M K, Arup Choudhury and Dibyendu Sekhar Bag**	445494-001 filed on **January 27, 2025**	Technical Evaluation is awaiting
2.	A process for manufacturing melamine-based silica for the development of self-extinguishing dopo epoxy composites cured by aliphatic amine by **Akhil Kumar Sen**	**202531038920** filed on **April 23, 2025**	Technical Evaluation is awaiting

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of Radiation, Chemical and Flame-Resistant High-Performance Polymer Composite for Defence Application	P. Datta (PI)	ER & IPR, DRDO, New Delhi	36.72lakhs	2023 - 2026
Study the Effect of Stretching on the Physico-mechanical Properties of Acrylates	G. Sarkhel (PI)	DMSRDE-DRDO	81.368 Lakhs	2022-2025
Development of Electronic Nose for detection of Biomarker Vapor blends using conductive polymer nanocomposite sensors	G. T. Mohanraj (PI)	SERB, DST	39.64 lakhs	2017-2022
Development of organophosphorous based flame retardant for epoxy and vinyl ester resin	A.K. Sen (PI)	DRDO, NRB	21.37lakhs	2014-2018
Interpenetrating networks based on hydrophilic- hydrophobic acrylics	S.Goswami (PI)	DST,SERC	10.2 lakhs	2010-2013

Industry/Academia Collaborations: Group members have handled Sponsored project with DMSRDE Kanpur, SERB, DST, NRB, DRDO.

Targeted Application Area: Polymer blends and composites for defence, aerospace, Navy and some industrial applications

Achievements:

1. Project Title: Development of Radiation, Chemical and Flame-Resistant High-Performance Polymer Composite for Defence Application (ongoing)

Problem Statement:	**Applications:**
The project has the potential to contribute to a defence sector in becoming self-sufficient in innovative technologies for producing high-end defensive applications. Using high performance polymers to combine a material with good mechanical qualities plus physiochemical capabilities, such as chemical inertness, flame resistance, and radiation resistance, which hinders indigenous development in cutting-edge space and defence technologies.	

Strategy/ Approach/ Technique/ Experiments used to solve

The high-performance polymer nanocomposite developed through micro-compounder & injection moulding comprising of polyphenylene sulphide (PPS) matrix, for its inherent flame & chemical resistance. Blended with Na-ionomer to overcome the limitations of PPS and reinforced with radiation resistant filler.

2. Project Title: Development of organophosphorus based flame retardant for epoxy and vinyl ester resin (completed)

Problem Statement	**Applications:**
Flame retardant materials are added to the plastics and resins to prevent fire propagation. The global flame retardant market, encompassing various fillers and additives, is experiencing significant growth driven by increasing fire safety regulations and demand across industries such as construction, electronics, transportation, and textiles. Non halogenated flame retardants (aluminium trihydrate and magnesium hydroxide) accounted for largest share (62% in 2024).	The product can be added to polyolefins and resins to reduce the spread of flame and prevent the polymer from dripping and suppress smoke formation. Construction mattress covers, roofing and siding, components in trains and planes, carpet backing, automotive interior, and others that require flame retardants. The rapidly developing transportation industry and the need to address fire safety in the automobile industry are expected to boost product demand.

Strategy/ Approach/ Technique/ Experiments used to solve

Stricter environment regulations demand for low cost, non-toxic, non-hazardous, environment friendly fire retardant filler. A novel silica phosphate based nitrogen/ boron containing flame retardant filler has been developed from low cost sodium silicate by simple sol gel technique.
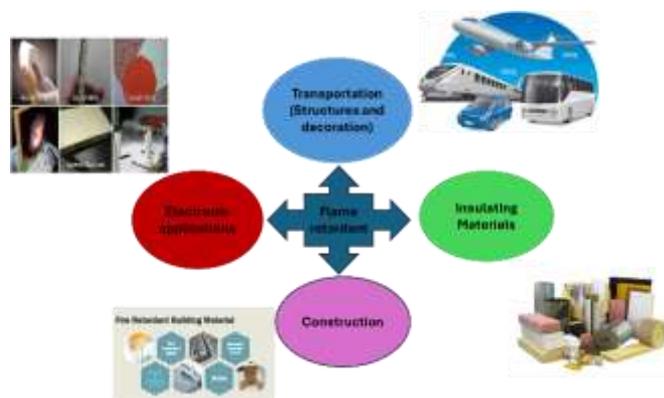
Group Members

Research Group -Supercapacitor and Biosensor

- ▪ **Name of Principal Investigator/ Group Leader**: Dr. Arup Choudhury
- ▪ **Research Theme**: Carbon based materials and its functional Application in Energy Storage and Biosensing field
- ▪ **Broad Area of Research and Scope:**
  - ➢ Nanomaterials for supercapacitors and battery applications
  - ➢ Waste biomass derived carbon-based matrix for energy storage applications
  - ➢ Metal organic framework/carbon nanocomposite for electrochemical sensing applications

Schematic Representation of Broad Area of Research:
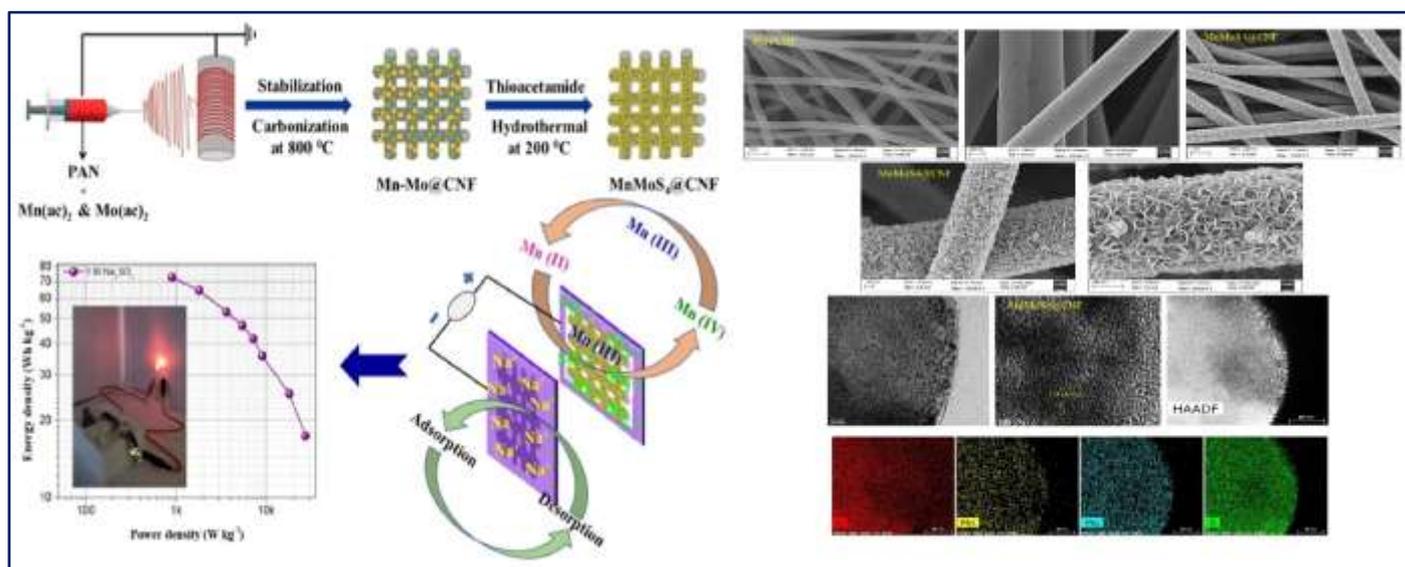
- • **Total Number of Publications by the group: 70**
- • **Top 5 Article with impact factor: (Vancouver Style)**
  1. Ahmad M.W, Singh J, Syed A, Bahkali A.H, Subramaniam M, Yang D.J, Choudhury A. Bimetallic manganese–nickel metal–organic framework anchored hexyl-aminated carbon nanotube hybrid as an anodic material for solid-state asymmetric supercapacitors. Energy & Fuels 2024;38(15):14672-14684. (**Impact Factor 5.2**)
  2. Singh J, Ahmad M.W, Choudhury A, Al-Humaidi J.Y, Hossain S.K.S, Ul-Islam M, Rahman M.M, Yang D.J. Chemical growth of Niobium-doped vanadium pentoxide on aminated graphene for all-solid-state asymmetric supercapacitors. Materials Today Sustainability 2024;28:100969. (**Impact Factor 7.1**)
  3. Ahmad M.W, Choudhury A, Dey B, Anand S, Al Saidi A.K.A., Lee G.H, Yang D.J. Three-dimensional core-shell niobium-metal organic framework@ carbon nanofiber mat as a binder-free positive electrode for asymmetric supercapacitor. Journal of Energy Storage 2022;55:105484. (**Impact Factor 8.9**)
  4. Ahmad M.W, Anand S, Dey B, Yang D.J, Choudhury A. N/P/O/S Heteroatom-doped porous carbon nanofiber mats derived from a polyacrylonitrile/L-cysteine/P2O5 precursor for flexible electrochemical supercapacitors. ACS Applied Energy Materials 4 (2021) 12177–12190. (**Impact Factor 5.5**)

5. Choudhury A, Kim J.-H, Mahapatra S.S, Yang K.-S, Yang D.-J. Nitrogen-Enriched Porous Carbon Nanofiber Mat as Efficient Flexible Electrode Material for Supercapacitors. ACS Sustainable Chemistry Engineering 2017;5:2109–2118. (**Impact Factor 7.1**)

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Waste Nutshell-derived Porous Carbon Nanofibers and Their Hybrid Mats as Advanced Electrode Materials for Supercapacitors	PI	BRNS	31.85	3 Years
Development of 3D Flexible mat based on waste sugarcane bagasse-derived carbon nanofibers and metal organic frameworks for Fabrication of Next Generation flexible/wearable supercapacitors	PI	DST-CRG	25.33	3 Years
Development of Radiation, Chemical and Flame-Resistant High-Performance Polymer Composite for Defence Application	Co-PI	DRDO	36.72	3 Years
Study the Effect of Stretching on the Physico-Mechanical Properties of Acrylates	Co-PI	DMSRDE-DRDO	81.36	3 Years
Development of Advanced Polybenzimidazole Based Nanocomposite Materials for Potential Defence Applications	PI	DRDO	23.7	3 Years

Industry/Academia Collaborations:

❑ Professor Duck-Joo Yang, The University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080, United States **[QS ranking 520]**
❑ Professor Thaseen Kamal, King Abdulaziz University, Jeddah 21589, Saudi Arabia **[QS ranking 143]**
❑ Dr. Asad Syed, King Saud University, P.O. 2455, Riyadh 11451, Saudi Arabia **[QS ranking 203]**
❑ Dr. Bo-Hye Kim, Daegu University, South Korea **[QS ranking 307]**
❑ Dr. SK Safdar Hossain, King Faisal University, Al Ahsa, Saudi Arabia **[QS ranking 851-900]**
❑ Dr. Md Wasi Ahmad, Dhofar University, Salalah, P.O. Box 2509, Postal Code 211, Sultanate of Oman **[QS ranking 800-1000]**

Targeted Application Area: Supercapacitor and Biosensing

Achievements:

Problem Statement:

The progressive development of flexible and wearable electronics has created a huge demand for advanced, low-cost, shape-adaptive, and flexible energy-storage systems. The proposed research is aimed to develop waste biomass-derived carbon nanofibers and their hybrid composite mats as a novel flexible binder-free supercapacitor electrode with the emphasis on high energy density, long cycle life, good scalability, low cost and also to develop ionic gel electrolytes suitable for flexible solid-state SCs.

Applications:

➢ Wearable and Flexible Electronics
➢ Satellite and Spacecraft Power in Defense
➢ Renewable Energy Systems
➢ Automotive Industry
➢ Consumer Electronics

Strategy/ Approach/ Technique/ Experiments used to solve

To develop cheap self-standing electrospun carbon nanofibers (CNFs) mats from different industrial waste nutshell biomass as carbon precursors and explore them as promising binder-free supercapacitor (SC) electrodes for flexible/wearable electronics as well as to solve the waste disposal issue. Improvement of electrochemical performances of waste nutshell-derived CNFs by self-doping, in-situ/ex-situ heteroatoms (N, P, O, S) doping and metallic doping, and construction of hierarchical and heterogeneous porosity. Designing and assembling of prototype flexible solid-state asymmetric (Hybrid) supercapacitor devices using as-developed mats as electrode and suitable polymeric gel electrolyte, and optimize their energy, discharge kinetics, cycling stability, operational temperature range as per commercial demand for portable electronic devices.

Graphical Abstract
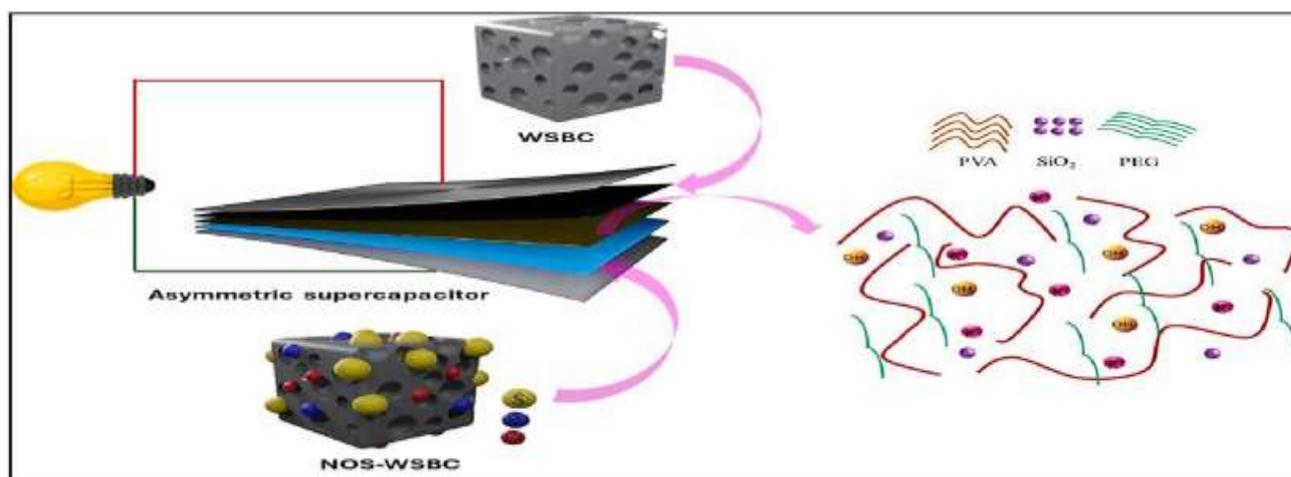
Group Members

Research Group- Sustainable Multiphase Reaction Engineering

- **Principal Investigator**: **Dr. Sangram Roy**
- **Research Theme**: Process intensification for carbon dioxide removal (CDR) and green hydrogen production technologies
- **Broad Area of Research and Scope:**
  - Multiphase Transport Phenomena and Reaction Engineering
  - Physics and data-driven Modeling
  - Electrification and decarbonization of chemical industry

Schematic Representation of Broad Area of Research:
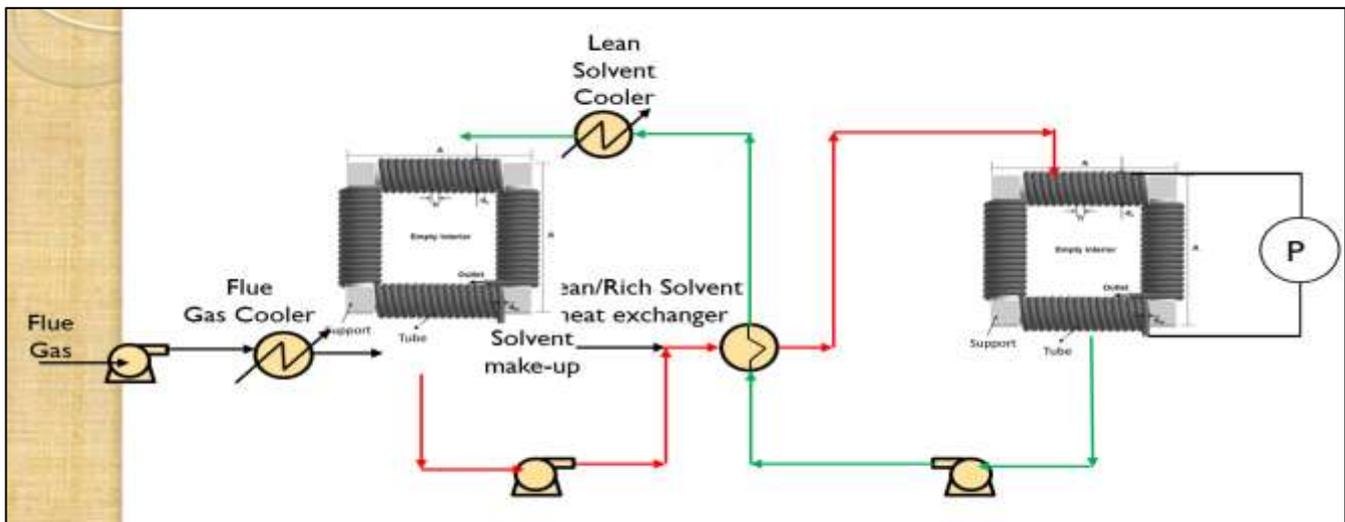
Process Intensification for post-combustion capture of CO₂
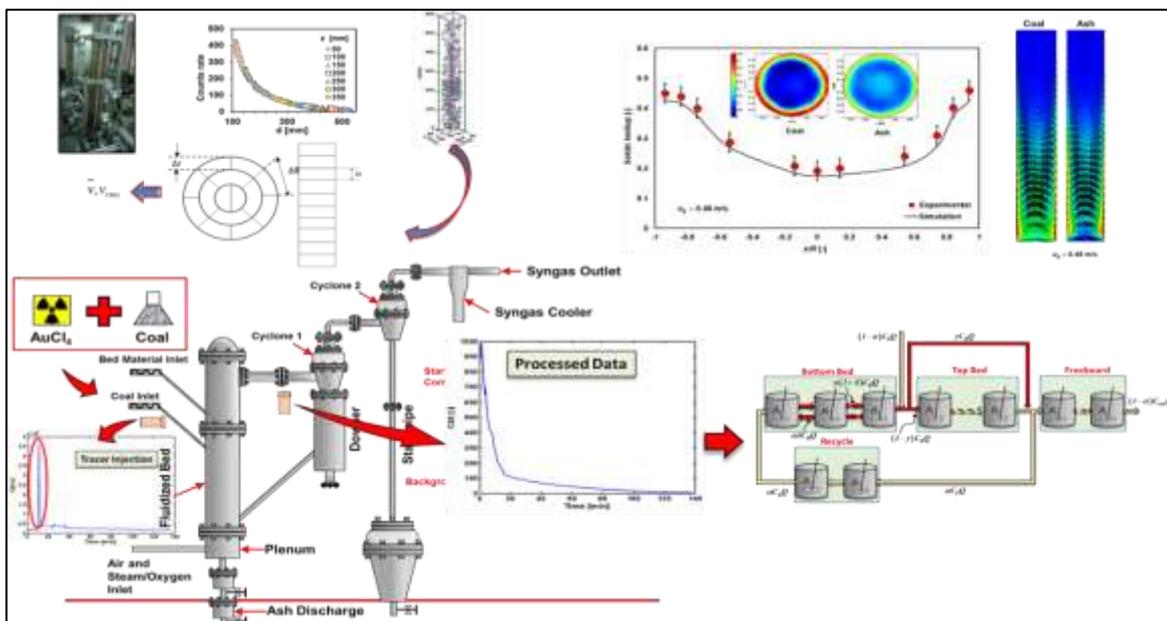
Radiation based non-invasive measurements of coal/ash flow behaviour in fluidized bed gasifiers
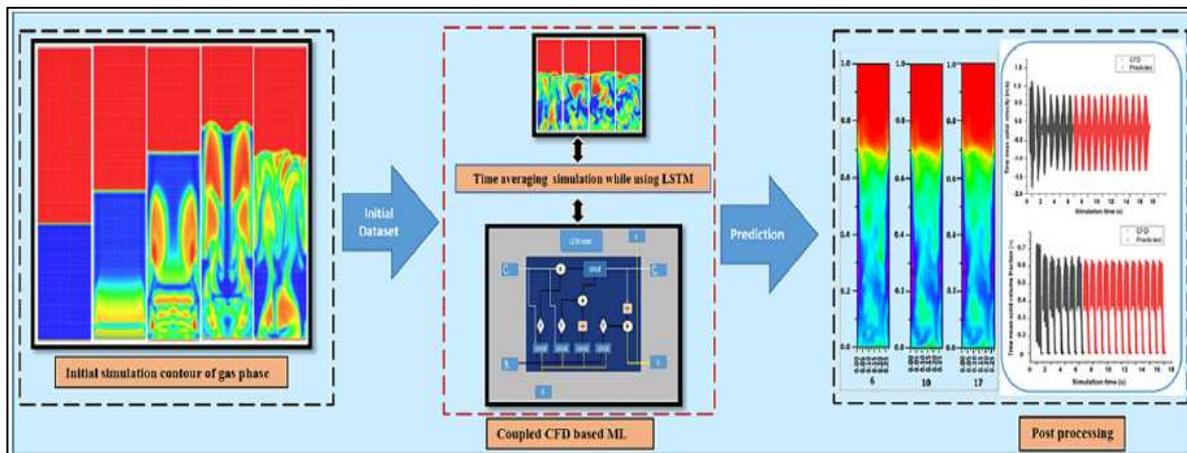
Data-Driven Modelling of hydrodynamics of fluidized beds

Total Number of Publications by the group:14

Top 5 Article with impact factor:

1. Nadda, M., Avilala, P., Banaeizadeh, A., **Roy, S**. and Yadav, A. Coupled Computational Fluid Dynamics-Discrete Element Method (CFD-DEM) Modeling of Moisture Removal in a Fluidized Bed Dryer for Heterogeneously Coated Solids. Chem. Eng. Sci., 2025. (IF: 4.1)
2. Dutta, S., **Roy, S**., Lang, X., Chen, S., Kumar, R., Loha, C., Verspeelt, T., Van Geem, K.M., Heynderickx, G.J. and Ouyang, Y. Process Intensification of CO_2 Desorption in a Gas-Liquid Vortex Reactor. Ind. Eng. Chem. Res., 2024, 63, 10544−10553. (IF: 3.8)
3. Nadda, M., Singh, K., **Roy, S**. and Yadav, A. A comparative assessment of CFD-based LSTM and GRU for hydrodynamic predictions of gas-solid fluidized bed. Powder Technol., 2024, 441, 119836. (IF: 4.5)
4. **Roy, S**., Pant, H.J. and Roy, S. Velocity characterization of solids in binary fluidized beds. Chem. Eng. Sci., 2021, 246, 116883. (IF: 4.1)
5. **Roy, S**., Pant, H.J. and Roy, S. Solids flow pattern in cold flow mockup of fluidized bed gasifier. Chem. Eng. Sci., 2019, 210, 115225. (IF: 4.1)

Academic Collaborations: Ashutosh Yadav, Department of Chemical Engineering, Indian Institute of Technology Jammu

Targeted Application Area: Intensified process development for Carbon Capture and Utilization

Brief Description of Project	
Problem Statement	**Applications**
Process Intensification technologies are now sought after for developing efficient processes for solvent absorption of Post Combustion Capture. It is thus proposed to use compact coiled flow inverters (CCFI) for chemical absorption of CO_2. The proposed project envisions two significant developments: • Development of CFI for solvent regeneration • Electrification of solvent regeneration	• Hard-to-abate sectors like steel, cement industries and power plants • Modular design for remote deployment

Group Member

54

Research Group- Electrochemical Process Intensification & Transformation

- **Name of Principal Investigator/ Group Leader**: Dr. Abhijit Mondal

- **Research Theme**: Process intensification on electrochemical process and engineering approaches for the application of microplastic degradation and the production of value-added fuels.

- **Broad Area of Research:**

    - Electrochemical Degradation Mechanisms
    - Electrode Material Development
    - Reactor and Process Engineering
    - Conversion Pathways to Value-Added Fuels
    - Environmental and Toxicological Assessment
    - Socioeconomic and Policy Implications
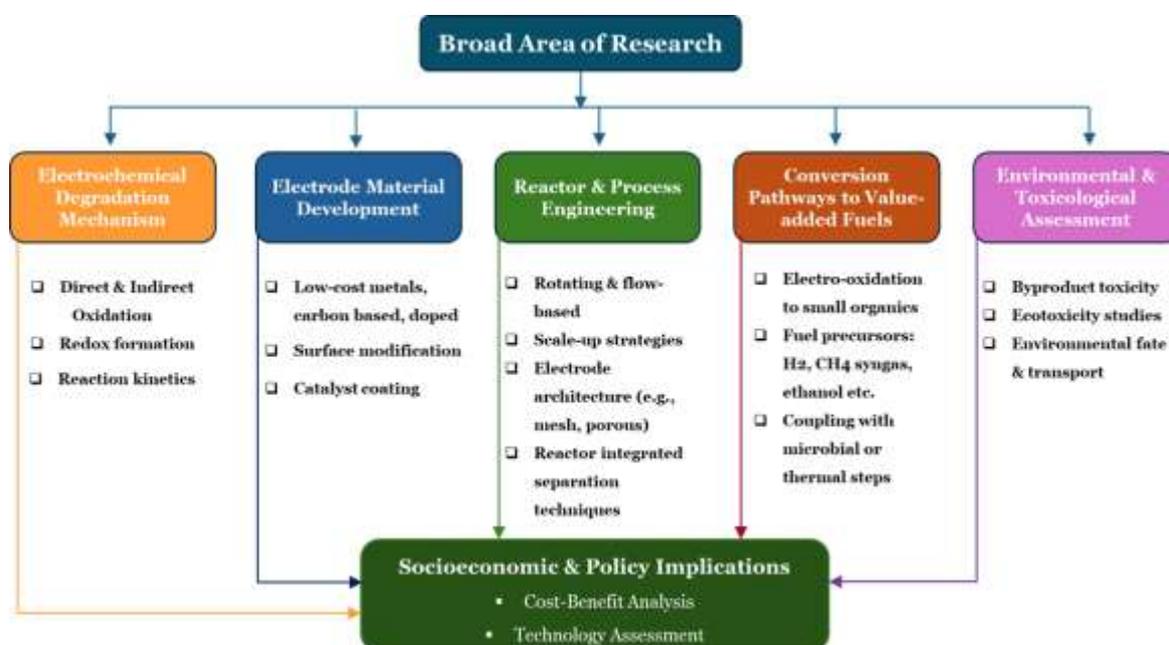
- **Total Number of Publications by the group: 58**
- **Top 5 Article:**
1. P. Gokul Gangadharan, A. Bharti, A. Mondal, Exploring the degradation of polyethylene terephthalate microplastics from water and synthetic marine water by the electrochemical method, **Journal of Water Process Engineering** 76 (2025) 108101. https://doi.org/10.1016/j.jwpe.2025.108101.
2. G.G. P, A. Bharti, A. Mondal, Electrochemical degradation strategies for polystyrene microplastic: Current trends and future prospects, **Polymer Degradation and Stability** 238 (2025) 111351. https://doi.org/10.1016/j.polymdegradstab.2025.111351.
3. N. Shekhar, A. Mondal, Synthesis, properties, environmental degradation, processing, and applications of Polylactic Acid (PLA): an overview, **Polymer Bulletin** 81 (2024) 11421–11457. https://doi.org/10.1007/s00289-024-05252-7.
4. J. Das, A. Mondal, A. Tarafdar, S. Nag, Optimizing Ni (II) adsorption on Carica papaya fiber through experimental and advanced neural network prediction, **Separation Science and Technology** 60 (2025) 583–604. https://doi.org/10.1080/01496395.2025.2452425.
5. R. Majumdar, U. Mishra, N. Mahata, M.P. Shah, A. Mondal, B. Bhunia, Preparation, characterization, and

performance evaluation of composite films of polyvinyl alcohol/ cellulose nanofiber extracted from Imperata cylindrica, **Chemosphere** 337 (2023) 139370. https://doi.org/10.1016/j.chemosphere.2023.139370.

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status
1.	An Electro-Chemical Batch Reactor (ECBR) for degradation of polyethylene terephthalate (PET) microplastics (MPs) in water. (Gokul Gangadharan P and Abhijit Mondal)	202531006308 & 31/01/2025	Published
2.	A Rotating Electrochemical Reactor Using Boron-doped Diamond and Titanium Electrodes for Degrading Polystyrene Microplastics, and Method Thereof. (Gokul Gangadharan P and Abhijit Mondal)	202431087019 & 22/11/2024	Published

▪ **Research Project:**

Sl. No.	Title of Project	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
1.	Degradation of polystyrene microplastics (PMSs) from wastewater using Novel Continuous Rotating Electro-Chemical Reactor (CRECR)	**PI**	**ICMR_DHR**	44.17 Lakhs	20.03.2023 to continuing

Brief Description of Projects: Degradation of Polystyrene (PS) and Polyethylene terephthalate (PET) microplastics (MPs) from wastewater using Novel Rotating Electro-Chemical Reactor (RECR).

Problem Statement:

▪ Due to the easiness, strong oxidation performance, and environmental compatibility, electrochemical oxidation process has been accepted as a promising technology for treating refractory organic wastewaters.
▪ Although electrochemical oxidation technology for wastewater treatment was not widely used. There are very few works on electrooxidation of microplastics (MPs) observed in the literature.
▪ There is a formation of bubble curtain by the gas accumulation on anode surface during the electrochemical reaction which hampered reaction rate and very few solutions have been proposed against the problem of a bubble curtain on the anode surface in aqueous system.
▪ There is no evidence in the literature that the suggested prototype "Rotating electrochemical reactor" (RECR) has been investigated for the degradation of MPs overcoming all the problems of conventional electrochemical reactor.

Strategy/ Approach/ Technique/ Experiments used to solve

In Rotating electrochemical reactor (RECR), high centrifugal force removes the buildup of bubble curtain over the electrode surface and enhances the mass transfer and reaction area over the electrode surface. This RECR promotes faster electro-oxidation process which lowers the current efficiency and increases energy consumption.

Highest removal rate and 100% current efficiency are achieved for the electrochemical oxidation process by using the Boron-Doped Diamond (BDD) electrode.

Applications:

➢ Reduce the burden of MPs from the environment by using biodegradable method without using any toxic chemicals.
➢ Avoid incineration of plastic waste which releases toxic chemicals, MPs, and NPs into the air and to evade the contamination of soil and water during landfilling.
➢ By the application of the proposed prototype in the wastewater effluent treatment plant, it can assist to decline many negative aspects of the marine or aquatic fish, marine food chain and consequently curtail the threat to animals due to consumption of MPs in different way.

Publication / patent:

1. P. Gokul Gangadharan, A. Bharti, A. Mondal, Exploring the degradation of polyethylene terephthalate microplastics from water and synthetic marine water by the electrochemical method, Journal of Water Process Engineering 76 (2025) 108101.
2. G.G. P, A. Bharti, A. Mondal, Electrochemical degradation strategies for polystyrene microplastic: Current trends and future prospects, Polymer Degradation and Stability 238 (2025) 111351.
Patent: 2
1. Application no.- 202531006308; Published on 31 January 2025
2. Application no.- 202431087019; Published on 22 November 2024.
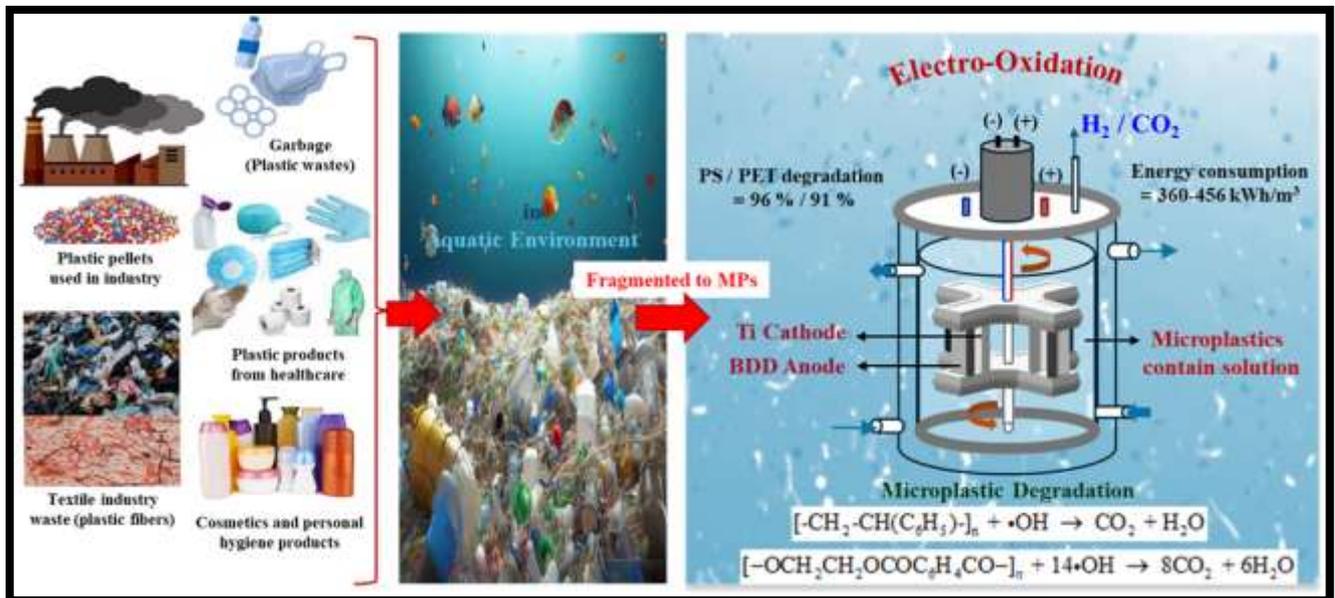
Group Members

Dr. Abhijit Mondal   Dr. Anand Bharti   Dr. Aniruddha Deb   Mr. Gokul G. P.

Research Group- AFoC-MiPE Research Group
(Applied Food Chemistry, Microbiology, and Process Engineering)

- **Name of Principal Investigator/ Group Leader**: Dr. Anupam Roy
- **Research Theme**: Food Engineering and Technology
- **Broad Area of Research:**
    1. Process Development and Mechanization
    2. Processing Impact Assessment on Food Chemistry, Microbiology and Quality
    3. Staple Fortification
    4. Starch and Resistant Starch
    5. Nutraceuticals and Functional Foods
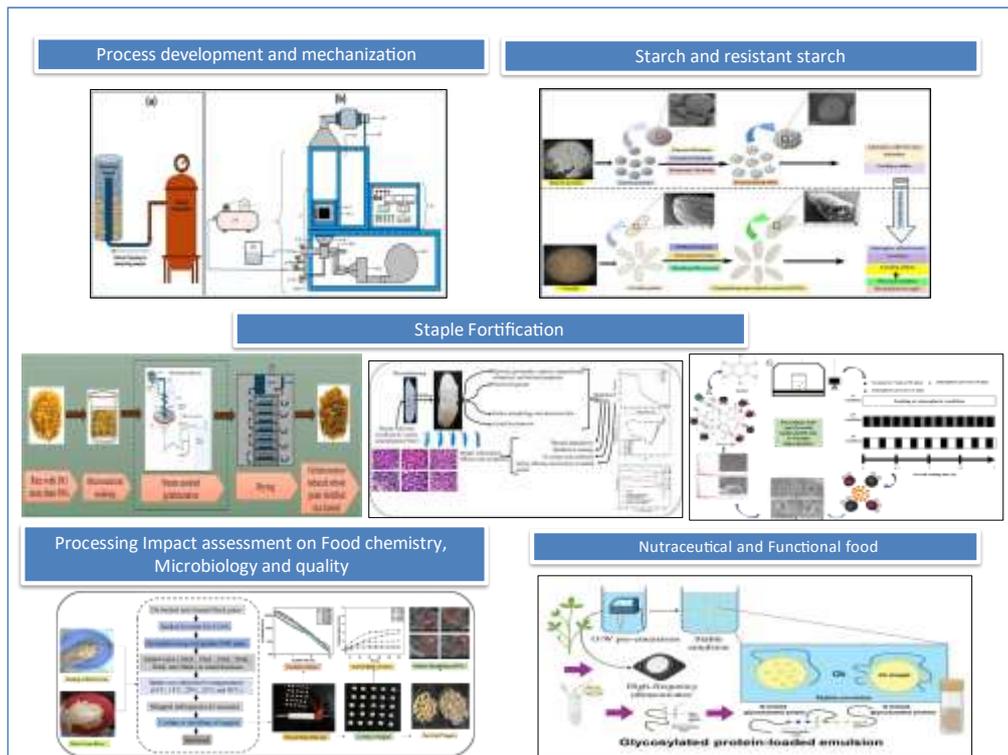
Total Number of Publications by the group:

Top 5 Article:

1. Sarkhel S, Bhattacharjee S, Pathak S, Datta P, Roy A. Temperature guided foam stability, structure and texture of pulse nugget: Exploring traditional food physics for aerated batter applications. *J Food Eng*. 2025;391:112447. https://doi.org/10.1016/j.jfoodeng.2024.112447
2. Kumari A, Sahoo B, Sarkhel S, Hait S, Chatterjee R, Mohan A, Roy A. Microwave Assisted Fluidized Bed Spray Soaking and Gelatinization for Whole Grain Rice Fortification. *Food Front*. 2025;0:1–14. https://doi.org/10.1002/fft2.70074
3. Sarkhel S, Roy A. Vacuum impregnation assisted simultaneous micronutrients fortification and phytic acid reduction in lentils. *J Food Eng*. 2024;365:111823. https://doi.org/10.1016/j.jfoodeng.2023.111823
4. Saha S, Roy A. Whole grain rice fortification as a solution to micronutrient deficiency: Technologies and need for more viable alternatives. *Food Chem*. 2020;326:127049. https://doi.org/10.1016/j.foodchem.2020.127049

5. Roy A, Patra M, Sarkhel S, Sengupta S, Saha S, Jha S, Sarkhel G, Shrivastava SL. Fucose-containing *Abroma augusta* mucilage hydrogel as a potential probiotic carrier with prebiotic function. *Food Chem*. 2022;387:132941. https://doi.org/10.1016/j.foodchem.2022.132941

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status
1.	Anupam Roy, Ankanksha Kumari & Sreyajit Saha "An apparatus for grains fortification"; Application no."	202231057966 12/04/2024	Published
2.	Anupam Roy & Ankanksha Kumari "A method for fortification of grains".	202311010189 23/08/2024	Published
3.	Anupam Roy, Bijendra Sahoo, Ankanksha Kumari and Shubhajit Sarkhel " An integrated apparatus for blanching, sterilization, drying and recovery of volatile components"	202331085872 19/04/2024	Published
4.	Sreyajit Saha, Shubhajit Sarkhel, Anupam Roy et al., "A method for fortification of whole grain puffed rice"	202331036336 06/10/2023	Published
5.	Anupam Roy, Bijendra Sahoo, Ankanksha Kumari and Shubhajit Sarkhel "Microwave, superheated steam, hot and cold air assisted fluidized bedchamber and application thereof"	202331056554	Filed

Research Projects: Recent 5 in chronological

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Biopolymer based nano-layer fortification of self-assembled micronutrients over pre-conditioned rice: Retention of fortified nutrients and scale up studies	PI	The Indian Council of Medical Research (ICMR)	43.81 lakh	2019-2022
Development of process technology for enhanced resistant starch content in rice and rice-based snack (Puffed rice)	PI	SERB	53.064 lakh	2019-2022
Development of non-destructive process technology for simultaneous micronutrient fortification and bioavailability enhancement in Dal through selective binding of phytic acid.	PI	Department of Biotechnology (DBT)	57.9 lakh	2020-2024
Design and development of low-cost technology for micronutrient protein-fortified whole grain puffed rice	PI	The Indian Council of Medical Research (ICMR)	49 lakhs	2022-2024
Design and Development of short-time Microwave Assisted Vacuum-Steam-Vacuum (MAVSV) process technology for simultaneous reduction of rancidity-causing enzymes and antinutrients in Millet: Enhancing shelf life and micronutrient bioavailability	PI	Department of Biotechnology (DBT)	30 lakhs	2024-2026

Biopolymer based nano-layer fortification of self-assembled micronutrients over pre-conditioned rice: Retention of fortified nutrients and scale up studies

Problem Statement
Extrusion-based fortified rice kernels (FRKs) face consumer rejection with limited bioavailability due to differences in density, color, texture, cooking properties, and sensory properties

Aim of this work
To develop a process technology for fortifying whole-grain rice with identical physicochemical and sensory properties as regular rice that overcomes the shortfalls of existing fortification techniques

Phase-I
Optimizing degree of gelatinization (DG) in Rice preventing soaking induced fissure formation

7.08 %   16.82 %   38.79 %   47.66 %   50.34 %   52.98 %   57.06 %

Rice with high DG restricts fissure formation up to 50% moisture grain during soaking

Phase-II
Optimizing short-time steam treatment for subsequent gelatinization & fissure development in micronutrient-soaked rice with preoptimized DG

Rice (DG >50%) → Micronutrient soaking → Steam assisted gelatinization → Drying → Gelatinization-induced whole grain fortified rice kernel

Micronutrient Soaking in partially gelatinized rice → Second stage Gelatinization → Drying

Rice with high DG (>50%) soaked with micronutrients, steamed for 120 seconds, dried to 13% moisture results in fortified rice with 80% washing and 70.33% cooking retention.

Gelatinization Induced Whole Grain Rice Fortification Technology (GIWGFR-Technology)

Phase-III   **Mechanization of the lab-scale GIWGFR-Technology**

Part A   **Development of Microwave assisted fluidized bed spray dryer (MAFBSD)**

Microwave-assisted Soaking → Microwave-assisted Gelatinization → Microwave-assisted Drying

Drawback
Low micronutrient Retention: GIWGRF from MAFBSD offered 52.19% washing & 22.77% cooking retention

Learnings
Low micronutrient retention compared to lab scale process due to insignificant secondary stage gelatinization of micronutrient soaked rice

Part B   **Overcoming the drawback Development of Microwave-assisted screw conveying spraying and drying setup (MASCSD) to overcome the problem with MAFBSD**

Microwave-assisted Soaking → Soaking and microwave-steam assisted gelatinization → Microwave-assisted Drying

Achievement
GIWGRF from MASCSD offered 89.19% washing & 65.77% cooking retention maintaining physiochemical & cooking properties similar to regular rice

Step Forward
Multi-nutrient fortification using GIWFRK and comparative efficacy assessment

Optimal conditions: Initial Rice DG: 58%, Micronutrient soaking reaching a moisture content: 47%. Steaming:60.88%, Drying:13% at 0.6 kW/kg

Phase-IV   **Comparative efficacy assessment with EFRK and regular rice**

Multi-nutrient fortification using GIWFRK and comparative quality efficacy assessment with crude rice

GIWFRK technology exhibited high retention of iron, folic acid, cyanocobalamin, better quality attributes, overcoming the drawback of ERFK

Conclusion
Whole rice grain fortification using SMS-assisted gelatinization through GIWGRF technology in MASCSD is an efficient method and processing approach to effectively produces fortified rice with high micronutrient retention, maintaining physicochemical and cooking properties identical to regular rice.

60

Development of non-destructive process technology for simultaneous micronutrient fortification and bioavailability enhancement Dal through selective binding ofphytic acid.

Objective

1. Design and development of process technology for simultaneous non-destructive Dal fortification and phytic acid reduction

2. Study the effects of the developed process on thephytic acid reduction, retention of micronutrients and product quality in comparison with conventionalDal

3. Assessment of bioavailability and accelerated shelf life of fortified Dal

Experiments used to solve

- Optimized migration of selective additives and micronutrient in dal matrix for machinery fabrication
- Optimized selective interaction of phytic acid with additives and deposition of micronutrients for machinery fabrication
- Developed a pre-conditioning chamber (Soaking) for Dal for the migration of selective additives and micronutrients with a capacity 10 kg/hour
- Developed a conveying system for selective interaction of phytic acid with additives with a capacity 10 kg/hour
- Developed a Nano-layer Deposition Chamber for depositing self-assembled micronutrient over conditioned Dal with a capacity 10 kg/hour

- Optimized processing condition on the designed machinery
- Optimized the process for maximum reduction of phytic acid and retention of micronutrients.
- Optimized the processing and micronutrient level to get a comparable product similar to conventional counterpart

- Depletion Repletion study for micronutrient bioavailability
- Histological assay after animal sacrifice and study of other biomarkers
- Finding shelf life of the fortified dal through accelerated shelf life testing

Noticeable Achievements

Publication:

1. Sarkhel, S., & Roy, A. (2023). Vacuum impregnation assisted simultaneous micronutrients fortification and phytic acid reduction in lentils. Journal of Food Engineering (IF - 5), 365, 111823. https://doi.org/https://doi.org/10.1016/j.jfoodeng

2. Sarkhel, S., & Roy, A. (2022). Phytic acid and its reduction in pulse matrix: Structure –function relationship owing to bioavailability enhancement of micronutrients. Journal of Food Process Engineering (IF- 3), 45(5), e14030. https://doi.org/https://doi.org/10.1111/jfpe.14030

3. Saha, S., Sarkhel, S., Sahoo, B., Kumari, A., Jha, S., Mukherjee, A., … Roy, A. (2023). Impact of fortificants on the powder properties of a gluten-free porous starch matrix of puffed rice flour. LWT - Food science and Technology (IF -6), 175, 114432. https://doi.org/https://doi.org/10.1016/j.lwt.2023.114432

4. Jha, S., Sarkhel..Roy, A. (2023). Expanded porous-starch matrix as an alternative to porous starch granule: Present status, challenges, and future prospects. Food Research International, (IF-8.1), 175, 113771. https://doi.org/https://doi.org/10.1016/j.foodres.2023.113771

Patent:
1. "A multipurpose integrated apparatus for treatment of food matrices and ingredients thereof" Application No 202331056554.

Three publications are under review, three patent is with attorney

Group Members

DEPARTMENT OF CHEMISTRY

Research Group- Drug Discovery Education & Research

- **Name of Principal Investigator/ Group Leader:** Dr. Ashoke Sharon
- **Research Theme:** Organic & Medicinal Chemistry, Molecular Modeling, Drug Design and Discovery.
- **Broad Area of Research and Scope:**
  - Organic Synthesis: Carbocyclic Nucleoside, Heterocyclic, and Green Synthesis
  - Computational Chemistry/Biology & Molecular Modeling-Based Drug/ Molecular Design for Target Enzyme
  - Small Molecule X-Ray Crystallography, Structural and Non-Covalent Interaction Studies

Schematic Representation of Broad Area of Research:
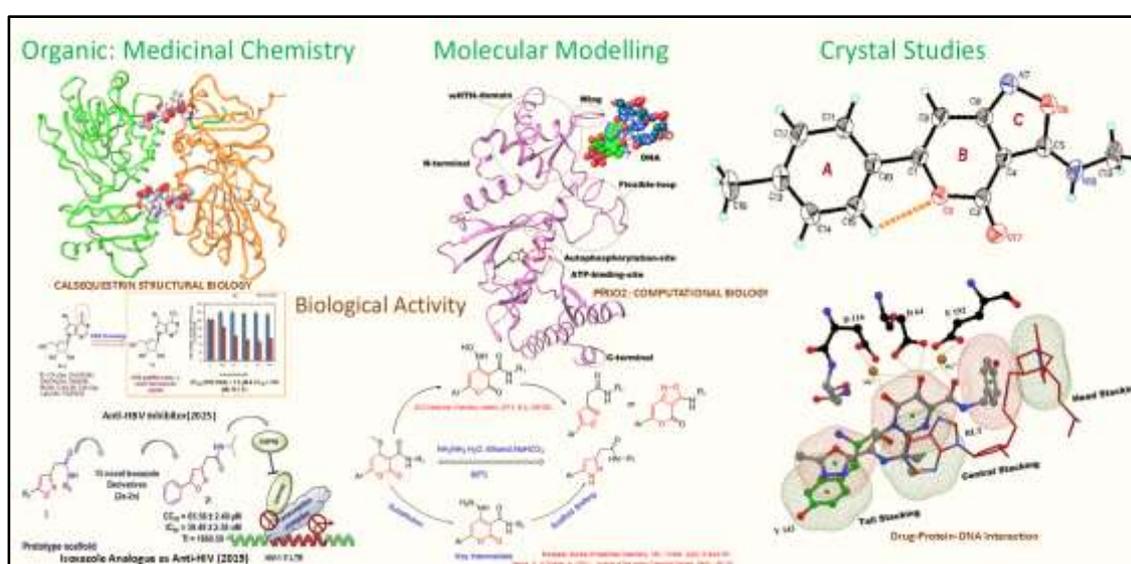
- ## Patent (Published or Granted)

1. Japanese Patent (*JP2024-022940 dated Feb 19, 2024*) Filed on "Anti-SARS-CoV-2 Drug Development" through International Joint Research Collaboration of Birla Institute of Technology and Kagoshima University, Japan.

2. Protein hydrogel for Topical Application and Formulation for Skin regeneration/Wound Healing; Ashoke Sharon, A.Basu, N. C. Bal; Indian Patent App. No: 202031000910; Complete Specification Filing date: Jan. 08, 2020. GRANTED PATENT NO: 396049 [Date of Grant: 02/05/2022]

3. Novel pyranone carboxamide derivative and use thereof as Anti-Hepatitis C Virus drug, Masanori Baba, Ashoke Sharon, C. Bal, and A. K Konreddy; **Publication No: WO/2015/008779**, Application No: PCT/JP2014/068880, Priority Date: July 17, 2013. Publication Date: **Jan 22 2015**.

4. Anti-hepatitis B virus drugs, Masanori Baba, T. Hamazaki, Ashoke Sharon, C Bal, Anandarajan Thiyagrajan, and Mohan Kasula, Japanese Patent Application number: JP 2013-254236, Filing date: Dec. 9, 2013. [publication number: JP 2015-113285 (P2015-113285A) [publication date] June 22, 2015. http://ipforce.jp/patent-jp-A-2015-113285

5. "3-(Isoxazolylmethyl)-1,2,4-Oxadiazole Derivatives And Method Of Preparing The Same" Ashoke Sharon, C. Bal, P. K. Kushwaha, N. Kumari, Indian Patent Application No: 202031034370; Date of File: 11.08.2020,; **Indian *Patent No: 56766; Date of Grant 23.06.2025***

Recent Selected 05 Publications with Impact Factor:

1. Samunuri, R., Toyama, M., Kasula, M., Jha, A. K., Okamoto, M., Baba, M., & **Sharon, A. (2025).** Synthesis, Cytotoxicity, and Mechanistic Evaluation of 7-Deazapurine-Based Neplanocin Analogues as Selective Anti-HBV Agents. *Chemistry Select*, *10*(22), 00784. **IF: 2.4**

2. Kasula, M., Toyama, M., Samunuri, R., Jha, A. K., Okamoto, M., Baba, M., & **Sharon, A. (2025).** Pyrazolo [3, 4-d] pyrimidine-based neplanocin analogues identified as potential de novo pharmacophores for dual-target HBV inhibition. *RSC Medicinal Chemistry*, *16*(4), 1740-1745. **IF: 4.5**

3. Joshi, G.; Yadav, U. P.; Rafiq, Z.; Grewal, P.; Kumar, M.; Singh, T.; Jha, V.; Sharma, P.; Eriksson, L. A.; Srinivas, L.; Dahibhate, N. L.; Srivastava, P.; Bhutani, P.; Mishra, U. K.; **Sharon, A**.; Banerjee, U. C.; Sharma, N.; Chatterjee, J.; Tikoo, K.; Singh, S.; Kumar, R., **(2025).,** Design and Synthesis of Topoisomerases-Histone Deacetylase Dual Targeted Quinoline-Bridged Hydroxamates as Anticancer Agents. *Journal of Medicinal Chemistry* **2025,** *68* (3), 2849-2868. **IF: 6.8**

4. Mishra, U. K., Kumar, R., Jha, A. K., Bal, C., & **Sharon, A**. **(2024).** One-Pot Microwave-Assisted Intramolecular Rearrangement of Pyranone Amide to Pyridone Ester. *Synthesis*, *56*(23), 3669-3679. **IF: 2.7**

5. Kumari, N., Kumar, S., Desai, V. A., Patel, D. B., & **Sharon, A.** (2024). A One-Pot Microwave Green Synthesis of Pyrrolo [1, 2-C] Imidazole-1-One Analogs and Structural Studies. *Journal of Structural Chemistry*, *65*(5), 1024-1039. **IF: 0.8**

Industry/Academia Collaborations:

1) Kagoshima University, Japan

2) ICMR-NIMR Ranchi,

3) NCCS Pune

4) Dr. Reddy Lab Hyderabad,

5) PI Industries Udaypur

6) Central University of Punjab

Achievements:

- Pyridone class of the molecules are patented and under development as potential antiviral candidates in collaboration with Kagoshima University, Japan.
- Isoxazole-oxadiazole class of the molecules are patented (Granted Patent) and currently in development in Collaboration with ICMR-NIMR to control malaria.

Group Members

DDER Research Group Members

Current Group Members (From right of photo):

Permeswer kumar (CSIR JRF), Afsana Pravin (DST-PDF), Suprita Jha (IRF.), Dr. Ashoke Sharon (Supervisor), Shivam Kumar (Ph.D.), Uttam Kumar Mishra (Ph.D.), Preeti (Ph.D.).

Research Group-Biomaterials and Material Chemistry

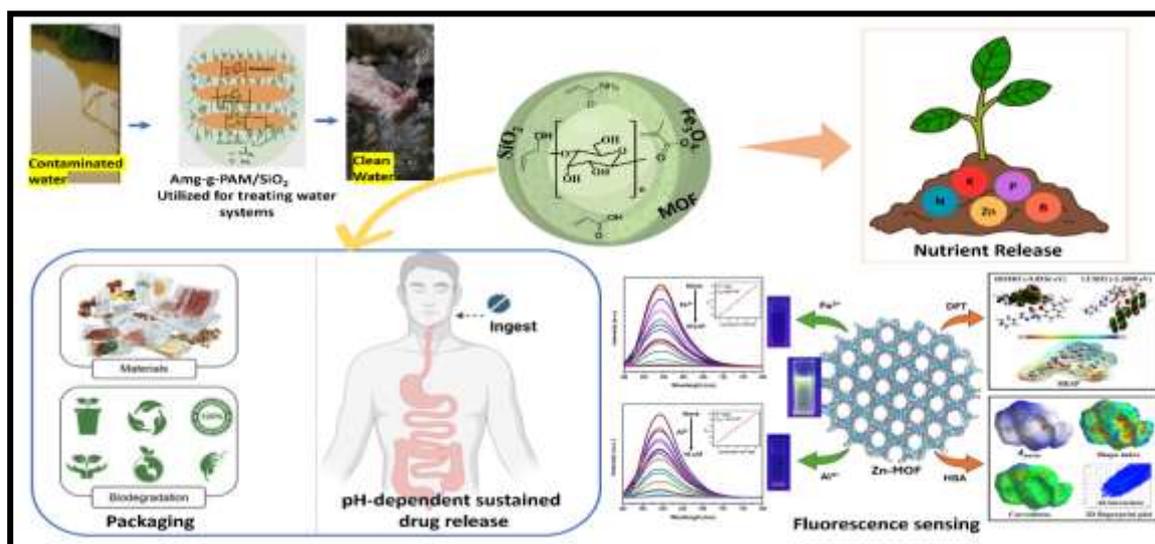**Name of Principal Investigator/ Group Leader:** Dr. Sumit Mishra
Research Theme: Biomaterials
Broad Area of Research and Scope: Development of hybrid materials for

- Water treatment
- Fluorescent sensing
- Drug delivery
- Nutrient release
- Packaging

Schematic Representation of Broad Area of Research:

- **Total Number of Publications by the group: 80**
- **Top 6 Articles with impact factor:**

1. N. Kumari, S. Mishra, Synthesis, characterization and flocculation efficiency of grafted Moringa gum based derivatives, Carbohydr. Polym. 281 (2022) 119079. **IF: 12.5**
2. A. Jha, S. Mishra, Exploring the potential of waste biomass-derived pectin and its functionalized derivatives for water treatment, Int. J. Biol. Macromol. 275 (2024) 133613. **IF: 8.5**
3. N. Tirkey, S. Mishra, Evaluation of neem gum-poly (acrylic acid) based adsorbent for cationic dye removal using adsorption isotherm, kinetics and thermodynamics: Linear regression models, Int. J. Biol. Macromol. 307 (2025) 142059. **IF: 8.5**
4. M. Choudhary, S. Mishra, Silica Functionalized Almond Gum Derivatives for Integrated Flocculation Cycles for Natural and Synthetic Water Systems, J. Polym. Environ. (2024) 1–21. **IF: 5.3**
5. A. De, S. Mishra, Synthesis of fenugreek gum-based metal–organic framework (FG/Zr-AIPA MOF) composite beads for sequestration of heavy metal ions from aqueous solution, Environ. Sci. Pollut. Res. 31 (2024) 32571-32587. **IF: 5.8**
6. A. Mahto, S. Mishra, Guar gum grafted itaconic acid: a solution for different waste water treatment, J. Polym. Environ. 29 (2021) 3525–3538. **IF: 5.3**

Patents Published:

- Sumit Mishra and Asmita De, A method for synthesizing a new fluorescent metal organic framework, *Patent Application No.*:202431018460 A, Date: 22.03.2024
- Sumit Mishra, Munmun Choudhary, Asmita De and Srinath Das, A biopolymer-based metal-

organic framework composite and method of fabrication thereof, *Patent Application No.*:202431053454 A, Date: 20.09.2024

Research Projects:

Title	Role (PI/ Co PI)	Funding Agency	Amount (in Lacs)	Duration
Metal organic frameworks and sequential electrocoagulation for remediation of mining effluents	PI	SERB	44.16	3 yrs
Synthesis of biobased and multifunctional adhesive hydrogels for environmental and biomedical applications	PI	SERB	17.77	6 mths
Synthesis and characterization of thermo sensitive nano composites based modified agar and its applications", Jharkhand Council of Science and Technology	PI	JCSTI	5.00	
Microwave Based Synthesis of Poly-2-hydroxyethylmethacrylate/Cinnamic acid grafted guar and its applications	PI	AICTE	14.12	3 yrs
Microwave Based Synthesis of Graft copolymers of Barley, its Characterizations and Applications	PI	DST	27.92	3 yrs

- **Industry/Academia Collaborations:**
- **Targeted Application Area:**

Achievements:

Developed innovative multifunctional hybrid materials such as MOFs and biopolymer-based nanocomposites for efficient environmental remediation and biomedical applications.

| Brief Description of Projects	
Problem Statement:	**Applications:**
Industrial and mining effluents contain complex pollutants that are difficult to treat using conventional methods. This calls for the development of advanced, materials like MOFs, biopolymer hydrogels, thermo-sensitive nanocomposites, and graft copolymers. These multifunctional systems offer promising solutions for efficient remediation.	- Mining wastewater treatment - Smart environment sensors - Biobased adhesives - Sustained drug delivery - Sustainable packaging

Group Members

Research Group -Biomaterial

- ▪ **Name of Principal Investigator/ Group Leader**: **Dr. Deep Shikha**
- ▪ **Research Theme**: Synthesis of new Biomaterials for orthopaedic implants
- ▪ **Broad Area of Research and Scope:**
- ➢ Synthesis of new Biomaterial
- ➢ Surface modification of biomaterials by various coating techniques
- ➢ In vitro testing of Biomaterials for hard tissue implant

Schematic Representation of Broad Area of Research :
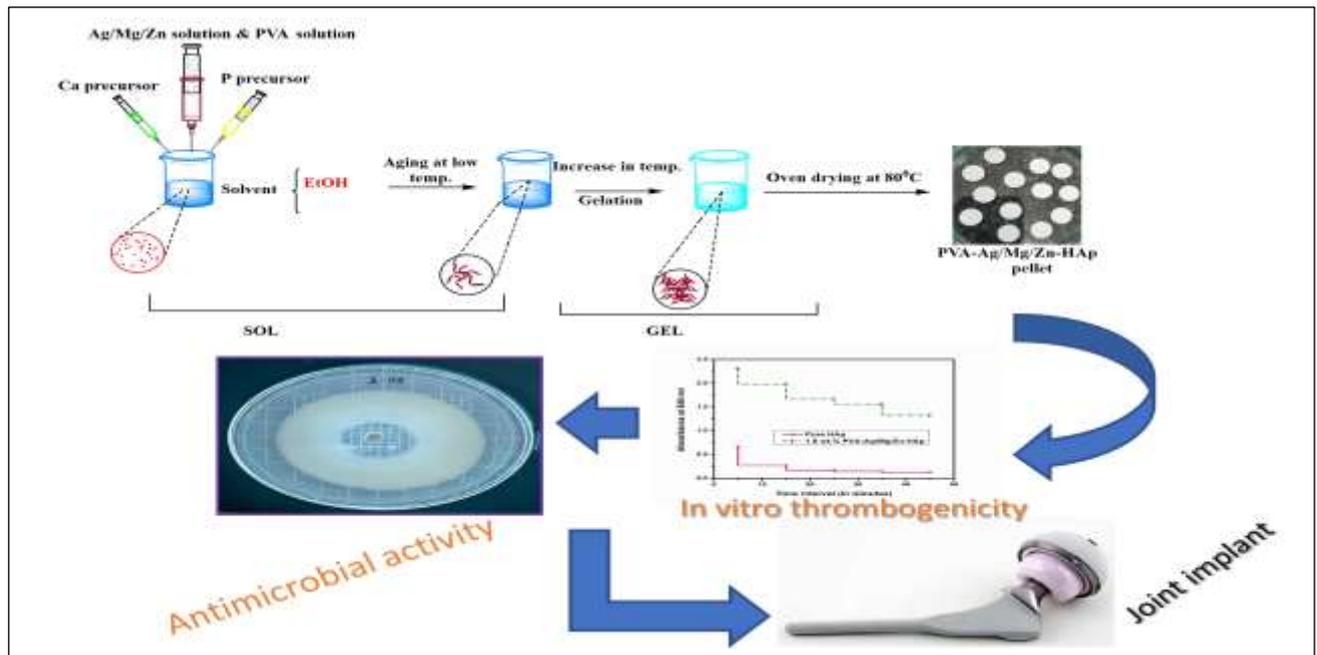
- • **Total Number of Publications by the group: 21**
- • **Top 5 Article with impact factor: (Vancouver Style)**
  1. Ranbir Kumar, Deep Shikha, Smit Anand, Sanjay Kumar Sinha, Paresh Kumar Mohanty, Sanjay Mhaske, Abhinandan Kumar, Arkadeb Mukhopadhyay, *Integration of 3% Silver-Doped Hydroxyapatite coated on alumina using Radio Frequency Magnetron Sputtering for Superior Bioactivity, Mechanical, Electrical and Wear Resistance, ACS Biomaterials Science and Engineering, 18 April 2025.* https://doi.org/10.1021/acsbiomaterials.4c02471
  2. Ranbir Kumar, Deep Shikha, Sanjay Kumar Sinha, Improvement in Bioactivity, Hardness and Friction Resistance of 3% Manganese-doped Hydroxyapatite coated on alumina using Radio Frequency magnetron sputtering, **Surface and Coatings Technology,Volume 494, Part 2, 2024,** 131481, https://doi.org/10.1016/j.surfcoat.2024.131481.
  3. Kumar, R., Shikha, D. & Sinha, S.K. Structural, mechanical, electrical, and biocompatibility investigation of nanostructured hydroxyapatite coating on alumina by radio frequency magnetron sputtering. *J Mater Sci* 59, 15764–15779 (2024). https://doi.org/10.1007/s10853-024-10132-6.
  4. Ranbir Kumar, Deep Shikha, S.K Sinha, Antioxidant Properties and Thrombogenic Evaluation of Copper-Manganese Alloy Doped Hydroxyapatite in Comparison to un-doped Hydroxyapatite, Inorganic Chemistry Communications, Volume165, July 2024, 112490. https://doi.org/10.1016/j.inoche.2024.112490.

5. Ranbir Kumar, Deep Shikha, Sanjay Kumar Sinha, DPPH radical scavenging assay: A tool for evaluating antioxidant activity in 3 % cobalt – Doped hydroxyapatite for orthopaedic implants, Ceramics International, Volume 50, Issue 8, 2024, Pages 13967-13973, ISSN 0272-8842,https://doi.org/10.1016/j.ceramint.2024.01.314.

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Kumar Ranbir, Shikha Deep, Sinha Sanjay Kumar, Hydroxyapatite pellets and method of preparation thereof, and the hydroxyapatite pellets-based nanocoated substrate	No.: 02331073541 Dated 10/11/2023	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Biocompatibility and mechanical studies of nanostructured HAP,metal doped nanostructured HAPon alumina by RF Magnetron Sputtering	PI	SERB	27,71,824	3
Ion beam treated HAP coating on alumina for orthopaedic implants	PI	DST	17,05,000	3

Targeted Application Area: Hard Tissue Implant

Achievements: Paper publication and patent published

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)

Problem Statement:

While hydroxyapatite (HAP) offers excellent biocompatibility, osteoconductivity, osteointegration, and non-toxicity, its brittleness and low fracture toughness make it unsuitable for load-bearing implants. Its slow resorption delays bone regeneration, poor moldability hinders complex device design, and lack of antimicrobial activity raises infection risks. These mechanical and biological limitations restrict HAP's clinical viability as a long-term orthopedic implant.

Applications:

➢ Hard tissue implant
➢ Joint replacement
➢ Bone cement
➢ Dental implants

Graphical Abstract
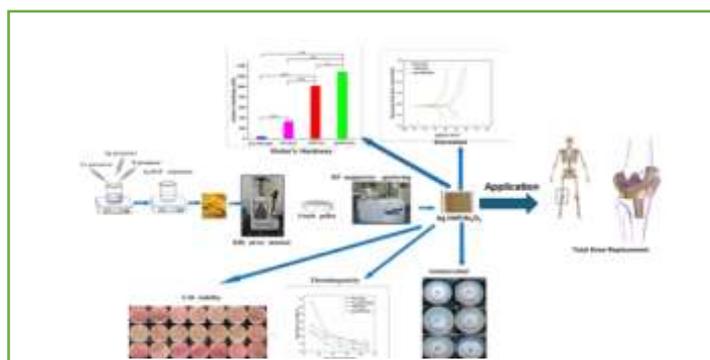
Strategy/ Approach/ Technique/ Experiments used to solve

This study improves hydroxyapatite coatings on alumina by doping with metallic ions and biopolymer via sol-gel and other coating techniques. Coatings are analyzed by XRD, SEM-EDS, hardness, adhesion, corrosion resistance, cytocompatibility, and antibacterial activity to identify the best implant.

Group Members

Research, Innovation & Entrepreneurship Cell
RESEARCH GROUPS @ BIT-MESRA

Research Group -Electrochemistry

- **Name of Principal Investigator/ Group Leader**: Dr. Susanta Sinha Mahapatra
- **Research Theme**: Electrochemical Energy Conversion & Storage Systems
- **Broad Area of Research and Scope:**

Development of Nano catalysts:

- Direct Alcohol Fuel Cells
- Supercapacitor
- Hydrogen Evolution Reactions
- Electrochemical CO_2 Reduction.

Schematic Representation of Broad Area of Research:
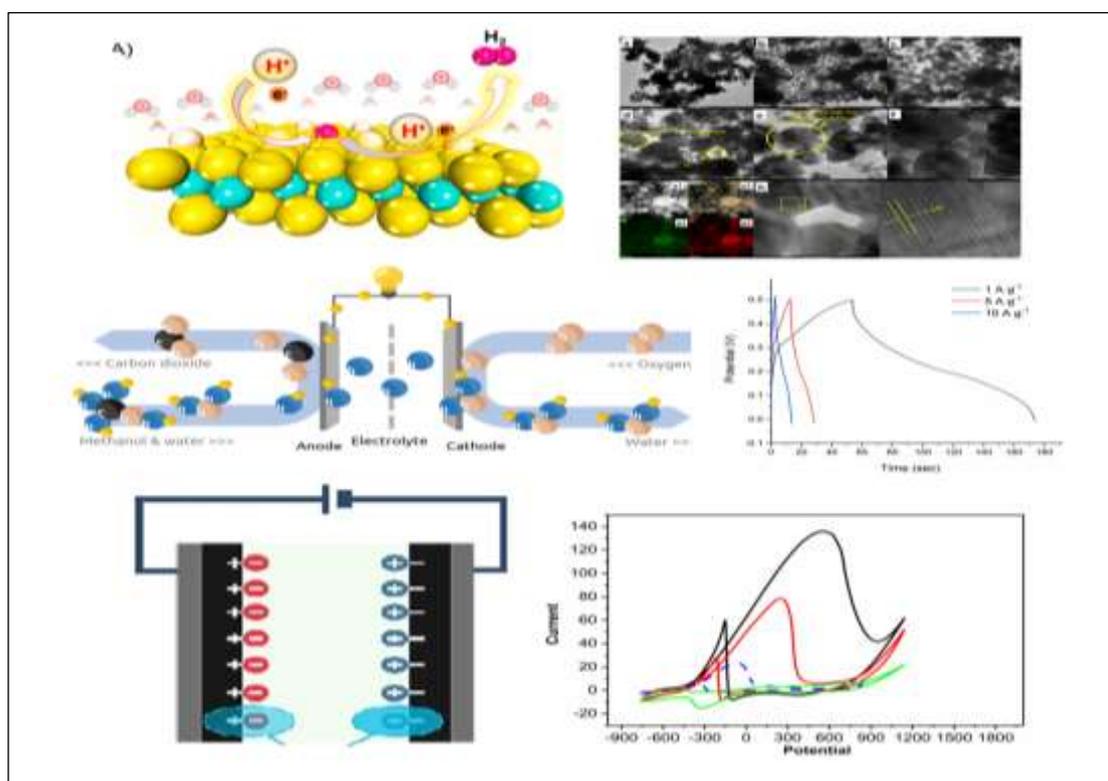
- **Total Number of Publications by the group: 22**
- **Top 5 Article with impact factor:**

1. Mukherjee A, Abdinejad M, Sinha Mahapatra S, Ruidas BC. Metal sulfide-based nanomaterials for electrochemical CO2 reduction. Journal of Materials Chemistry A. 2023;11: 9300-32. **IF: 10.7**
2. Choudhury A, Kim J-H, Sinha Mahapatra S, Yang K-S, Yang D-J. Nitrogen-enriched porous carbon nanofiber mat as efficient flexible electrode material for supercapacitors. ACS Sustainable Chemistry & Engineering. 20175;5(3):2109−18. **IF: 7.1**
3. Dutta A, Sinha Mahapatra S, Datta J. High performance PtPdAu nano-catalyst for ethanol oxidation in alkaline media for fuel cell applications. International Journal of Hydrogen Energy. 2011;36(22):14898–06. **IF: 8.1**

4. Sinha Mahapatra S, Dutta A, Datta J. Temperature dependence on methanol oxidation and product formation on Pt and Pd modified Pt electrodes in alkaline medium. International Journal of hydrogen Energy 2011;36(22):14873–83. **IF: 8.1**

5. Sinha Mahapatra S, Dutta A, Datta J. Temperature effect on the electrode kinetics of ethanol oxidation on Pd modified Pt electrodes and the estimation of intermediates formed in alkali medium. Electrochimica Acta. 2010;55(18):9097–9104. **IF: 5.5**

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of low cost electrocatalysts for the hydrogen production by water splitting	Co-PI	DST-SERB	44.16	3 yrs
One-dimensional Nanostructured Si-based Electrodes for High-Performance Energy Storage Devices	PI	BRNS	30.02	3 yrs

Industry/Academia Collaborations: Analytical Chemistry Division, Bhabha Atomic Research Centre, Trombay, Mumbai-400085

Targeted Application Area: Transportation, Backup Power, Consumer Electronics

Achievements:

Developed anode Si-based materials for supercapacitors with high stability, high power, and energy densit

Brief Description of Projects

Problem Statement:

Traditional energy storage systems, such as batteries, often suffer from limitations including long charging times, limited cycle life, and relatively low power density. As the demand for efficient, fast-charging, and durable energy storage devices grows—particularly in applications such as electric vehicles, portable electronics, and renewable energy systems—there is a pressing need for alternatives that can overcome these limitations.

Applications:

➢ Regenerative braking systems in electric and hybrid vehicles
➢ Power stabilization in heavy machinery
➢ Uninterruptible Power Supplies (UPS)
➢ Drones and

Graphical Abstract
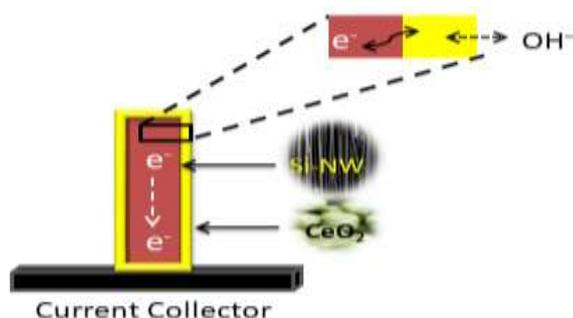
Group Members

Research Group - Green Energy Catalysis

- **Name of Principal Investigator/ Group Leader**: Dr. Subhendu Naskar
- **Research Theme**: Homogeneous & Surface immobilized Catalysis
- **Broad Area of Research and Scope:**
  - Oxygen Evolving Reaction (OER)
  - Hydrogen Evolution Reaction (HER)
  - Carbon dioxide Reduction Reaction (CO2RR)
  - Electrochemical synthesis of industrial chemicals

Schematic Representation of Broad Area of Research

Total Number of Publications by the group: 50

Top 5 Article with impact factor:

1. Khan Md. A, Khan S, Sengupta S, Naskar S. Electro catalytic water oxidation by molecular Cobalt-terpyridine complexes in alkaline medium: Experimental and theoretical study; *New Journal of Chemistry*, **2025**; 49: 6963-6974; DOI: https://doi.org/10.1039/D4NJ05517A **(IF - 3.3)**

2. Khan Md A, Khan S, Sengupta S, Mongal B. N, Naskar S. Earth Abundant Transition Metal Complexes as Molecular Water Oxidation Catalysts; *Coordination Chemistry Reviews*, 2024, 504,215679. https://doi.org/10.1016/j.ccr.2024.215679 **(IF - 20.3)**
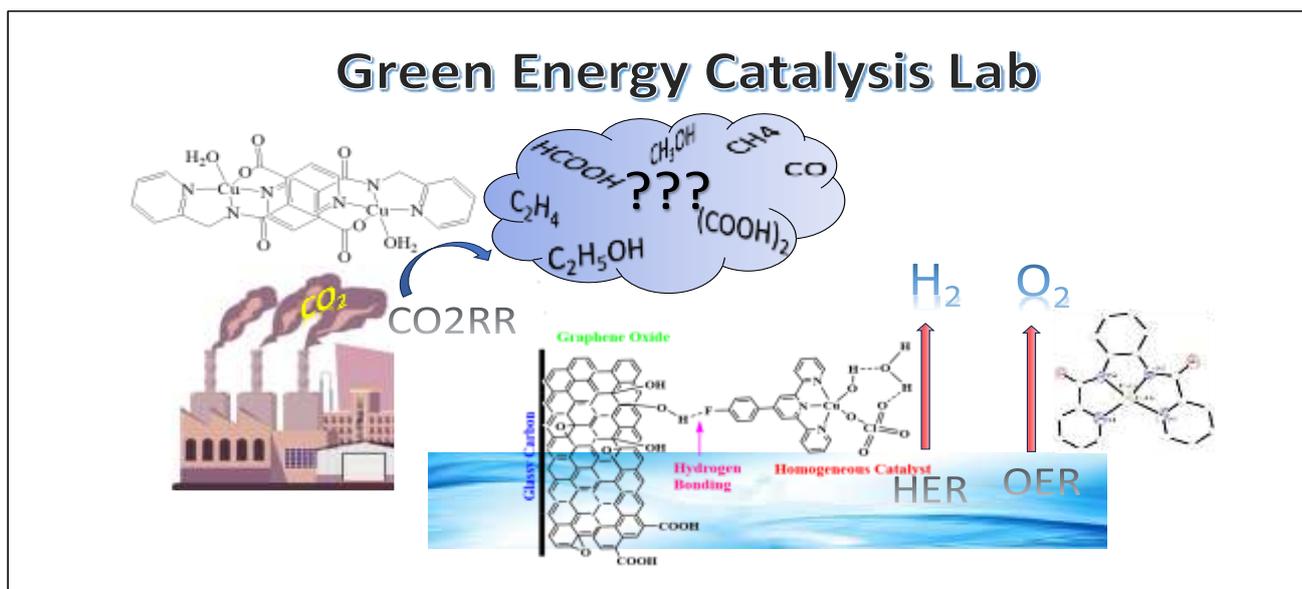
3. Khan S, Sengupta S, Khan Md. A,, Sk Md. P, Jana N. C, Naskar S. Electrocatalytic Water Oxidation by Mononuclear Copper Complexes of bis-amide Ligands with N4 donor: Experimental and Theoretical Investigation;; *Inorganic Chemistry*; 2024;63,4,1888. https://doi.org/10.1021/acs.inorgchem.3c03512 **(IF - 4.3)**

4. Khan S, Sengupta S, Khan Md. A,, Sk Md. P, Naskar S. Electrocatalytic Water Oxidation by heteroleptic Ruthenium complexes of 2,6-bis(benzimidazolyl) pyridine Scaffold: A mechanistic investigation; *Dalton Trans*., 2023; 52, 7590-7601; DOI: 10.1039/d3dt00128h **(IF – 3.5)**

5. Cubane-like tetranuclear Cu(II) complexes bearing a Cu_4O_4 core: crystal structure, magnetic properties, DFT calculations and phenoxazinone synthase like activity; Sagar S, Sengupta S, Chattopadhyay S K, Mota A J, Ferao A E, Riviere E, Lewis W, Naskar S. *Dalton Trans.* **2017**,46: 1249-1259, https://doi.org/ 10.1039/C6DT03754B **(IF – 3.5)**

Research Projects:

	Role (PI/Co-PI)	Funding Agency	Fund Value	Year (From-to)
Development of Low cost Electrocatalysts for the Hydrogen production by Water Splitting	PI	ANRF	44.16	16th March 24 – 15 March 27
"Development of non-destructive process technology for simultaneous micronutrient fortification and bioavailability enhancement in Dal through selective binding of phytic acid"	Co-PI	DBT	57.90	2021-2024
Development of Transition Metal Complexes as Water Oxidation Catalyst	PI	SERB	28.34	28 Jul 2017 - 27 Dec, 2020
Synthesis, characterisation and reactivity studies of Biologically relevant and industrially important Coordination Complexes of Mn, Co, Ni, Cu & Zn with N, O & S donor ligands	PI	CSIR	18.42	03 Apr, 2012 - 02 Apr, 2015
Synthesis, characterization and redox & photo-physical study of Ruthenium dyes for Dye Sensitized Solar Cell	PI	AICTE	20.0	03 Feb, 2012 - 02 Feb, 2014

Industry/Academia Collaborations:

1. **Department of Chemistry, Aligarh Muslim University, Aligarh 202002, India**
2. **School of Chemical Sciences, NISER, An OCC of Homi Bhabha National Institute, Bhubaneswar**

Targeted Application Area: Renewable Energy Harvesting

Achievements:

Brief Description of Projects

Problem Statement:

Electrolysis of water to produce hydrogen is an established technique in the renewable energy sector. Main problem with the current electrolyser is the cost of the electrodes, mostly made of noble metals. To make the hydrogen available for common people, the electrodes must be replaced by a cheap material as electrode surface or catalysts.

Applications:

➢ Hydorgen production
➢ Carbon dioxide reduction to chemical feedstocks
➢ Production of industrial chemicals and reagents by green synthesis

Strategy/ Approach/ Technique/ Experiments used to solve

➢ Synthesis of new 1st row transition metal based catralyst
➢ Catalytic study for several reaction; OER, HER, CO2RR
➢ Fabrication of electrolyser with the catalysts developed
➢ Electrochemical synthesis of new molecules of commercial importance

Group Members:

Research Group - Materials Chemistry

- **Name of Principal Investigator/ Group Leader**: Dr. Joydeep Dhar
- **Research Theme**: Development of Organic-Inorganic Semiconductor Materials for Clean Energy Harvesting
- **Broad Area of Research and Scope: Materials Chemistry**
  - Semiconductor Material Synthesis and Characterization
  - Nanomaterials Preparation
  - Optoelectronic Device Fabrication
  - Harvesting Renewable Energy like solar, piezo and others

Schematic Representation of Broad Area of Research:
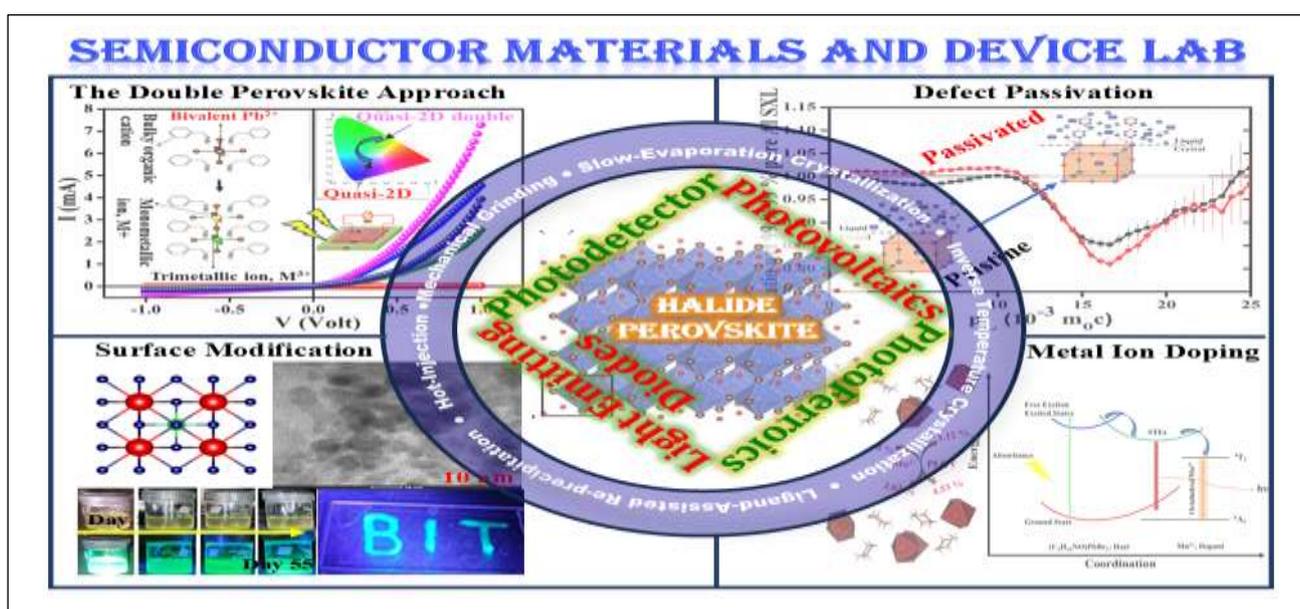
Total Number of Publications by the group: 25

Top 5 Article with impact factor:

1. De A, Singh V, Dhar J, Mishra S. Zn (II) based fluorescent metal-organic framework as a'turn-off'sensor for Al^{3+} and Fe^{3+} ions in aqueous solution: Synthesis, DFT calculations and Hirshfeld surface analysis. J. Mol. Struct. 2025; 1329: 141426. IF: 4

2. Singh V, Das M, Mondal K, Barua S, Sanyal D, Ray P P, Dhar J. Investigating the effect of lead substitution on the optical, electrical, and photoresponse properties of Quasi-2D double perovskites. J. Phys. Chem. Solids. 2024; 192: 112082. IF: 4.3

3. Moshat S, Ray P P, Sil S, Dhar J, Sanyal D. Positron annihilation studies of methylammonium lead bromide perovskite. Physica Scripta. 2023; 98(3): 035822. IF: 2.6

4. Sil S, Moshat S, Ray P P, Dhar J, Sanyal D. Investigating the effect of applied bias on methylammonium lead iodide perovskite by electrical and positron annihilation spectroscopic studies. J. Phys. D: App. Phys. 2021; 54(46), 465502. IF: 3.1

5. Bandyopadhyay B, Luitel H, Sil S, Dhar J, Chakrabarti M, Nath P, Ray P P, Sanyal D. NMR study of defect-induced magnetism in methylammonium lead iodide perovskite. Phys. Rev. B 2020; 101(9): 094417. IF: 3.9

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Investigating the Effect of Molecular Doping in Halide Perovskites Based Energy Harvesting Devices	PI	SERB-DST	30.09	2023-2025

Targeted Application Area: Optoelectronic device applications like photovoltaics, light emitting diodes, photodetectors, Photo ferroics.

Brief Description of Projects :

Problem Statement:

It has been observed that the high-performing hybrid perovskite-based semiconductor materials are prone to easy defect formation. The point defects which are formed due to external stimuli like light, heat, oxygen, moisture and even applied bias lead to decrease in device performance and subsequent material degradation. Thus, several strategies have been tried and adopted to improve and stabilise the device efficacy.

Applications:

- Development of optoelectronic device like photodetectors, solar cell, light emitting diode
- Organic-and inorganic semiconductors will be used in conjugation to improve the overall performance
- Newer semiconductor materials with new device architecture will be used for clean energy (solar, piezo) harvesting.

Strategy/ Approach/ Technique/ Experiments used to solve

Till date, small organic molecule or polymer matrix are used to encapsulate the inorganic halide perovskite based-optoelectronic device to prevent its degradation from external stimulant. Here, we will develop new small molecule p-and n-type organic semiconductors which will be used as encapsulant as well as work in tandem with perovskite based semiconductors to improve efficacy in a optimized device geometry.

Graphical Abstract
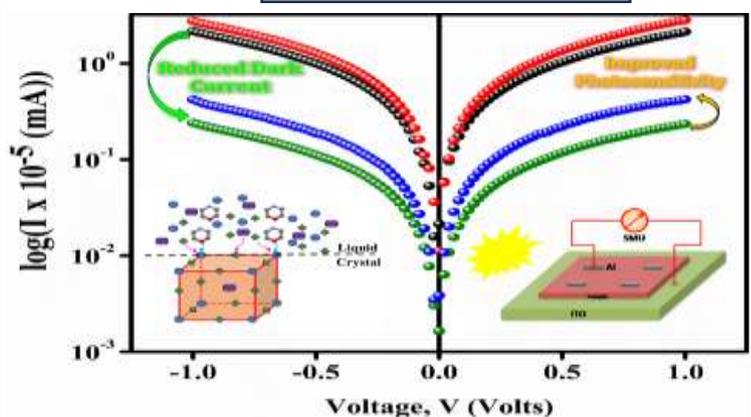
Group Members:

Research Group-Materials for Energy Harvesting and Storage

- **Name of Principal Investigator/ Group Leader**: Dr. Barnali Dasgupta Ghosh
- **Research Theme**: Design and development of functional polymer-ceramic nanocomposites for advanced energy harvesting and storage applications
- **Broad Area of Research and Scope:**
  - *Synthesis & Surface Functionalization of Nano-materials*
  - *Preparation of Polymer-Ceramic Nanocomposites: Film, Electrospun mat, Hydrogel, Aerogel*
  - *High dielectric, Piezoelectric, Triboelectric Materials*
  - *Energy Harvesting and Storage Materials*
  - *Smart Wearables, Flexible Energy Harvesting Devices (PENG and TENG)*
  - *Novel Coatings: Superhydrophobic, Fire-retardant, Antibacterials, Anti-fouling*
  - *Waste valorization (Food, plastic, agrowaste, etc*

Schematic Representation of Broad Area of Research:

- **Total Number of Publications by the group: 27**
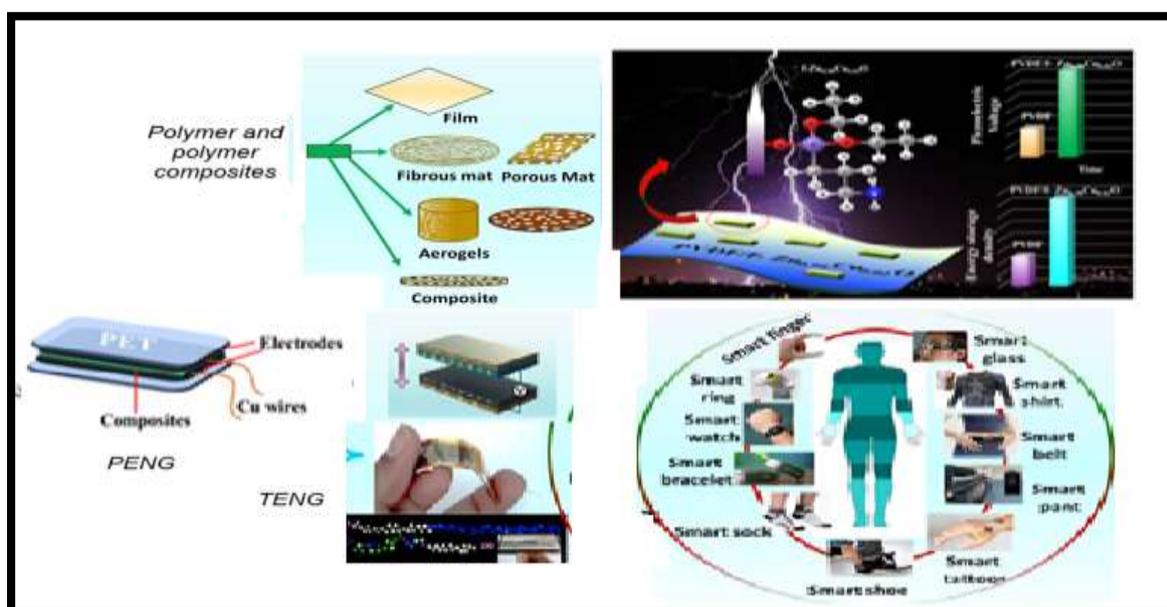- **Top 5 Article with impact factor: (Vancouver Style)**
  1. Mukherjee, S. Roy, P. K. Kaji, **B. Dasgupta Ghosh**[*], Functionalized Cu-Doped ZnO/PVDF Composite: An Excellent Energy Storage Material for Wearable Devices, ACS Applied Energy Materials 7 (19) (**2024**) 8903-8915
  2. S. Roy, **B. Dasgupta Ghosh**, S. Mishra, K. L. Goh, J. Kim, Customized Extrusion Nozzle Assisted Robust Nylon 6/MWCNT Nanocomposite Based Triboelectric Nanogenerators for Advanced Smart Wearables, Chemical Engineering Journal 493 (**2024**) 152598
  3. Mukherjee, **B. Dasgupta Ghosh***, S. Roy, K. L. Goh, Ultra strong Flexible $Ba_{0.7}Sr_{0.3}Zr_{0.02}Ti_{0.98}O_3$/MWCNT/PVDF Nanocomposites: Pioneering Material with Remarkable Energy Storage for Self-Powered Devices, *Chemical Engineering Journal*, 488 (**2024**) 151014
  4. S. Roy, K.L Goh, C. Verma, **B. Dasgupta Ghosh***, K. Sharma, P.K. Maji, A Facile Method for Processing Durable and Sustainable Superhydrophobic Chitosan-Based Coatings Derived from Waste Crab Shell, ACS Sustainable Chemistry & Engineering, 2022, 10(14): 4694–4704.

5. S. Roy, **B. Dasgupta Ghosh**, K. L. Goh, H. J. Ahn, Y. W. Chang, Super expanded freestanding 3D graphene foam as a versatile platform for CO2 capture and hydrogenation, Chemical Engineering Journal 466 (**2023**) 143326.

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	Barnali Dasgupta Ghosh, Sunanda Roy, Anindita Mukherjee, A metal and plant-based pigment containing polymer composite for industrial applications and Method.	202431100934 & 27/12/2024	Published
2	Sunanda Roy, Barnali Dasgupta Ghosh, Eco-Smart Coating Transforming Eggshell Biowaste into Durable and Long-Lasting Waterproof Coatings	Ref No. PAT199/165/25	Patent filed

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Electrospun PVDF based piezoelectric nanocomposite energy harvesters for self-powered smart wearable and implantable electronics.	PI: Dr. Barnali Dasgupta Ghosh Co-PI: Dr. Trishna Bal	ANRF (SERB-CRG)	48.19 Lakh	Onging (2023-2026)
Development of polymer - ceramic nanocomposites with high dielectric constant	PI: Dr. Barnali Dasgupta Ghosh	SERB-DST Fasttrack Young scientist	22.9 Lakh	Completed (2014-2017)

Industry/Academia Collaborations:

Part of a team that included researchers from Inha University and Hanyang University in South Korea, Newcastle University in Singapore, IIT Kharagpur, IIT Roorkee and Alliance University in India.

Targeted Application Area: *Synthesis & Surface Functionalization of Nano-materials and Preparation of Polymer-Ceramic Nanocomposites: Film, Electrospun mat, Hydrogel, Aerogel for different advanced applications like*
  ➢ Energy Harvesting and Storage(High dielectric, Piezoelectric, Triboelectric Materials)
  ➢ Smart Wearables, Flexible Energy Harvesting Devices (PENG and TENG)
  ➢ Novel Coatings: Superhydrophobic, Fire-retardant, Antibacterials, Anti-fouling
  ➢ Waste valorization (Food, plastic, agrowaste, etc)

Achievements:

- National Eligibility Test (NET) 2005: Awarded Junior Research Fellowship in Chemical Sciences (UGC)
- Graduate Aptitude Test in Engineering (GATE) 2005: Percentile score 96.90 (Scored 437) & all India rank 107 (in Chemistry).
- State Level Eligibility Test (10th West Bengal SLET) 2005: (The West Bengal College Service Commission), in Chemical Science.
- Awarded National Scholarship, Government of India, Chemistry Hons 2002.
- MHRD (Ministry of Human Resource and Development) scholarship 2005.
- Awarded 2nd prize in oral presentation on Research Scholar Day, 10th December 2009, Materials Science Centre, IIT Kharagpur

- Awarded SRF by Council of Scientific and Industrial Research (CSIR), New Delhi, 2010
- Outstanding Woman in Science award, 5th Venus International Women Awards - VIWA 2020
- Resource Person: DST-STUTI One Week Training Programme on Advanced Instrumental Techniques in Chemistry and Materials Sciences (AITCMS22).
- BIT Faculty Appreciation Award 2024 (BITFAA 2024): HIGHEST SPONSORED RESEARCH PROJECT SANCTIONED during Year 2023 (Science Category)

Brief Description of Projects : **Development of potential sustainable materials for efficient piezoelectric**	
Piezoelectric energy harvesters (PEHs) ▪ Batteryless powering system ▪ Harvest bio-mechanical energy from human motion ▪ Durable efficient self-powered systems ▪ Made of eco-friendly materials ▪ Cost-effective and user friendly ▪ Reduces global carbon emissions	❑ New Materials Development ❑ Viable Process Designing ❑ Clean Energy Generation - Reduces carbon footprint ❑ Lead-free Smart Electronics ❑ Safe, Maintenance Free, Power Efficient Durable System ❑ Advanced and Beautiful Life and Society

Graphical Abstract

Group Members

80
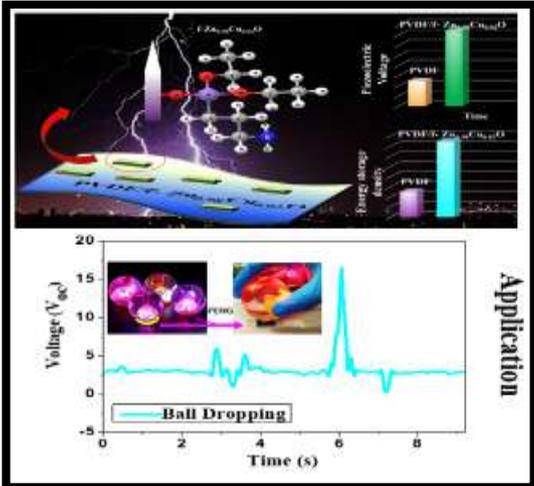
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Research Group - AI Health Innovations

- **Name of Principal Investigator/ Group Leader**: Dr. Akriti Nigam
- **Research Theme**: Computer Vision and AI in the field of healthcare
- **Broad Area of Research and Scope:**

➢ Medical Imaging and Diagnostics: AI based analysis of medical images like X-rays, MRIs, and CT scans to detect conditions such as tumours, fractures, and neurological disorders.

➢ Mental Health Diagnostics: AI based analysis of speech patterns and gait to detect signs of mental health disorders like depression and anxiety.

➢ Clinical Decision Support Systems: AI assists clinicians by analysing patient data and providing evidence-based recommendations for diagnosis and treatment. This support enhances decision-making, reduces errors, and improves patient outcomes.

➢ Predictive Analytics and Risk Stratification: Machine learning models predict disease progression and patient outcomes by analysing clinical data, enabling early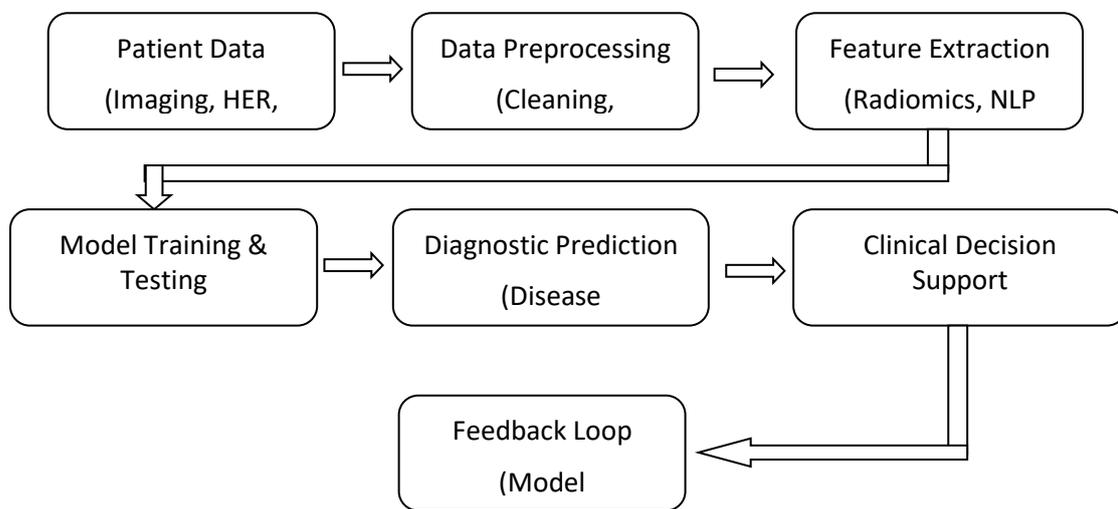 interventions and personalized care plans. These tools assist in managing chronic diseases and optimizing resource allocation.

Schematic Representation of Broad Area of Research:

```
Patient Data        →   Data Preprocessing   →   Feature Extraction
(Imaging, HER,           (Cleaning,               (Radiomics, NLP
        ↓
Model Training &    →   Diagnostic Prediction →   Clinical Decision
Testing                 (Disease                  Support
        
Feedback Loop       ←
(Model
```

- **Total Number of Publications by the group:**
- **Top 5 Article with impact factor: (Vancouver Style)**

1. Kumari R, Nigam A, Pushkar S. Machine learning technique for early detection of Alzheimer's disease. Microsyst Technol. 2020;26(12):3935–3944. doi:10.1007/s00542-020-04888-5.
2. Kumari R, Nigam A, Pushkar S. Multi-layered convolutional neural network on multi-modal images for classifying Alzheimer's disease. Turk J Physiother Rehabil. 2021;32(3):14506–14511.
3. Kumari R, Nigam A, Pushkar S. An efficient combination of quadruple biomarkers in binary classification using ensemble machine learning technique for early onset of Alzheimer disease. Neural Comput & Appl. 2022;34(14):11865–11884. doi:10.1007/s00521-022-07076-w
4. Kumari R, Das S, Nigam A, Pushkar S. Patch-based Siamese 3D convolutional neural network for early Alzheimer's disease using multi-modal approach. IETE J Res. 2023;70(4):3804–3822. doi:10.1080/03772063.2023.2205857.
5. Kumari R, Das S, Nigam A, Singh RK. Multimodal diagnosis of Alzheimer's disease based on volumetric and cognitive assessments. Multimed Tools Appl. 2024;83(17):14506–14511. doi:10.1007/s11042-024-19794-5.

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of a robust Machine Learning tool to support quick Malaria detection and parasite stage identification for reducing Malaria burden.	Dr Akriti Nigam (PI) Dr Manish Kumar Pandey (Co- PI)	ICMR	151.50	3 years

Industry/Academia Collaborations:

- Rajendra Institute of Medical Sciences (RIMS), Ranchi- Two Co- PI's Dr. Rashmi Sinha and Dr Mithilesh Kumar are from RIMS Ranchi. RIMS is one of the tertiary care centres from where the samples would be collected.
- National Institute of Malaria Research (NIMR), ICMR- NIMR is a unit of ICMR at Namkum, Ranchi. Two Co- PI's Dr Piyoosh Kumar Singh now at ICMR New Delhi and Dr. Praveen Tripathi are from NIMR. The sample collection from Community Health Centres would be using the NIRM set ups in these endemic villages.

Targeted Application Area: Medical Imaging,

Achievements:

Brief Description of Projects :

Problem Statement:

It is focused on the development of an AI-driven diagnostic tool for the rapid and accurate detection of malaria and its various parasite stages. The core objective is to create a comprehensive image library featuring high-resolution microscopic images of prevalent Plasmodium species- particularly P. falciparum and P. Vivax- across different stages of the parasite's life cycle, including ring, schizont, and gametocyte stages. Mixed infections will also be documented to build a clinically diverse dataset. The project sources samples from three healthcare levels to ensure a representative and a scalable model: Community based samples, Primary healthcare facility-based samples and Tertiary care facility samples. This tool aims to support frontline health workers and clinicians in improving early diagnosis, leading to faster treatment and reduced malaria burden in endemic regions.

Applications:

➤ Thin blood Smear slide annotated library
➤ A sophisticated machine learning tool and mobile application to assist healthcare professionals in:
  o Locating malaria parasites in microscopic images
  o Identifying the plasmodium Species (among the four main types)
  o Classifying the parasite's life cycle stage.

Strategy/ Approach/ Technique/

SPR of 6.0 % testing 5,000 suspected febrile cases to capture at least 100 positive cases.   like Manoharpur and Goilkera- SPR of 40.62 % testing 2,464 casesfor the desired 1000 positive cases.

at West Singhbhum district, Angara- Annual Parasite Incidence is 22.625- Testing 22,095 cases for the desired 500 positive cases.
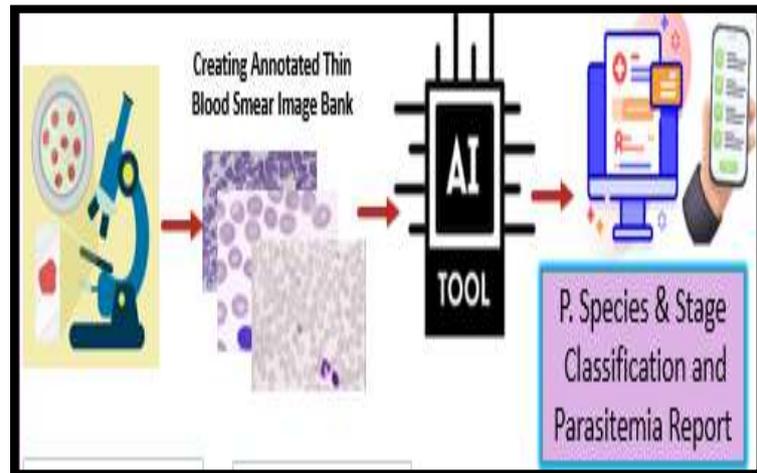

Group Members

Research Group -AI4Health: Predictive Modelling Approaches

- **Name of Principal Investigator/ Group Leader**: Dr. Debjani Mustafi
- **Research Theme**: Leveraging Artificial Intelligence for early detection, risk Stratification, and prognostic modelling of medical conditions through data-driven predictive analytics."
- **Broad Area of Research and Scope:** The group explores a wide spectrum of research areas which includes:

- ➤ **Disease Prediction and Risk Assessment**: Building AI models to forecast the onset or progression of diseases such as cancer, cardiovascular conditions, diabetes, and neurological disorders.
- ➤ **Clinical Decision Support Systems**: Designing intelligent tools to assist healthcare professionals in making data-driven clinical decisions. Clinical applications of herbs and natural products in medicine
- ➤ **Medical Imaging Analysis**: Using deep learning to detect anomalies in radiology, pathology, and other diagnostic imaging modalities.
- ➤ **Electronic Health Record (EHR) Mining**: Extracting insights from patient records for outcome prediction, patient stratification, and early warning systems.
- ➤ **Natural Language Processing in Healthcare**: Analyzing clinical notes and medical literature to enhance patient understanding and automate documentation.
- ➤ **Explainable and Ethical AI in Medicine**: Ensuring model transparency, fairness, and adherence to medical ethics and regulatory compliance.
- ➤ **Multi-Modal Data Fusion**: Integrating data from diverse sources such as clinical, imaging, genomic, behavioural for holistic health modelling.

Schematic Representation of Broad Area of Research:
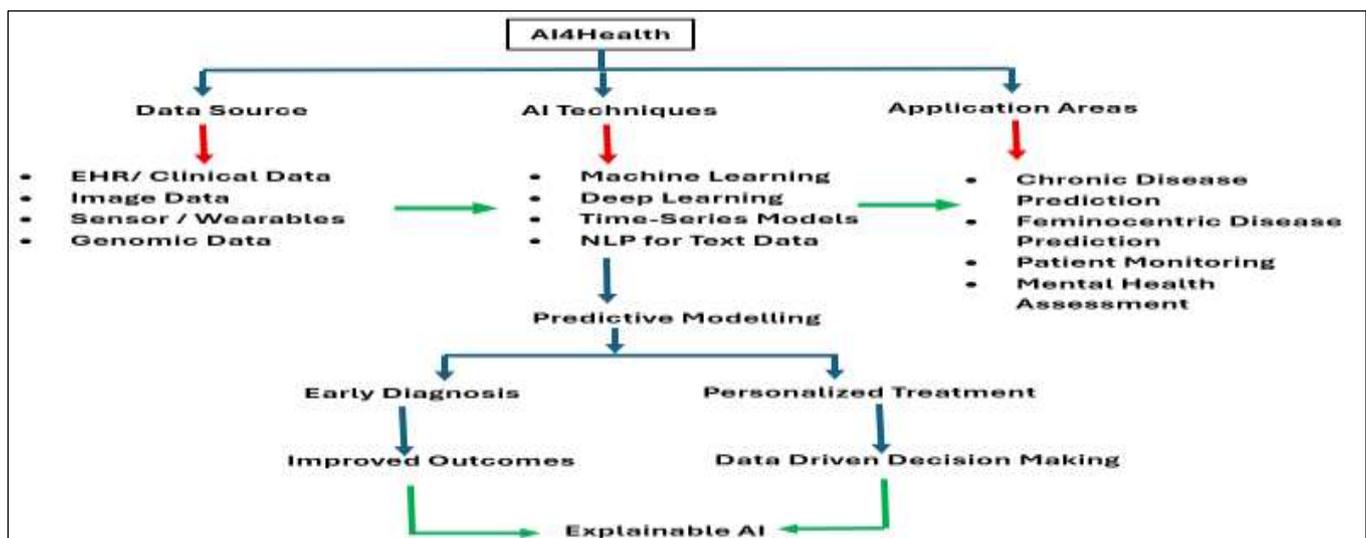
Total Number of Publications by the group: 70

Top 5 Article with impact factor: (Vancouver Style)

1. Moral P, Mustafi D, Mustafi A, Sahana SK. CystNet: An AI driven model for PCOS detection using multilevel thresholding of ultrasound images. Scientific Reports. 2024 Oct 23;14(1):25012. (IF: 3.8)

2. Moral P, Mustafi D, Sahana SK. PODBoost: an explainable AI model for polycystic ovarian syndrome detection using grey wolf-based feature selection approach. Neural Computing and Applications. 2024 Oct;36(30):18627-44. (IF: 4.5)
3. Jha R, Bhattacharjee V, Mustafi A. Increasing the prediction accuracy for thyroid disease: a step towards better health for society. Wireless Personal Communications. 2022 Jan;122(2):1921-38. (IF: 1.9)
4. Jha R, Bhattacharjee V, Mustafi A. Transfer learning with feature extraction modules for improved classifier performance on medical image data. Scientific Programming. 2022;2022(1):4983174. (IF: 1.672)
5. Jha R, Bhattacharjee V, Mustafi A, Sahana SK. Improved disease diagnosis system for COVID-19 with data refactoring and handling methods. Frontiers in Psychology. 2022 Aug 12;13:951027.(IF: 2.6)

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
ARMLEGS: Center for Advanced Research on Machine Learning for Geospatial Analytics and Solutions for the state of Jharkhand	Dr. Debjani Mustafi (Co-PI) Prof. Abhijit Mustafi (PI)	DST (Under PURSE Scheme)	₹ 84500000.00	2023-2027
360-degree Health Monitoring of Miners and Mining Community of CCL	Dr. Debjani Mustafi (Co-PI) Prof. Abhijit Mustafi (Co-PI)	CCL, GoI (CSR Scheme)	₹ 3311000.00	2022-2025

Industry/Academia Collaborations: Under process

Targeted Application Area: Creation of secure multimodal medical data repository, Prediction of chronic diseases and Feminocentric diseases, Assessment of Mental Health, Remote Patient Monitoring.

Achievements:

- **9 Publications Peer-reviewed Journal relevant to the domain in last 3 years.**

Brief Description of Project :

Problem Statement:

The research addresses the challenge of accurately predicting disease onset and progression using diverse healthcare data. Current systems lack integration and precision. AI4Health aims to develop robust predictive models to enhance early diagnosis, personalized treatment, and data-driven decision-making in clinical settings.

Applications:

- Early Detection of Chronic and Feminocentric diseases.
- Personalized Cancer Prognostics
- Real-Time Monitoring in Critical Care
- Mental Health Risk Assessment

Strategy/ Approach/ Technique/ Experiments used to solve

To address this challenge, the research employs machine learning and deep learning techniques. Multimodal data comprising clinical records, medical images, wearable sensor data, and genomics is integrated using data fusion and preprocessing strategies. Feature selection, dimensionality reduction, and time-series analysis are applied to enhance model performance. The models are trained and validated through cross-validation, with performance evaluated using metrics like accuracy, precision, recall, and AUC-ROC that provides a more natural walking experience and reduces these issues. Block chain technology may be used to provide a secure health care framework.

Graphical Abstract
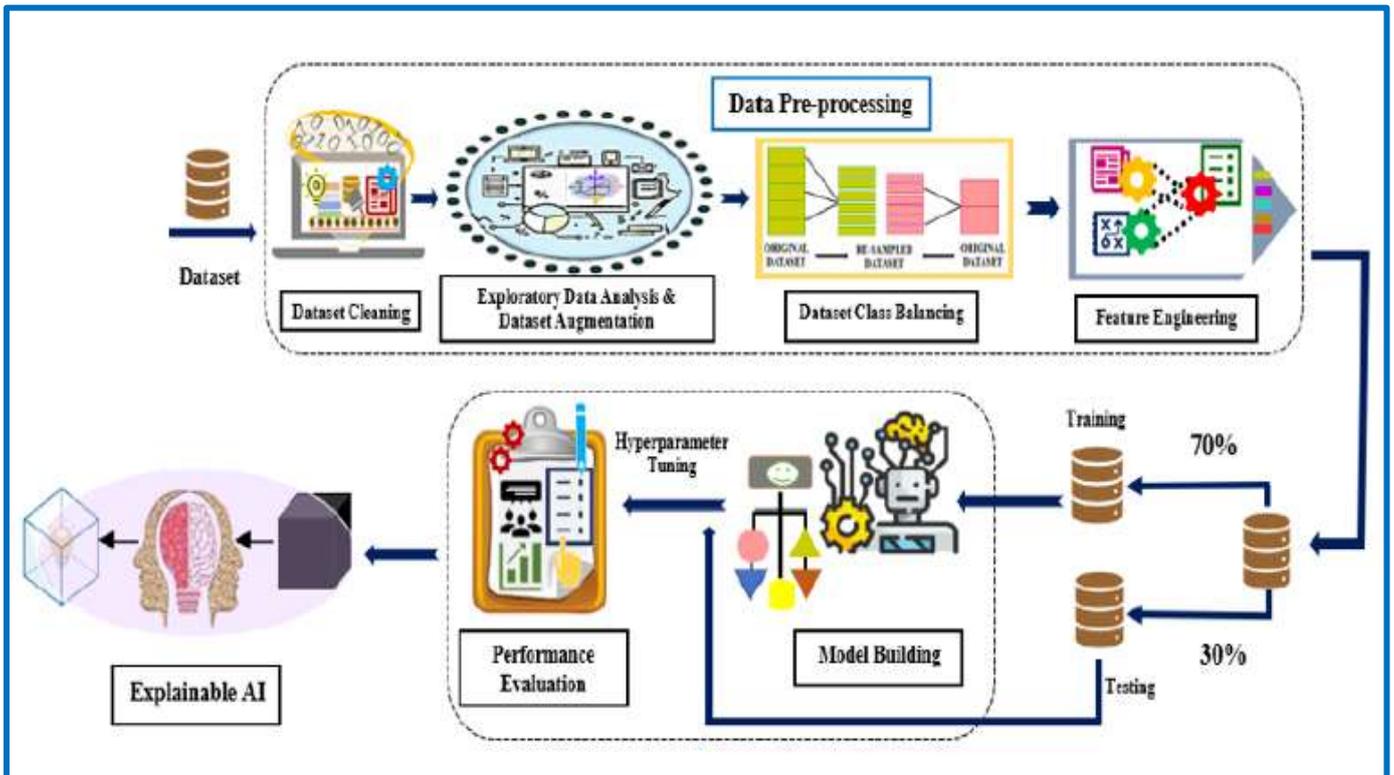
Group Members:

Research Group -Applied Data Intelligence

- **Name of Principal Investigator/ Group Leader**: **Dr. I. Mukherjee**
- **Research Theme**: Develop intelligent data-driven solutions that address real-world challenges across sectors such as healthcare, education, agriculture, environment, governance, and inclusive technology.
- **Broad Area of Research and Scope:**

Applied Data Intelligence integrates advanced computational techniques and domain knowledge to extract actionable insights from diverse data sources for solving practical problems. The group will focus on fundamental and applied research in:

- ➢ Scalable and distributed data processing
- ➢ Predictive modeling, pattern recognition, generative models.
- ➢ Multilingual AI, low-resource languages, sentiment analysis.
- ➢ Object detection, remote sensing image analysis.
- ➢ Real-time decision-making on IoT and edge devices.
- ➢ Secure, explainable, and trustworthy AI.
- ➢ Energy-efficient AI for sustainability.
- ➢ Inclusive design and societal impact.

Schematic Representation of Broad Area of Research:

Total Number of Publications by the group: Amritanjali (28)

Top 5 Article with impact factor: (Vancouver Style)

1. Sinha, K., Paul P. and Amritanjali, An Improved Pseudorandom Sequence Generator and its Application to Image Encryption, KSII Transactions on Internet and Information Systems, 2022, 16(4), 1307-1329, SCIE (IF 1.2), DOI: 10.3837/tiis.2022.04.012.

2. Bhosale, T.A., Pushkar, S. IWF-ECTIC: Improved Wiener filtering and ensemble of classification model for tourism image classification. Multimed Tools Appl (2024). https://doi.org/10.1007/s11042-024-20452-z (IF 3.0)

3. Rashmi Kumari, Subhranil Das, Akriti Nigam & Shashank Pushkar (2023) Patch-Based Siamese 3D Convolutional Neural Network for Early Alzheimer's Disease Using Multi-Modal Approach, IETE Journal of Research, DOI: 10.1080/03772063.2023.2205857**[SCIE]** (IF 1.3)

4. Kumari, R., Nigam, A. & Pushkar, S. An efficient combination of quadruple biomarkers in binary classification using ensemble machine learning technique for early onset of Alzheimer disease. Neural Comput & Applic **(2022)**. https://doi.org/10.1007/s00521-022-07076-w **(SCIE) IF** (4.5)

5. Mukherjee, R., Kundu, A., Mukherjee, I. et al. IoT-cloud based healthcare model for COVID-19 detection: an enhanced k-Nearest Neighbour classifier based approach. Computing (2021). https://doi.org/10.1007/s00607-021-00951-9 [SCIE]

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	"Hospital Environment Monitoring Robotic Device" by 1. Dr. Vishnu Kumar Saxena 2. Dr. Shashank Pushkar	Design Number: 377265-001, Journal No :12/2023 Journal Date :24/03/2023	Published
2.	Construction operation, monitoring, maintenance planning and future risk prediction of bigger constructions using Artificial Intelligence-based Internet of Things Anandharaj G.; B. Venkatesh; Mukherjee lndrajit;	Patent number: 2021105481 27/10/2021	Granted

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Multi-Source Optimization using Deep Learning framework for Downscaling Satellite-Derived Thermal Data	**PI**	**SERB**	**1908240/-**	**3 year**

Targeted Application Area:

Domain	Key Applications
Healthcare & Assistive Tech	Predictive diagnostics, speech and gait analysis, mental health AI, health informatics
Education & Language Tech	AI tutors, adaptive learning, speech-to-text for low-resource languages
Agritech & Food Security	Crop monitoring, soil and yield prediction, supply chain optimization
Environment & Climate Intelligence	Pollution prediction, disaster modeling, remote sensing analytics
Energy & Resource Optimization	Smart grids, energy consumption forecasting, industrial automation

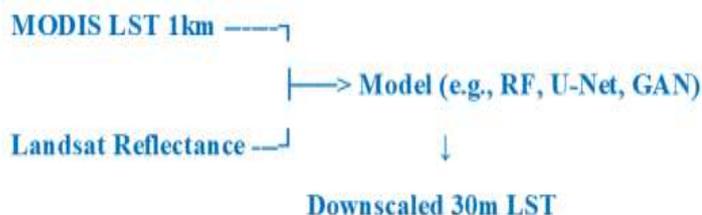| Domain	Key Applications
Social Impact & Governance	Policy modeling, digital inclusion, AI for tribal and underserved communities

Achievements:

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)

Problem Statement:

The broad objective is to propose an efficient image data analytics based on deep learning framework to predict an accurate downscaled LST at high spatial and high temporal resolutions using LANDSAT derived LST, SENTINEL-2 derived Vegetation Condition (VC) and MODIS derived LST. Following are the focused objectives:

- To Predict land surface temperature at 100m spatial resolution from 1km MODIS LST data and optimize the error between the actual LST at 1km to the predicted LST through statistical evaluation at various heterogeneous features.
- To Estimate land surface temperature at 20m spatial resolution using three-faceted interaction and deep learning model (using data from MODIS, LANDSAT and SENTINEL-2).
- To propose a suitable Spatio-Temporal fusion algorithm for blending of MODIS, LANDSAT and SENTINEL-2 data to minimize the trade off the uncertainty due to differences in spatial and temporal resolution data

Applications:

- Agricultural Monitoring and Precision
- Drought Assessment and Water Resource Management
- Urban Heat Island (UHI) Studies
- Ecological and Environmental Modeling
- Disaster Monitoring (e.g., Wildfires, Heatwaves)

Strategy/ Approach/ Technique/ Experiments used to solve

The methodology for downscaling MODIS Land Surface Temperature (LST) data to Landsat spatial resolution (from ~1000 m to 30 m) typically involves data fusion techniques and machine/deep learning models that leverage the complementary spatial and temporal characteristics of both datasets.

Group Members

Graphical Abstract

MODIS LST 1km ----┐

├──> Model (e.g., RF, U-Net, GAN)

Landsat Reflectance ──┘   ↓

Downscaled 30m LST

Research Group- DST Purse-Armlegs

- **Name of Principal Investigator/ Group Leader**: Dr. Abhijit Mustafi
- **Research Theme**: Machine learning solutions to analyse and predict the nature of geo-environmental phenomenon witnessed in the state of Jharkhand.
- **Broad Area of Research and Scope:**
  ➢ Use of Generative neural networks to model terrain.
  ➢ Semi-supervised learning for automated firefighting in case of forest fires.
  ➢ Study of rain shadow regions of Palamau and Latehar.
  ➢ Marking the pathway of shrinking riverways
  ➢ Groundwater analysis in and around the district.

Schematic Representation of Broad Area of Research:
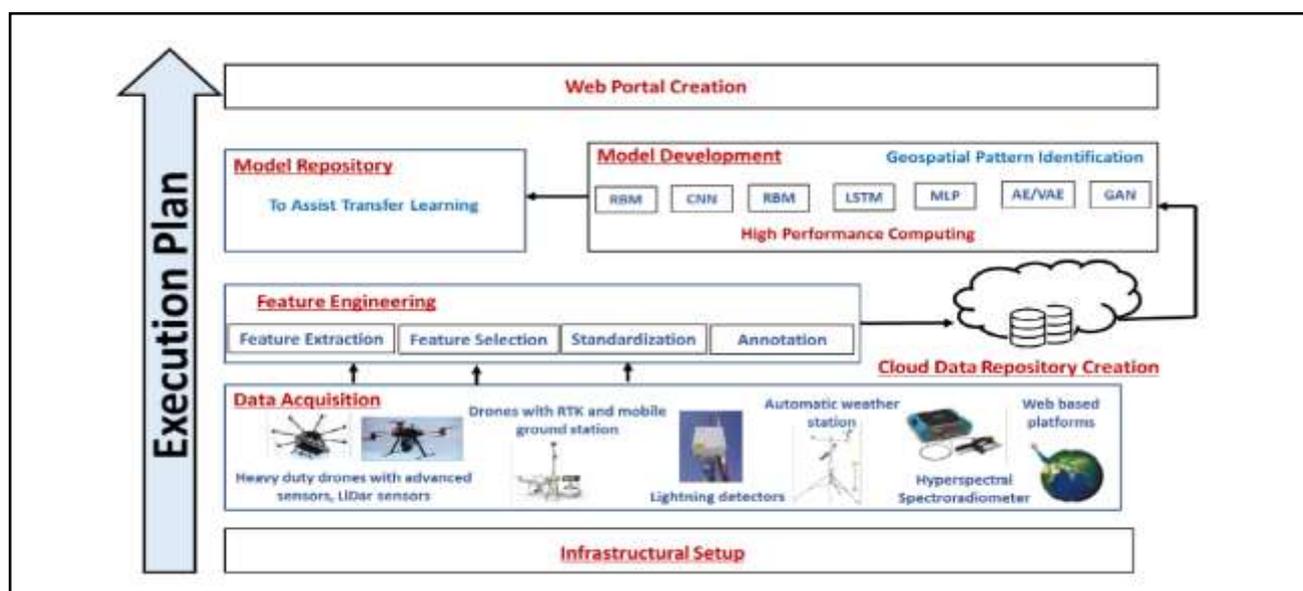
Total Number of Publications by the group: 100 (Approx.)

Top 5 Article with impact factor: (Vancouver Style)

1. Parasar P, Moral P, Srivastava A, Krishna AP, Sharma R, Rathore VS, Mustafi A, Mishra AP, Hasher FF, Zhran M. TeaNet: An Enhanced Attention Network for Climate-Resilient River Discharge Forecasting Under CMIP6 SSP585 Projections. Sustainability. 2025 May 7;17(9):4230. (IF: 3.3)
2. Moral P, Mustafi D, Mustafi A, Sahana SK. CystNet: An AI driven model for PCOS detection using multilevel thresholding of ultrasound images. Scientific Reports. 2024 Oct 23;14(1):25012. (IF: 3.8)
3. Moral P, Mustafi D, Sahana SK. PODBoost: an explainable AI model for polycystic ovarian syndrome detection using grey wolf-based feature selection approach. Neural Computing and Applications. 2024 Oct;36(30):18627-44. (IF: 4.5)
4. Anwar S, Srivastava A. A threefold chaotic image encryption technique for efficacious image data protection. *International Journal of Computers and Applications*, 2024, *46*(11), 974–982. (CiteScore: 4.7)

5. Sanober A, Anwar S, MeDiStore Trust Protocol Integrating Reputation based Proof of Stake Consensus for Enhanced Security of Blockchain Networks in Electronic Health Record Management;, accepted on 05-04-2025 in Discover Computing (Accepted) (IF: 1.7)

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Centre for Advanced Research on Machine Learning for Geospatial Analytics and Solutions for the State of Jharkhand (ARMLEGS)	PI: Dr. Abhijit Mustafi Co-PI: Dr. Sudip Kumar Sahana, Dr. Shamama Anwar, Dr. Debjani Mustafi, Prof. A. P. Krishna, Dr. Mili Ghosh nee Lala	DST (PURSE Scheme)	₹ 84500000.00	2023 - 2027

Industry/Academia Collaborations: In the pipeline

Targeted Application Area:

Achievements:

The Group was recognized for its activities when BIT, Mesra was chosen the first institute in the state of Jharkhand to be awarded the DST PURSE 2022.

Brief Description of Projects:

Problem Statement:

1. To establish a cutting-edge research facility to investigate geospatial applications using Machine Learning algorithms particularly spatio-temporal monitoring in Jharkhand.

2. To investigate innovative machine learning solutions to analyse and predict the nature of geo-environmental phenomenon witnessed in the state of Jharkhand and thus alleviate the unpredictability often associated with such events.

3. To support the state government and other relevant agencies for decision making pertinent to various aspects of concerns with respect to geospatial patterns in the state of Jharkhand.

4. Facilitating researchers and the student community to access equipment, data, tools and facilities dedicated to the study of AI or ML based geospatial aspects of Jharkhand.

5. To provide collaborative and interactive research resources to researchers across the country to enhance their knowledge base and research output.

Applications:

➢ Monitor reservoir water levels in Ranchi
➢ Predict groundwater levels using GRACE, GLDAS, and spatial features.
➢ Use CHIRPS rainfall data (2003–2023) to compute SPI, apply GMM for drought clustering,
➢ To accurately identify and predict lightning-prone zones in Jharkhand for improved early warning systems and disaster preparedness.
➢ To identify the forest fire in the region of Jharkhand.

Strategy/ Approach/ Technique/ Experiments used to solve

➤ Monitor reservoir water levels in Ranchi using SAR SLC images processed into InSAR to analyze surface displacement. Advanced interferometric techniques are applied to estimate water depth across Jharkhand.

➤ Predict groundwater levels using GRACE, GLDAS, and spatial features processed and modeled via ML techniques for visualization and groundwater mapping.

➤ Use CHIRPS rainfall data (2003–2023) to compute SPI, apply GMM for drought clustering, and implement an LSTM model to forecast SPI with high accuracy (RMSE 0.08–0.095) for drought management.

➤ To accurately identify and predict lightning-prone zones in Jharkhand for improved early warning systems and disaster preparedness. Applied Gaussian Mixture Clustering on LIS satellite data (2017–2022) for spatial zoning and performed temporal analysis by categorizing lightning events into key time slots to uncover high-risk districts and patterns.

Graphical Abstract
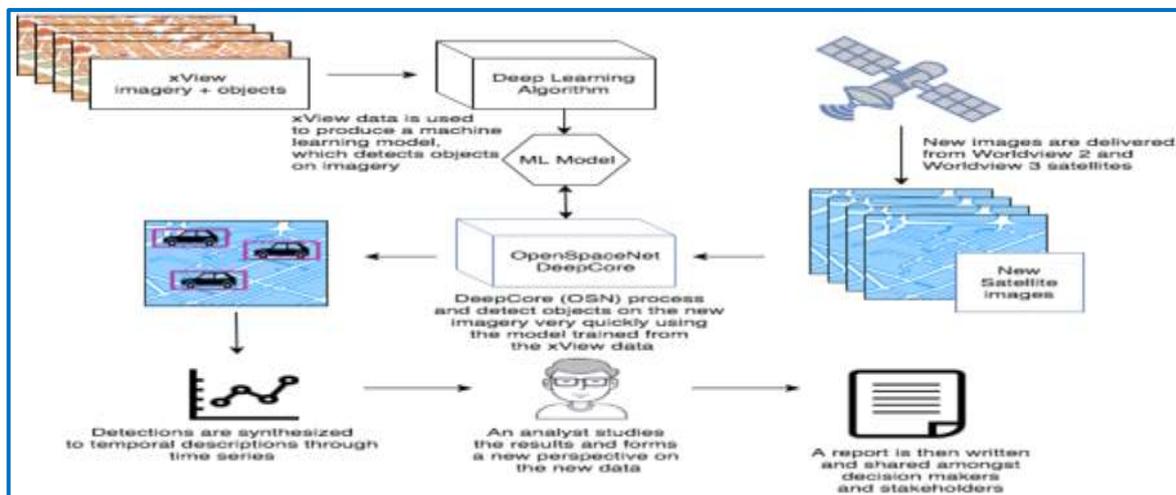
Group Members:

Research Group - Preterm birth (PTB) detection (Healthcare)

- **Name of Principal Investigator/ Group Leader**: Dr. B.K. Sarkar & Dr. S.K. Sahana
- **Research Theme**: Preterm birth (PTB) detection
- **Broad Area of Research:** Healthcare
  and Scope:

➢ Replacement of paper-form clinical information related to pregnant women by a computerized data collection system to store data in   e-database.

➢ Identifying the leading parameters to cause PTB, using expert opinion, existing studies and data analysis over the created database

➢ Development of medium-term (around next 10 months)   forecasting model for PTB cases to assist policy makers

➢ Development of early warning system for PTB cases to assist pregnant women (or the person concerned)

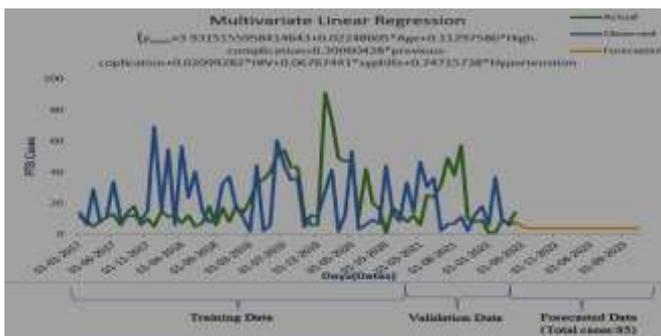## Schematic Representation of Broad Area of Research:

Total Number of Publications by the group: 02 (Scopus Indexed)

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Improving health services of rural areas in Indian healthcare system through Machine Learning approaches	PI	National Mission on Interdisciplinary Cyber Physical Systems	5.79	23.09.2022 to 31.03.2025

Targeted Application Area: Healthcare

Achievements: Development of GUIs for data curation and early prediction of PTB, Research work publications

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)

Problem Statement:

One of the challenging issues in healthcare domain is the preterm birth (PTB). PTB babies face serious problems like very low catch-up growth rate, low-birth-weight, often lifetime-disability, visual and hearing problems. Survivors have high chance of brain paralysis, breathing difficulty, and so on. For carrying out any fruitful research on PTB for maternal health as well as early warning system, we need complete, correct, up-to-date and consistent data which comes from digitized database.

Applications:

- ➢ Medical experts
- ➢ Policy makers
- ➢ Researchers
- ➢ Pregnant women (or the persons concerned) to prevent PTB.

### Strategy/ Approach/ Technique/ Experiments used to solve

- Digitized birth data collection [Web-page design]
- Descriptive statistics
- Linear regression-based forecasting model
- Random Forest based Early Prediction model

Research Group -Brain Computer Interface (BCI) Application using EEG

- **Name of Principal Investigator/ Group Leader**: Dr. Shamama Anwar
- **Research Theme**: Understanding brain signals for use in BCI applications
- **Broad Area of Research and Scope:**
  - Brain fingerprinting
  - Cognitive workload and mental fatigue detection
  - Emotion Recognition and mental health monitoring
  - Neurorehabilitation and Assistive Technologies
  - The use of diverse Deep learning paradigms like semi-supervised learning, to solve these problems

Schematic Representation of Broad Area of Research
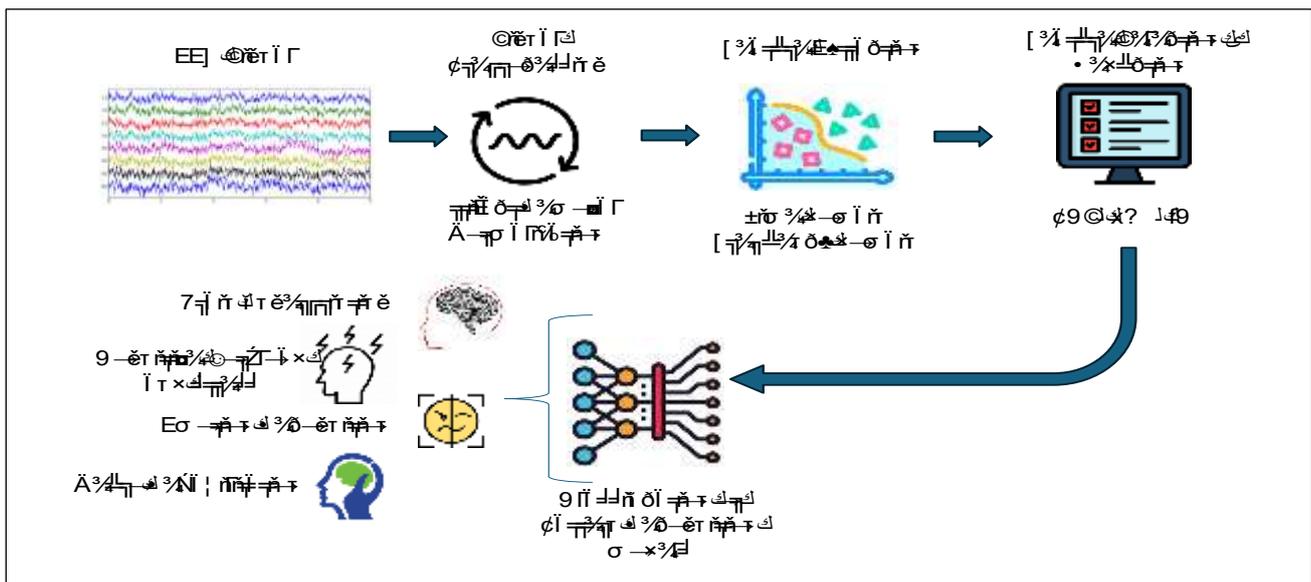
- **Total Number of Publications by the group: 70**
- **Top 5 Article with impact factor: (Vancouver Style)**

1. Karmakar *S, Kamilya* S, Koley C and Pal T. A deep learning technique for real time detection of cognitive load using optimal number of eeg electrodes. IEEE Transactions on Instrumentation Measurement, vol 74 (2502311), 2025. DOI: 10.1109/TIM.2024.3509604 **[SCIE Indexed IF 5.6]**

2. *Kamilya S*, Ritesh H, Vinod C S., Karmakar S, Pal T. Subject-Specific Temporal Analysis of Cognitive Load Using fNIRS: A Machine Learning Approach. accepted in Computing Conference, Springer, 2025, London June 19-20, 2025.

3. Karmakar S, *Kamilya S*, Dey P, et al. Real time detection of cognitive load using fnirs: A deep learning approach. Biomedical Signal Processing and Control, vol. 80, p. 104 227, 2023. **[SCIE Indexed IF 4.9]**

4. Kumari, N, *Anwar, S, Bhattacharjee, V*. Time series dependent feature of EEG signals for improved visually evoked emotion classification using Emotion Caps Net, Neural Computing and Applications, Special Issue for Deep Learning in Time-series data, pp. 1-13, Vol. 43, Issue 4, 2022, Online ISSN: 1433-3058, Print ISSN: 0941-0643 https://doi.org/10.1007/s00521-022-06942-x [**SCIE**, IF:5.606]

5. Kumari, N, *Anwar, S, Bhattacharjee, V*. Automated Visual Stimuli Evoked Multi-channel EEG Signal Classification Using EEGCapsNet, Pattern Recognition Letters, Elsevier, Vol. 153, pp. 29 – 35, 2022, ISSN: 0167-8655 doi: https://doi.org/10.1016/j.patrec.2021.11.019 [**SCI**, IF: 4.757]

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Visually Evoked EEG Classification and Perceived Image Regeneration using Deep Learning for Brain Fingerprinting (SPR/2022/000154)	PI (Shamama Anwar) Co-PI (Vandana Bhattacharjee)	SERB – SUPRA	₹ 24 L	3 years (2023 – 2026)

Targeted Application Area:

Achievements:

Brief Description of Projects: Visually Evoked EEG Classification and Perceived Image Regeneration using Deep Learning for Brain Fingerprinting

Problem Statement:

The objective of this proposal is to derive some cues from brain activity recorded using an EEG recording and use them to classify, visualize and generate an image of an object a person is thinking about.

Strategy/ Approach/ Technique/ Experiments used to solve

A brief description of the methodology to be followed for achieving the objectives defined has been outlined below:

Data Collection: Setting up a laboratory infrastructure to capture visually evoked EEG data.

EEG pre-processing and formulation: The acquired raw EEG signals are then pre-processed using various filtering techniques and then formulated for further processing using transformation.

EEG classification task: The EEG signals so obtained are labelled and a deep learning based classification model is to be developed for successful classification.

Image Regeneration task from EEG signals using Generative model: In image reconstruction task, the generative model consists of two modules: the Generator and Discriminator.

Applications:

- **Brain Fingerprinting:** Unique EEG responses to visual stimuli can act as a biometric for identifying individuals, offering highly secure authentication for sensitive systems (military, banking, medical records).
- **Cognitive Forensics:** EEG signals can be analyzed to determine whether a person recognizes or remembers certain images, useful in legal investigations.
- **Brain based Authentication System**
- **Mental Health Assessment**: By analyzing brain responses to emotionally charged images, systems can detect mood disorders, depression, PTSD, or cognitive impairments.
- **Neurofeedback Therapy**: Real-time EEG analysis and image regeneration can provide feedback to improve attention, anxiety, or learning outcomes.
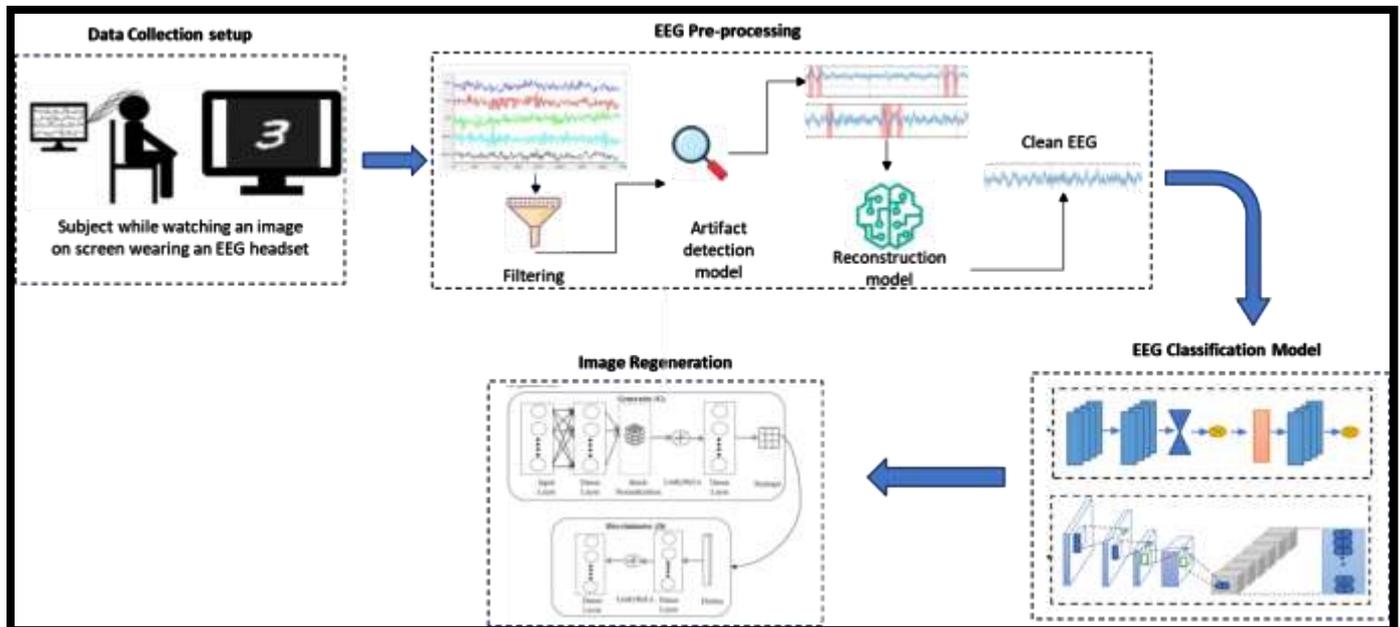
Problem Statement:

This work addresses the challenge of real-time cognitive load detection by reducing the number of EEG electrodes without compromising accuracy. It aims to optimize system performance through efficient electrode mapping, deep learning-based analysis, and resource-aware design.

Applications:

Following are the key applications based on the work.

- **Adaptive Learning Systems**: Personalizes content based on the learner's cognitive state.
- **Driver Monitoring**: Detects cognitive overload to improve road safety.
- **High-Stress Work Environments**: Monitors cognitive fatigue in fields like surgery and air traffic control.
- **Human-Computer Interaction (HCI)**: Enables systems to adapt based on user mental workload.
- **Virtual Reality and Gaming**: Adjusts game difficulty or immersion in response to cognitive load.
- **Mental Health Monitoring**: Assists in early detection of stress and cognitive disorders using EEG data.

Strategy/ Approach/ Technique/ Experiments used to solve:

The work presents a novel cognitive load detection mechanism using a proposed CNN model. Data are collected from some subjects for mental arithmetic tasks. The data are then filtered with band pass filters and alpha and theta bands are extracted. RMS values of theta-alpha ratio (TAR) have been calculated. The 3D coordinates of electrodes are mapped to 2D coordinates. Along with the electrode coordinates and the TAR values, topological brain images are generated as shown in the following figures. A CNN model has been proposed that classifies from the topographical brain images, whether there is metal load or rest. Performance metrics have been calculated for particular brain regions as shown in the table.
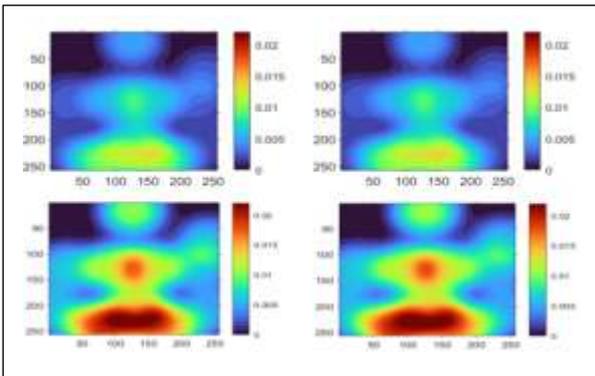
Brain regions (no. of EEG electrodes)	Seen Subjects				CPU Time (in hours)	Memory Utilization (in KB)
	Acc. (%)	Pre. (%)	Rec. (%)	F1. (%)		
Whole brain (13)	**94.79**	96.46	87.13	90.12	1.72	58.59
Frontal & Prefrontal (5)	94.77	**97.16**	**90.73**	**90.74**	1.56	57.12
Frontal, Prefrontal and Central (6)	86.53	83.96	88.96	86.23	1.58	56.90
Parietal (3)	81.41	87.20	78.47	82.38	1.58	**57.15**
Occipital (2)	61.94	68.18	60.48	63.68	**1.48**	57.16
Temporal (2)	65.00	69.08	64.39	66.27	1.49	58.18

The overall methodology is given in the following diagram.

Group Members

99
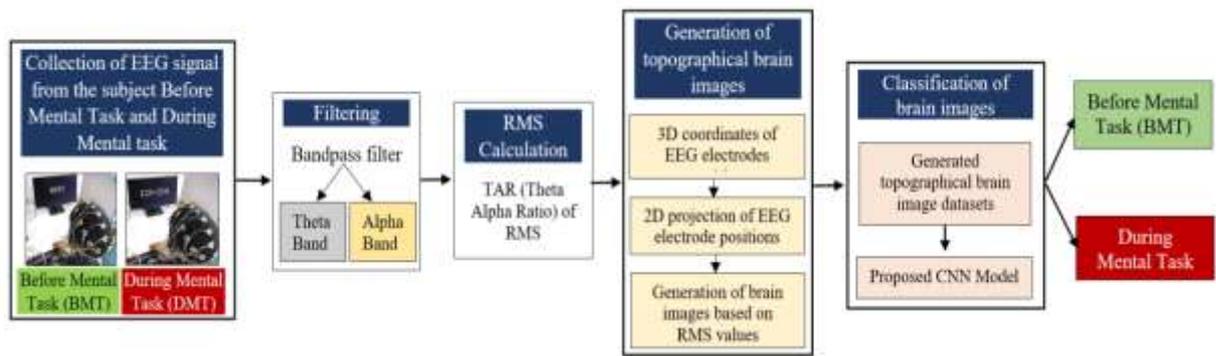
Research Group-Application of Machine Learning in Agriculture Domain

- ▪ **Name of Principal Investigator/ Group Leader**: **Dr. Ritesh Jha**
- ▪ **Research Theme**: AI driven solutions for agricultural domain
- ▪ **Broad Area of Research and Scope:**
- ➢ Plant disease identification
- ➢ Optimal uses of pesticides in crops
- ➢ Weed detection

Schematic Representation of Broad Area of Research:
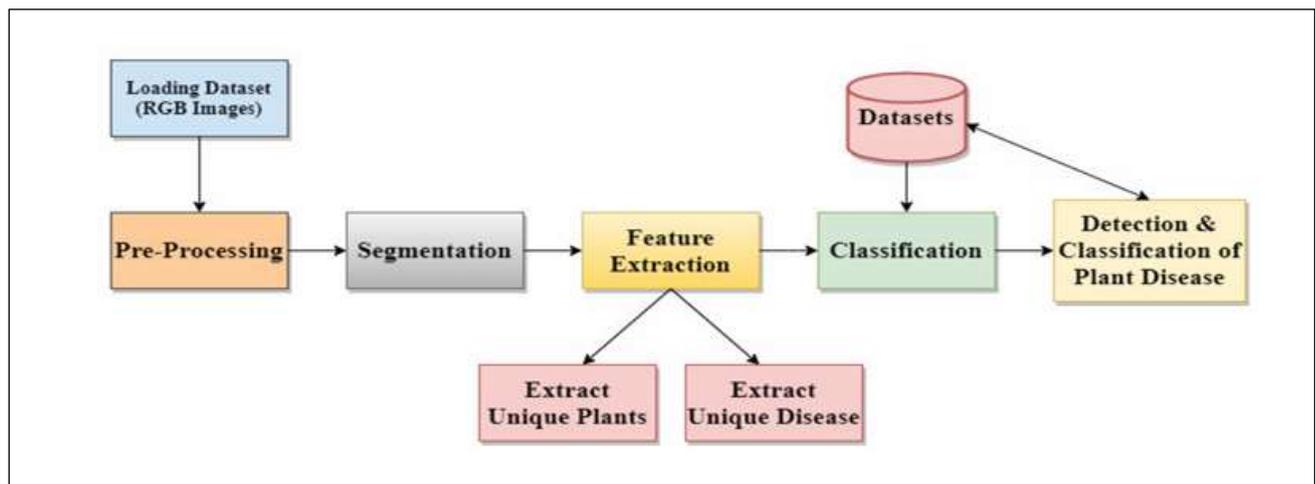
- • **Total Number of Publications by the group: 5**
- • **Top 5 Article with impact factor: (Vancouver Style)**

1. Ritesh Jha, Vandana Bhattacharjee, Chandan Chatterjee and Shivam Lohra. Plant Disease Detection Using Autoencoder-Based Feature Extraction and Hybrid Transformer Model, vol 5, Issue 5, JETIR, ISSN:2349-5162, 2025.
2. Swetav Suman, Ritesh Jha, Vandana Bhattacharjee. Classification of Brain MRI using the Hypercolumn technique with a Convolutional Neural Network and a feature selection method, vol-12, Issue 4, JETIR, ISSN:2349-5162, 2025.
3. P Lokeshwar Reddy, Ritesh Jha, V. Bhattacharjee, 2024, Performance of U-Net Based Architecture for Brain Tumor Segmentation: Choice of Backbone, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 13, Issue 06 (June 2024)
4. Animesh Mishra, Ritesh Jha and Vandana Bhattacharjee (2023), SSCLNet: A Self-Supervised Contrastive Loss-Based Pre-Trained Network for Brain MRI Classification, IEEE ACCESS, Digital Object Identifier 10.1109/ACCESS.2023.3237542.
5. Ritesh Jha, Vandana Bhattacharjee and Abhijit Mustafi, "Transfer Learning with Feature Extraction Modules for Improved Classifier Performance on Medical Image Data", ScientificProgramming, Hindawi, Volume 2022, Article ID 4983174 | https://doi.org/10.1155/2022/4983174(SCIE Indexed, IF 1.672].

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted
	Partha Sarathi Bishnu, Abhishek Kumar, and Vandana Bhattacharjee, BIRLA INSTITUTE OF TECHNOLOGY MESRA. System and Method for Optimizing Discounts to Enhance Customer Satisfaction and Company's Revenue,	Patent application no. 202431053477. Priority Date: July 12, 2024.	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Non-invasive method for detection and analysis of anaemia in pregnant women using a deep learning-based model: A Multidisciplinary	PI: Partha Sarathi Bishnu Co-PI: Vandana Bhattacharjee	ICMR	27.28 Lacs	3 years

Targeted Application Area: Agriculture

Achievements:

Brief Description of Projects : **(Maximum 2 project in the following format highlighting your research theme mentioned earlier)**

Problem Statement:

Plant disease detection is a critical task in agriculture for ensuring crop health and maximizing yield. In this project, we propose two approaches for plant disease detection. In the first approach, we use different types of autoencoders along with our defined CNN model to reduce training time and minimize the number of trainable parameters. The autoencoders extract compressed features from plant leaf images, which are then passed to the CNN for classification performance of these different autoencoders to identify the best one.

Applications:

➢ Agriculture field
➢ Early detection of plant disease
➢ Optimal Uses of Pesticides in Crops.
➢ Real-time applications in agriculture.

Strategy/ Approach/ Technique/ Experiments used to solve

In this research, two deep learning approaches are proposed. The first approach involves training a lightweight CNN model on encoded features extracted using various types of autoencoders, including convolutional, undercomplete, and deep variants.

Graphical Abstract

1: Graphical illustration of the first proposed deep learning approach oders and a lightweight CNN.

Group Members

101
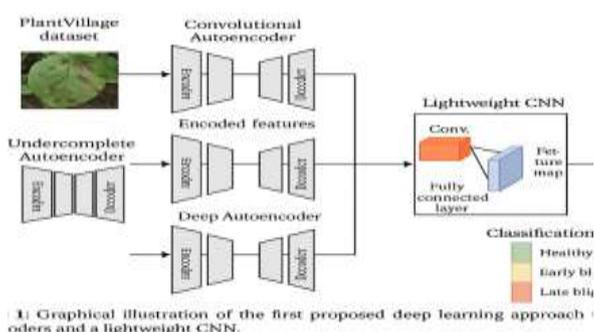
Research Group -Neuroinformatics and Affective Signal Processing using Advanced AI Models

- **Name of Principal Investigator/ Group Leader**: Dr. Shruti Garg
- **Research Theme**: Deep Learning Architectures for Biophysical Signal Analysis and Mental Health Assessment
- **Broad Area of Research and Scope:**

- **Multimodal Biophysical Signal Analysis:** Utilization of EEG and fMRI data to extract spatial, temporal, and frequency-domain features linked to human emotions and cognitive states.
- **Development of Hybrid Deep Architectures:** Design and implementation of CNN-BiGRU, S-LSTM-ATT, Graph Convolutional Networks (GCNN), and Transformer-based models tailored for feature fusion, temporal pattern recognition, and connectivity modeling.
- **Emotion Recognition Frameworks:** Classification of discrete and dimensional emotions using fused features and optimization techniques across public and culturally specific datasets (e.g., Bollywood-based fMRI datasets).
- **Psychological Disorder Screening:** Early detection of depression, stress, and autism spectrum disorders using EEG data and explainable deep learning models.
- **Culturally Relevant Neuroimaging Dataset:** Creation of new datasets like NeuroEmo that use Indian-specific stimuli to bridge cultural gaps in affective neuroscience research.
- **Applications in Human-Centric AI:** Enhancing HCI systems, mental health assessment tools, and intelligent tutoring systems through emotion-aware and cognition-aware AI.

Schematic Representation of Broad Area of Research
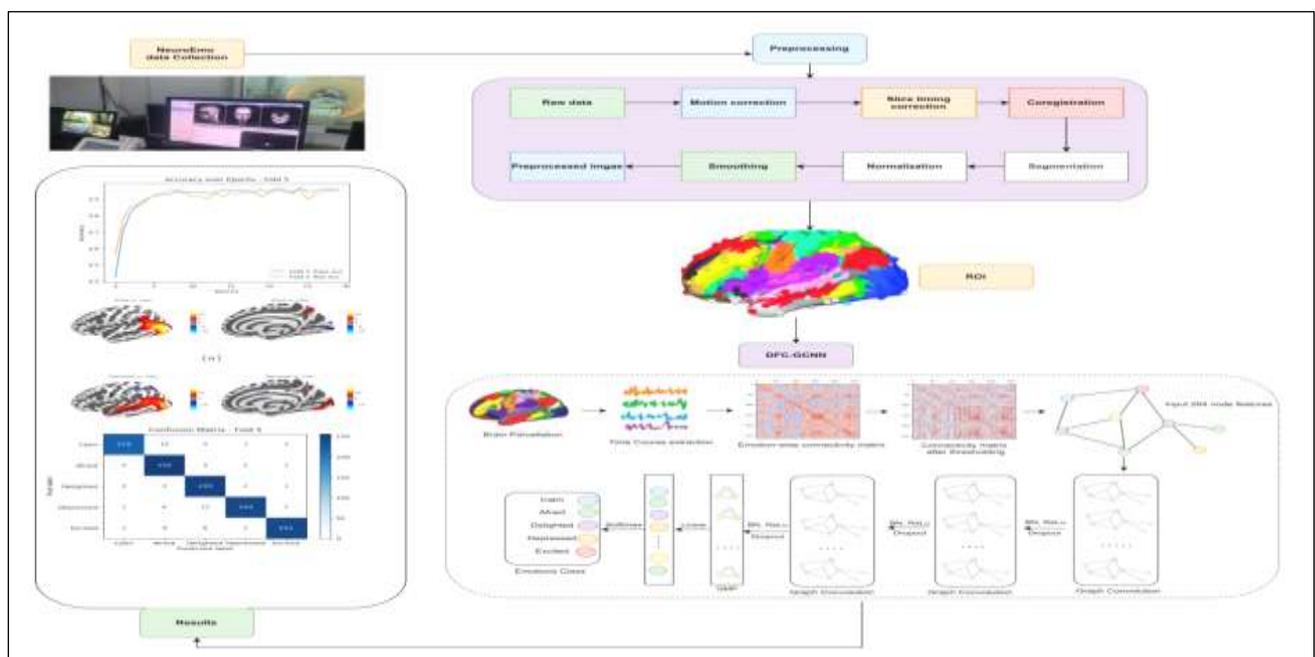
Top 5 Article with impact factor: (Vancouver Style)

1. Abgeena A, Garg S, Goyal N, Raj JP. NeuroEmo: A neuroimaging-based fMRI dataset to extract temporal affective brain dynamics for Indian movie video clips stimuli using dynamic functional connectivity approach with graph convolution neural network (DFC-GCNN). accepted to publish in Computers in Biology and Medicine, **IF 7.0** Elsevier E-ISSN 0010-4825.
2. Tigga NP, Garg S, Alnajjar F. Autism Spectrum Disorder Classification with EEG Signals Using Dense Graph. Converging Clinical and Engineering Research on Neurorehabilitation V. 2024:350.
3. Abgeena A, Garg S. S-LSTM-ATT: a hybrid deep learning approach with optimized features for emotion recognition in electroencephalogram. Health Information Science and Systems. 2023 Aug 29;11(1):40. **IF 5.4** Springer E-ISSN 2047-2501.
4. Tigga NP, Garg S. Efficacy of novel attention-based gated recurrent units transformer for depression detection using electroencephalogram signals. Health Information Science and Systems. 2022 Dec 29;11(1):1.**IF 5.4** Springer E-ISSN 2047-2501.
5. Tigga NP, Garg S, Goyal N, Raj J, Das B. Brain-region specific autism prediction from electroencephalogram signals using graph convolution neural network. Technology and Health Care. 2025 Jan;33(1):77-101. **IF 1.3** IOS Press E-ISSN:0928-7329

<h2 style="text-align:center">Patents by the group:</h2>

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted
1.	Neha Prerna Tigga, **Shruti Garg,** Nishant Goyal, Justin Raj, Basudeb Raj *"Brain-region specific autism prediction system from electroencephalogram signals using graph convolution neural network"*	Application No. 202431057950 Date of filing of Application 31/07/2024	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Proposing Health Indicators for Modelling and Prediction of Selected Biological Aspects in Human Communities	Co-PI	IOE FRP Delhi University, Delhi	5L	2024-25

Industry/Academia Collaborations:

1. *Dr Ashwani Garg, Faculty of Health, Biomedical Science and Medical Science, Griffith University, Queensland, 4122, Australia **[International Collaborator]***
2. *Dr Fady Alnajir**, Associate Professor, College of Information Technology, United Arab Emirates University Al Ain, UAE **[International Collaborator]***
3. *Dr Ranjita Pandey, Professor and Head, Department of Statistics, University of Delhi, Delhi **[Inter University Collaborator]***
4. *Dr Nishant Goyal, Professor, Central Institute of Psychiatry, Kanke, Ranchi **[Inter University Collaborator]***

Targeted Application Area: The targeted application areas of this research include:

Mental Health Monitoring and Early Diagnosis
Development of AI-powered screening tools for stress, depression, and autism spectrum disorder (ASD) using EEG and fMRI data.
Emotion-Aware Human-Computer Interaction (HCI)

Integration of emotion recognition systems in adaptive user interfaces, e-learning platforms, and assistive technologies to personalize user experience based on cognitive and affective states.

Cognitive Neuroscience and Affective Computing

Mapping temporal brain dynamics associated with discrete emotional states using neuroimaging datasets (e.g., NeuroEmo), enhancing understanding of neural correlates of emotion processing.

Achievements:

◆ **Received International Recognition** by presenting research work at the 9th International Conference on NeuroRehabilitation (ICNR 2024) held in Granada, Spain,

◆ **Released a Publicly Available fMRI Dataset, NeuroEmo,** on the OpenNeuro platform—facilitating open, reproducible research in affective computing using culturally relevant stimuli.
 Dataset Link: https://openneuro.org/datasets/ds005700/versions/1.0.2

◆ **Published Research Article in Seven Impact Factor Journal**

Group Members

Research Group -Protect- X

- **Name of Principal Investigator/ Group Leader**: Dr. Kishore Kumar Senapati
- **Research Theme**: Digital Security
- **Broad Area of Research and Scope:** Digital security projects encompass a broad range of initiatives aimed at protecting data, networks, and systems from cyber threats. Their scope can vary based on industry needs, technological advancements, and regulatory requirements. Some key areas are:
  ➤ Cybersecurity Infrastructure Development
  ➤ Data Protection & Privacy
  ➤ Threat Detection & Incident Response
  ➤ Emerging Technologies & Security
  ➤ Cybersecurity Awareness & Training
  ➤ Government & Industry Collaboration

Schematic Representation of Broad Area of Research:
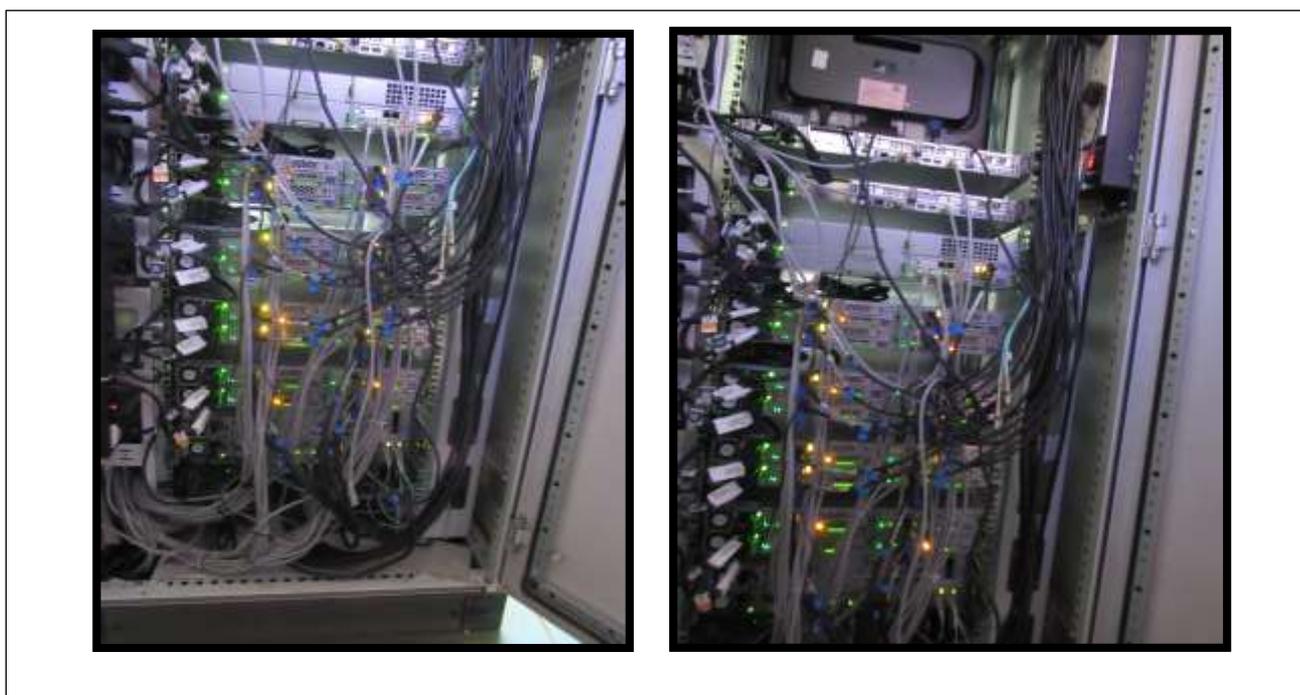
Total Number of Publications by the group: 150

Top 5 Article with impact factor: (Vancouver Style)

1. Abhishek Kumar, Kishore Kumar Senapati, K.S. Patnaik," Analysis of Pattern Matching Techniques used for Information Leakage" Hinweis Second International Conference on Recent Trends, Machine Learning, and Image processing, MLIP-2023, 22-23 December 2023, Hyderabad, India

2. Abhishek Kumar, Kishore Kumar Senapati, K.S. Patnaik," Mechanism to handle Mobile Devices in Cyber Security Investigations" International Conference on Computer Science, Cyber Security, and Information Technology, CCIT-2023, 22-23 April 2023, Kochi, India

3. Priyanka Kumari, Kishore Kumar Senapati, "A Dataset on Digital Image Forgery Detection" 8th International Conference on "Emerging Research in Computing, Information, Communication and Applications (ERCICA 2023), NITTE Meenakshi Institute of Technology, Yelahanka, Bangalore, India, 24-25 February 2023.
4. Saptorshi Bhattacharjee, Kishore Kumar Senapati. "Performance Analysis and Evaluation of Wi-Fi Security Protocols", 2022, 6th World Conference on Smart Trends in System, Security and Sustainability, WorldS4, 24-27 August 2022, 1, America Square, 17 Cross wall, London EC3N 2LB, UK.
5. Rupesh Kumar Sinha, Sitanshu Sekhar Sahu, "Multi-level Image Security using Modified Rubik's Cube Algorithm" Int. J. of Information and Computer Security, 23 (4), 396-409, 2024

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	A System or Method for Predicting Student Academic Performance [Akash Ranjan, Rohit Raj, Aman Deep and Kishore Kumar Senapati]	2021103829	Granted
2	A Point Cloud Generation System of an Object from Multiple Views [Radhamadhab Dalai, Kishore Kumar Senapati]	202231013133	Granted
3	Indian Dataset for Human Racial classification [Vani Hiremani, Kishore Kumar Senapati]	202231054120	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of AI assisted security framework with automated sketching and anomalous crowd behaviour detection	PI	NM-ICPS, DST, ISI	3.98L	2Years
Skill Development LAB	PI	AICTE	14.78	3 Years
Development of end-to-end speech-based AI system for Parkinson's Disease	PI	NM-ICPS	5.14L	2Years
Auto Robotic resection of Tumours by Volumetric Analysis of Medical Images	CO-PI	AICTE	11.38L	2 Years

Industry/Academia Collaborations:

- Industry and Academia Collaboration is an integral part of the research and development, this research group in last few years are actively involved in the collaboration process, which has already been initiated with esteemed organizations such as CRPF, NCC, BSF, Madras University, and the Cyber Police Stations, Jharkhand Police, Military organisations and Government of India Ministries along with distinguished experts including Prof. Vijay Vardharajan of New Castle University Australia, Prof. Cristan Maple of Warwick University UK, Prof. Somanath Tripathy, IIT Patna, Prof. Dharmendra Singh (IIT Roorkee), Mr. C.S. Murty (CDAC), and Prof. Matriee Dutta of NITTR. This initiative is to strengthen the Digital Security Group's education, research, and innovation.
- Additionally, discussions have been held with leading industry giants such as PWC, Cognizant, and Jio, Micro point. Their involvement will help bridge the gap between academia and industry, ensuring real-world applications and advancements in Digital security.

Targeted Application Area: Data Security plays a vital role in safeguarding data, systems, and networks. In today's world "Secure Data for Secure Country". The entire population of the world is almost in the Virtual Domain and consuming lots of time and doing as many as daily business through these virtual devices. Safeguarding and securing the virtual world are a tedious and real time-based task. Here are some key areas where digital security is essential.

- ✓ Cybersecurity & Network Protection
- ✓ Data Privacy & Compliance
- ✓ Artificial Intelligence (AI) & Machine Learning (ML) Security
- ✓ Blockchain & Secure Transactions
- ✓ Internet of Things (IoT) & Endpoint Security
- ✓ Cloud Security & Virtual Infrastructure
- ✓ Cyber Forensics & Incident Response
- ✓ Secure Software Development & Application Security
- ✓ Critical Infrastructure & National Security
- ✓ Digital Identity & Access Management

Achievements:

- Demonstrations of ATV, Quad bike and other products at Defence EXPO 2022
- 89 Officers are Trained on Cyber Crime and Investigation Tools in the Year 2022
- 72 Officers Trained on Cyber Crime and Block Chain in the Year 2023
- Consultancy Support to prepare a Data Center Project [100 Cr] to Jharkhand Agency for Promotion of Information Technology (JAP-IT)
- Dashboarding and Automation Solutions on Security delivered to Jharkhand Police
- Filed operations executed for Security Solutions tailored to the needs of CRPF
- Consultancy to Indian Army Projects on production and Training

Brief Description of Projects : Development of AI assisted security framework with automated sketching and anomalous crowd behaviour detection

Problem Statement:

This project aims to develop an AI-assisted security framework that integrates automated sketching for suspect identification and real-time anomalous crowd behaviour detection. The system will leverage computer vision, deep learning, and behavioural analytics to enhance security operations by:

- **Generating automated sketches**

- **Detecting unusual crowd behaviours**

- **Providing intelligent alerts to security agencies**

Applications:

- ➢ Law Enforcement and Criminal investigations
- ➢ Public safety and Surveillance
- ➢ Smart cities and Urban Security
- ➢ Border Security and Defence
- ➢ Retail and Commercial Security
- ➢ Healthcare and Hospital Security
- ➢ Emergency Response and disaster Management
- ➢ Cyber Security and Digital Forensic
- ➢ Behavioural Study and Investigation

Strategy/ Approach/ Technique/ Experiments used to solve

Developing an AI-assisted security framework with automated sketching and anomalous crowd behaviour detection requires a structured methodology. Here's a step-by-step approach to solving this problem effectively.

- Problem Definition & Requirement Analysis
- Data Collection & Preprocessing
- AI Model Development
- System Integration & Security Framework
- Testing & Validation
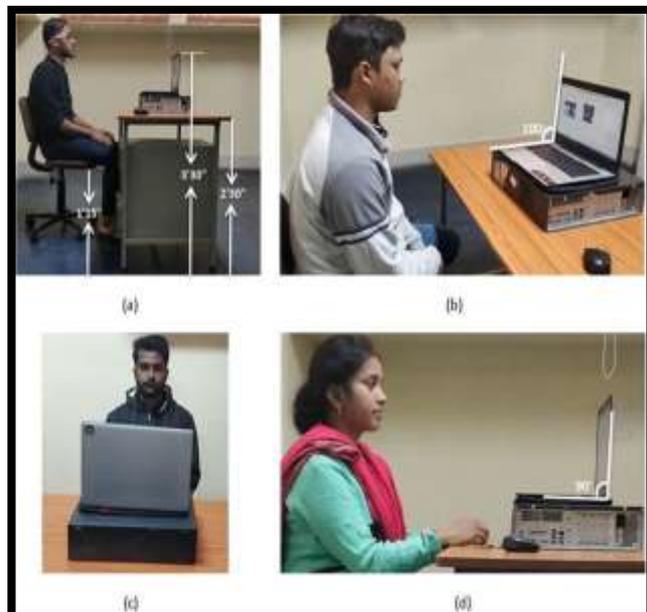
Group Members

Research Group -XAI

- **Name of Principal Investigator/ Group Leader**: Dr. K. Sridhar Patnaik
- **Research Theme**: Explainable AI and its applications
- **Broad Area of Research and Scope:**
  - Explainable AI in Medical Imaging
  - Explainable AI in Defence systems

Schematic Representation of Broad Area of Research:

- **Total Number of Publications by the group:**
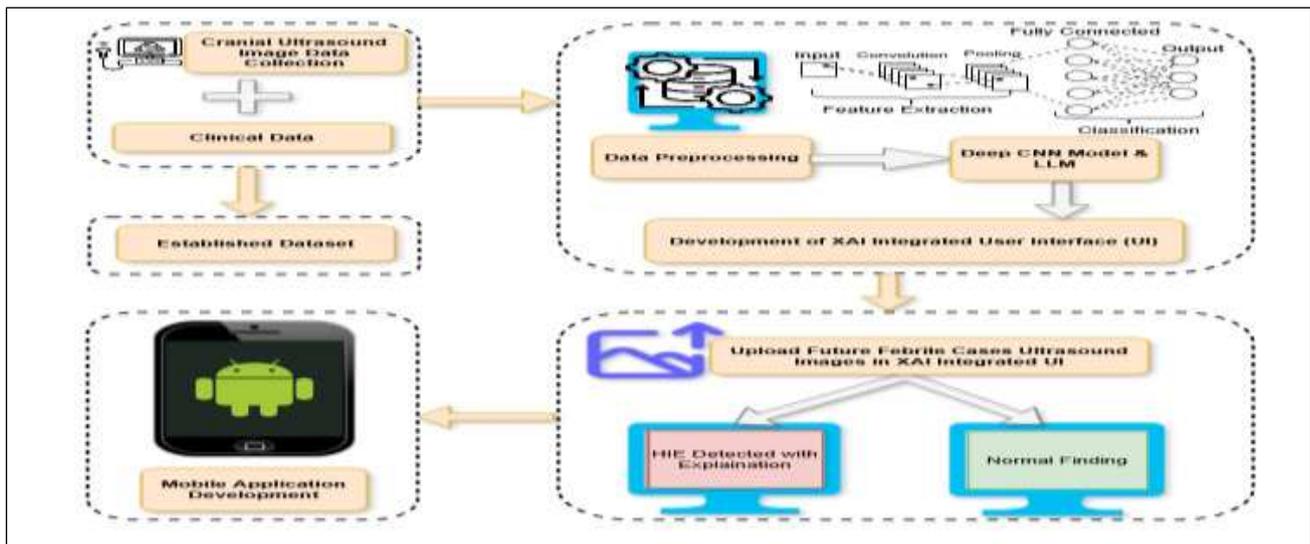- **Top 5 Article with impact factor: (Vancouver Style)**

1. Deepika Nikam, Ajuebor Chukwuemeke, Akriti Nigam, Tejaswini Bhosale, Sagar Nikam, (2025)., On the Application of YOLO- based Object Detection Models to Classify and Detect Defects in Laser Directed Energy Deposition Process" Progress in Additive Manufacturing, Springer, DOI:10.1007/s40964-025-01056-x, March 2025 **[ESCI,Scopus- impact factor 4.4]**

2. Yogesh H. Bhosale ,K. Sridhar Patnaik, S. R. Zanwar, Saket Kr. Singh, Vandana Singh, U. B. Shind e,Thoracic-net:(2024)., Explainable artificial intelligence (XAI) based few shots learning feature fusion technique for multi?classifying thoracic diseases using medical imaging,,Multimedia Tools and Applications,Spinger https://doi.org/10.1007/s11042-024-20327-3,Sep

3. Saket Kumar Singh,K.Sridhar Patnaik,(2024)., "Convergence of various computer aided systems for breast tumor diagnosis: a comparative insight,"Multimedia Tools and Applications,Spinger,July,. https://doi.org/10.1007/s11042-024-19620-y

4. Kumari, R., Das, Subhranil, Nigam, A., (2024) " Multimodal diagnosis of Alzheimer's disease based on volumetric and cognitive assessment", Multimedia Tools and Applications, https://doi.org/10.1007/s11042-024-19794-5 **[SCIE, impact factor 3]**

5. Bhosale, Y.H., Patnaik, K.Sridhar. (2023)., Bio-medical imaging (X-ray, CT, ultrasound, ECG), genome sequences applications of deep neural network and machine learning in diagnosis, detection, classification, and segmentation of COVID-19: a Meta-analysis & systematic review. *Multimedia Tools and Applications* ,Spinger pp: 1-54, doi: https://doi.org/10.1007/s11042-023-15029-1

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Solar Powered Car Ventilation System in association with Technotreon Innovation Academy	202211063324 05/05/2023	published
2	An automatic toilet door system and method thereof for maintaining hygiene in a toilet " in association with DAV School Hehal Ranchi.	202331090139 26/01/2024	published
3	Design- Robotic Cotton Boll Harvesting Gripper,1.Dr. Narendra Khatri 2. Mr. Chaitanya Sai Nikith Rambha 3.Dr. Sumit Pokhriyal 4.Dr. Sandeep Kumar 5.Dr. Rashmi Bangale 6.Dr. K.Sridhar Patnaik 7.Dr. Anupam Agrawal	387213-001 28/05/2023	published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Explainable AI for Hypoxic Ischemic Encephalopathy Detection using ultrasound images in Jharkhand Neonates: A Deep Learning Approach	PI	ICMR	40 Lacs	2024-25

Industry/Academia Collaborations: RIMS Ranchi

Targeted Application Area: AI and Medical Imaging

Achievements:

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)

Problem Statement:

The study focuses on the potential use of Explainable AI (XAI) in improving the detection of HIE using ultrasound in neonates born in Jharkhand, India.

Strategy/ Approach/ Technique/ Experiments used to solve

The study involves using appropriate deep Convolutional Neural Network (CNN) Models on ultrasound images. Later, hybrid models with transfer learning approach will be used to ensure better accuracy.

.

Applications:

➢ This approach builds trust and confidence in AI-based tools used in medical diagnosis and treatment. The use of XAI in improving the detection of HIE in this population can potentially save lives and improve long-term outcomes for neonates with HIE. At the later stage, we will build a user-friendly Computer-Aided interface for the doctors so that they can simply upload the image and get the result. Furthermore, XAI based tool will assist the doctor in distinguishing typical brain variations with HIE findings. Different modes of the proposed user interface are given as follows: 1. Offline: Lightweight IoT and smartphone (with or without internet) deployable XAI models for detection of HIE. 2. Online: A web application deployed on a Cloud server for the detection of HIE.

Group Members

Members from RIMS RANCHI

- Dr. Rajiv Ranjan, Radiology
- Dr. Rajeeva Mishra, Paedratics
- Dr. Rajesh Rao, Inmr-icmr

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Research Group - Advanced Device Analytics Group (ADAG)

- **Name of Principal Investigator/ Group Leader**: **Dr. Santashraya Prasad**

  Prof. Aminul Islam

  Dr. Kayan Koley

  Dr. Deepti Gola

- **Research Theme**: TCAD-Driven Design Space Exploration for High-Mobility Channel Materials in Sub-5nm Nodes

- **Broad Area of Research and Scope:**

➢ Device Physics and Quantum Modeling

➢ Advanced CMOS Device Architectures (HEMT, FinFET, GAAFET)

➢ High-Mobility Material Integration (Ge, InGaAs, 2D Materials)

➢ Process Simulation and Technology Optimization

➢ Performance Benchmarking and Reliability Analysis

➢ Compact Model Extraction for SPICE/EDA Tools

Schematic Representation of Broad Area of Research:
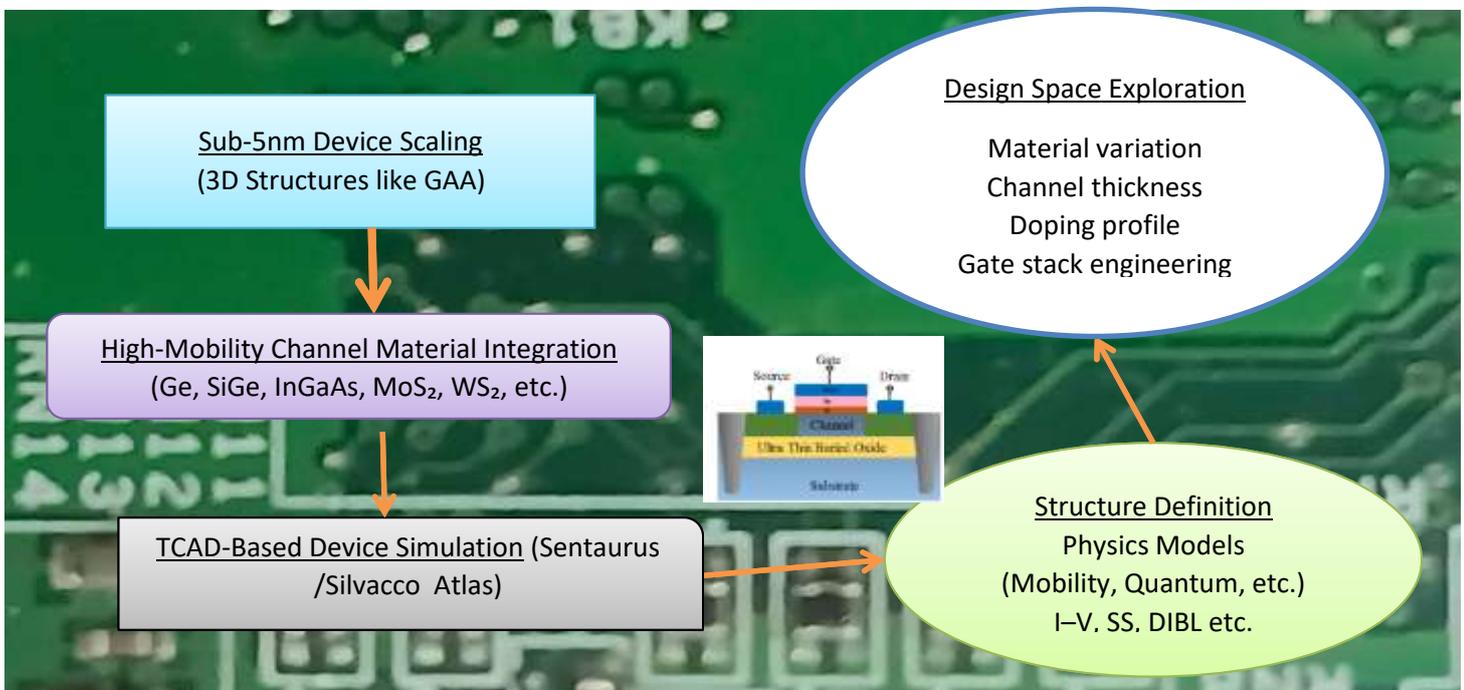
- **Total Number of Publications by the group: 250+ SCI papers**
- **Top 5 Article with impact factor: (Vancouver Style)**

S. No.	Publication Details: authors, title, journal name, year, vol, page: with clickable DOI	SCI/Scopus	IF
1.	Pratik Kumar Singh, Rohit Raj, Vivek Kumar, Monalisa Pandey, **Santashraya Prasad** & **Aminul Islam.** Comparative analysis and robustness study of logic styles. Microsystem Technology 28, 2807–2820 (2022). https://doi.org/10.1007/s00542-022-05378-6	**SCI**	**2.1**
2.	Mukesh Kumar, Gautam Bhaskar, Aditya Chotalia, Chhavi Rani, P Ghosh, Soumak Nandi, Shashank Kumar Dubey, Kalyan Koley and **Aminul Islam**, "Design, Simulation and Analog/RF Performance Evaluation of a	**SCI**	**2.767**

	Hetero- Stacked Source Dual Metal T-shaped Gate Tunnel-FET in Thermally Variable Environments" in Microsystem Technologies-Micro- and Nanosystems-Information Storage and Processing Systems, vol. 30, no. 4, pp. 1-17 - 525, May 2024, Publisher: Springer.https://doi.org/10.1007/s00542-024-05677-0,SharedIt: https://link.springer.com/article/10.1007/s00542-024-05677-0,		
3.	Deepti Gola, B. Singh, P.S.T.N. Srinivas and P. K. Tiwari, "Thermal Noise Models for Tri-gate Junctionless Transistors Including Substrate Bias Effects", IEEE Transactions on Electron Devices, vol. 67, no. 1, pp. 263-269, Jan. 2020, DOI: 10.1109/TED.2019.2953084	**IEEE**	**2.913**
4.	**Prasad, S.,** Dwivedi, A.K. & **Islam, A**. Characterization of AlGaN/GaN and AlGaN/AlN/GaN HEMTs in terms of mobility and subthreshold slope. Journal Computer Electron 15, 172–180 (2016) https://doi.org/10.1007/s10825-015-0751-8	SCI	**2.1**
5.	Pankaj Kumar, **Kalyan Koley**, Ashish Maurya, and Subindu Kumar, "Heavy ions and alpha particles irradiation impact on III-V broken-gap gate-all-around TFET," Microelectronics Reliability (Elsevier), Volume 158, Pages 115426, July 2024.	SCI	1.6

Industry/Academia Collaborations: Nil

Targeted Application Area: Low power Amplifier, High frequency communication systems, Memory devices , RF power amplifiers and fast-switching power supplies etc.

Achievements:

1.   **Project Tittle:- Thermal Analysis and lifetime estimation of AlGaN-GaN HEMTs.**

Brief Description of Projects

Problem Statement:

1.Project Tittle:- Thermal Analysis and lifetime estimation of AlGaN-GaN HEMTs. AlGaN/GaN-based high-electron-mobility transistors (HEMTs) are extensively utilized in high-power and high-frequency applications due to their superior power-handling capabilities. However, the high-power density results in substantial localized power dissipation, leading to a temperature rise within the device—a phenomenon often referred to as self-heating.

Applications:

-   High-frequency communication systems such as 5G base stations, satellite transceivers, and radar systems
-   Used in efficient power converters, electric vehicle chargers, and onboard power management systems.
-   RF power amplifiers and fast-switching power supplies.

Strategy/ Approach/ Technique/ Experiments used to solve

Heat generation, thermal conductivity, and temperature distribution are modeled under various bias and power circumstances using finite element method (FEM) simulations and TCAD (Technology Computer-Aided Design) tools. Accelerated stress testing, frequently at high temperatures and power levels, is used to investigate deterioration mechanisms including electromigration and thermal breakdown in order to estimate the lifespan of the device. The physics-based lifespan prediction models that incorporate material reliability metrics and thermal cycling are developed using the data from these tests. Furthermore, to improve heat dissipation and reduce self-heating at the source, sophisticated packaging methods and the incorporation of high thermal conductivity substrates (such as SiC or diamond) are investigated.

Barrier Layer

Channel Layer   2-DEG

Substrate Layer

S   G   D

N+   N+
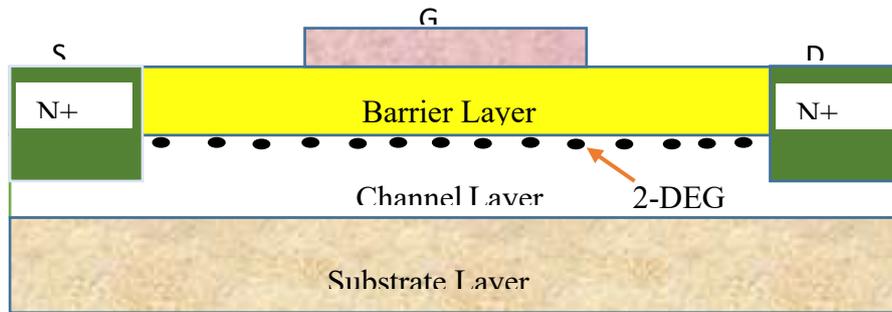
2. Project: A Reconfigurable Biomedical Processor tuned with AI based Smart Cap for Visually Impaired Persons

Problem Statement:

2.Project Tittle: A Reconfigurable Biomedical Processor tuned with AI based Smart Cap for Visually Impaired Persons. For people who are either completely blind or visually impaired, their day-to-day lifestyle needs assistance. Apart from this, the IQ levels of these people are quite a bit higher than normal individuals. But because of assistance, these blind / visually impaired persons may not use their IQ levels aptly. This is reducing the human resources of the country. It is high time to utilize the skills of blind / visually impaired persons by developing an assistive device for these persons and making their life a normal one.

Applications:

➢ Assistive Technology for the Visually Impaired
➢ Smart Healthcare and Rehabilitation
➢ AI-Powered Wearable Devices
➢ Human-Computer Interaction (HCI)
➢ Edge Computing in Biomedical Applications

Strategy/ Approach/ Technique/ Experiments used to solve

The idea behind this work is to use this technique to give the perception of objects by detecting them with sounds (using ultrasonic sensor) and informing the individual about them with actuators like vibrational actuator. The ultrasonic sensor mimics the sound produced and received by animals and the generated information is accordingly conveyed to the user after processing the signal received with the help of a microcontroller or microprocessor. In this work, we design and implement a smart cap which helps the blind and the visually impaired people to navigate freely by experiencing their surroundings. The scenes around the person will be captured by using a multiple number of cameras/sensors and the objects in the scene will be recognized/ detected. The earphones will give a voice output describing the recognized/detected objects.

Group Members

Research Group -Fiber Optics, Photonics and Rf Circuits

- **Name of Principal Investigator/ Group Leader : Dr. Somnath Sengupta**
  Group Members: Dr. Soumya Sidhishwari
                    Dr. Dileep Kumar Upadhyay
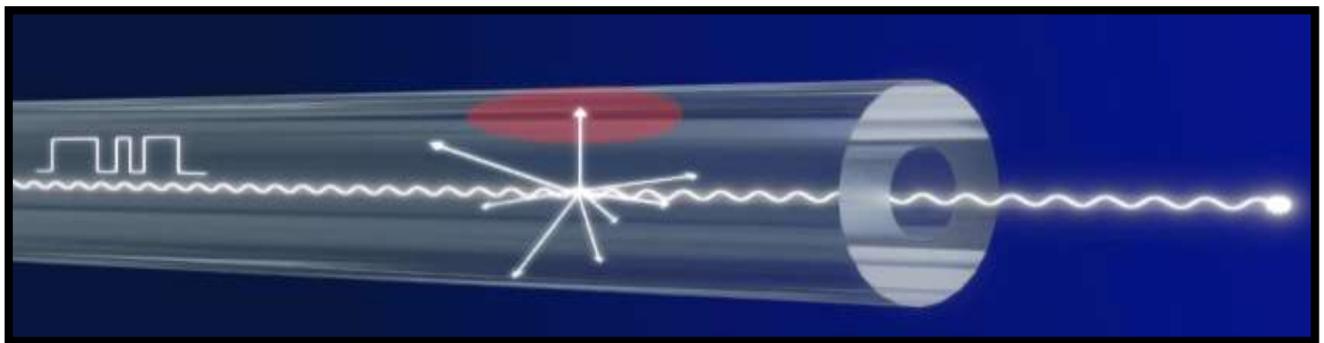   Dr. Megha Dadel
- **Research Theme**: Fiber optic sensors, optical communication and RF circuits
- **Broad Area of Research and Scope:**
  - Fiber Optic Sensors
  - Optical Communication
  - Signal Processing
  - RF Circuit Design

Schematic Representation of Broad Area of Research:

- **Total Number of Publications by the group:** Journals: 48, Conference: 49
- **Top 5 Article with impact factor:**

1. Ankita R, Sengupta S. Design of a microwave photonic filter using FBG-based delay lines and the FIR filtering technique for photonic integrated circuits. Applied Optics. 2025 Jan 13;64(3):507-16.   (IF: 1.7)

2. Shankar S, Upadhyay DK. A fractal monopole antenna with dual polarization reconfigurable characteristics for X-band applications. IEEE Access. 2023 Sep 1;11:95667-80. (IF: 3.4)

3. Mandal HN, Sidhishwari S. Theoretical investigation of the impact of apodized fiber Bragg grating and machine learning approaches in quasi-distributed sensing. Measurement Science and Technology. 2023 Jun 29;34(10):105101. (IF: 2.7)

4. Shankar S, Upadhyay DK. A compact maple leaf and triangular hybrid fractal shaped UWB frequency reconfigurable antenna with wide continuous tunable band notch. Iranian Journal of Science and Technology, Transactions of Electrical Engineering. 2023 Mar;47(1):301-16.(IF: 1.5)

5. Sengupta S, Ghorai SK, Biswas P. Design of superstructure fiber Bragg grating with efficient mode coupling for simultaneous strain and temperature measurement with low cross-sensitivity. IEEE Sensors Journal. 2016 Sep 19;16(22):7941-9. (IF: 4.325)

6. Mandal HN, Sidhishwari S. Apodized chirped fiber Bragg grating for measuring the uniform and non-uniform characteristics of physical parameters. Measurement. 2025 Jan 30;240:115606.   (IF: 5.2)

7. Dadel M, Parveen Z, Srivastava S. Compact UWB MIMO antennas with high isolation. IETE Journal of Research. 2023 Sep 7;69(7):4415-21.(IF: 1.3)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	A Frequency Reconfigurable Multiple-Input Multiple-Output (Mimo) Antenna System For Wireless Communication.	202431091330, Dated: 22nd Nov. 2024,	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Fiber Bragg Grating Interrogation using Microwave Photonic Filter with Machine Learning for Structural Health Monitoring" under the Under a Spoke Project	PI	TIH-IDEAS, ISI-Kolkata, NM-ICPS in Data Science, DST, GoI.	5 Lakhs (App.)	Sept. 22- Ongoing
Embedded Fiber Optic Sensor based Instrumentation System for Structural Health Monitoring"	Co-PI	ISRO, VSSC, RESPOND	16.36 Lakhs (App.)	Jan. 2009- Mar 2012
Working in a Sponsored Sub-Project as Co-PI, titled: "Big Data Analysis of 5G Network based Autonomous Drone Swarm System: A prototype" Under a Spoke Project	Co-PI	TIH-IDEAS, ISI-Kolkata, NM-ICPS in Data Science, DST, GoI.	14.4 Lakhs	Sept. 22- Ongoing

Industry/Academia Collaborations: CSIR-CGCRI

Targeted Application Area:

- Microwave photonic systems for sensing and communication
- FBG sensors for structural health monitoring
- RF circuits for wireless communication

Achievements:

- 2nd best Poster Presentation Award in the event 4th Research Colloquium (RESCOL-IV 15th – 17th July 2024) organized by BIT Mesra, awarded to Research Scholar.
- 2nd best prize for the Poster Presentation in the event Azadi ka Amrit Mahotsav Poster Competition organized by IIC at BIT Mesra on 17th August 2022, awarded to Research Scholar.
- First prize in the "Wireless Communication" track for presenting research work in the Research and Innovation Conclave 2023 at Dept. of E.C.E, BIT Mesra on 28th February 2023, awarded to Research Scholar.
- Best Paper award in International Conference on Intelligent Signal Processing and Effective Communication Technologies (IEEE- INSPECT), Gwalior, India, 2024

Brief Description of Projects :

i. Detection of acoustic waves using Microwave Photonic Sensor
   (Applications: Underwater applications, such as sonar, navigation, oceanography, marine life research, imaging and mapping of the seabed, depth measurement, and underwater acoustic communications)
ii. Fiber Optic based Quasi-Distributed Sensing Approach for Structural Health Monitoring using Machine Learning (Application: Structural Health Monitoring)
iii. RF and Microwave Component Design for wireless Communication (Wireless Communication)


Group Members

Research Group -ECE Microelectromechanical Systems(MEMS)

- **Name of Principal Investigator/ Group Leader**: Dr. Neela Chattoraj and Dr. Richa Mishra
- **Research Theme**: Microelectromechanical Systems (MEMS) based Sensor and Actuator
- **Broad Area of Research and Scope:**
  - Design and development of MEMS based devices for wearable electronics, defence and biomedical applications.
  - Theoretical and Simulation based approach
  - Fabrication and testing of MEMS devices

Schematic Representation of Broad Area of Research: Microelectromechanical Systems Devices
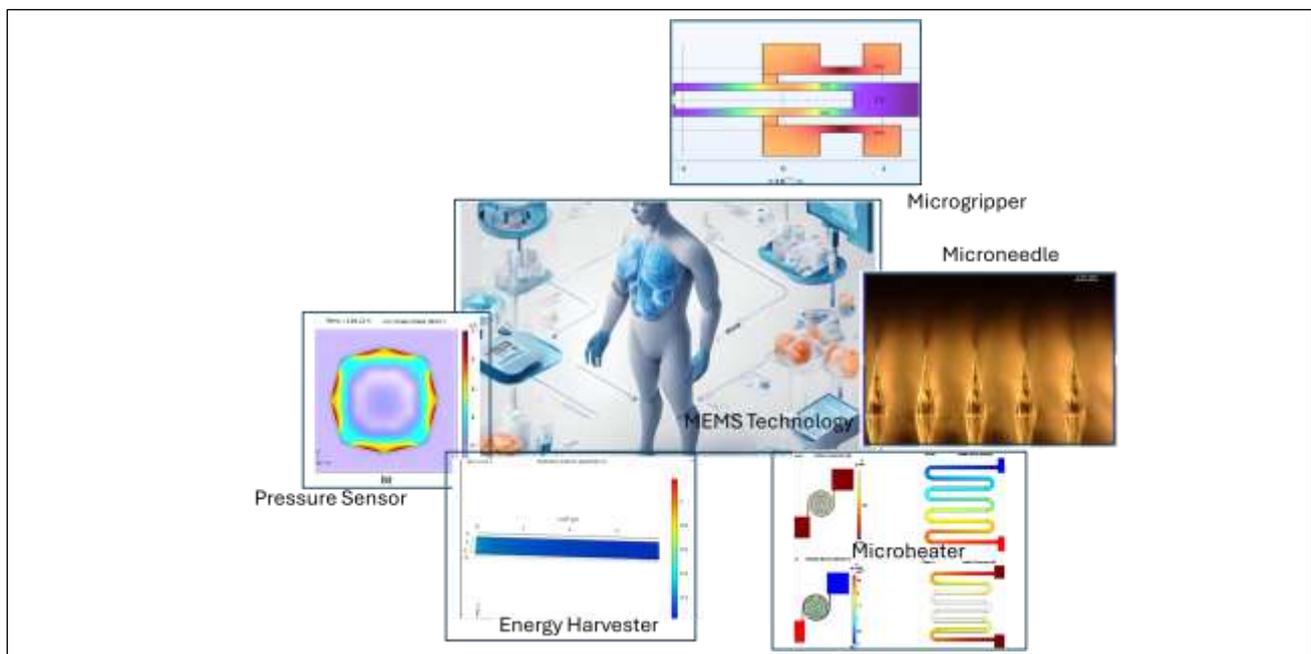
Total Number of Publications by the group: 30+

Top 5 Article with impact factor: (Vancouver Style)

1. Chanchala kumari and Neela Chattoraj. Performance analysis of TSA array with elliptical patch. International Journal of Microwave and Wireless Technologies IJMWT,2023,15(7)pp.1242-12509, Impact factor 1.4
2. Chanchala kumari and Neela Chattoraj. Miniaturized Vivaldi Tapered Slot Antenna (VTSA) with Microstrip to SIW Feed Structure for X Band. IETE Journal of Research (2024):70(2).pp1283-1291, Impact factor 1.5
3. Dipta Chaudhari, Sudip Kundu and Neela Chattoraj Design and analysis of MEMS based piezoelectric energy harvester for machine monitoring application .Microsystem Technologies .2019,25.pp1437-1446   Impact factor 2.06
4. Singh SK, Dwivedi M, Bhattacharyya TK, Mishra R. Simulation of hollow Ormocomp microneedles and fabrication by two photon photolithography. *Microsyst Technol*. 2025. https://doi.org/10.1007/s00542-025-05847-8 Impact factor - 1.6

5. Mishra R, Pramanick B, Maiti TK, Bhattacharyya TK. Glassy carbon microneedles—new transdermal drug delivery device derived from scalable C-MEMS process. *Microsyst Nanoeng.* 2018;4:38. https://doi.org/10.1038/s41378-018-0039-9 Impact factor 8.1

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Microneedle and Micropump based Fluid Delivery System, Richa Mishra, T.K.Bhattacharyya, T.K.Maiti.	Indian Patent No. 555 945(201831017171) of 7th May 2018	Granted
2	Rectangular dielectric resonator antenna (rdra) and method thereof, Prof. Parikshit Vasisht, Taruna Sharma, Prof. Sudhakar Ranjan, Prof.Moin Uddin, Dr. Neela Chattoraj, Dr. Atul Kathait, Prof. Varuna Tyagi((Apeejay Stya University)	202211027164, 2022	published
3	Multiband rectangular dielectric resonator antenna (rdra) for ultra wideband applications, Prof. Parikshit Vasisht, Ekta Bhayana, Prof. Sudhakar Ranjan, Prof. Moin Uddin, Dr. Neela Chattoraj, Taruna Sharma, Dr. Svav Prasad	202211027160, 2022	Published
4	Wideband rdra covering dielectric resonator, matching dielectric slab, copper gnd plane, chamfered edges, Dr.Parikshit Vasisht, Dr. Neela Chattoraj BIT Mesra , Prof. Sudhakar Ranjan, Dr. Atul Kathait, Anuranjan Sharma(Apeejay Stya University)	202211031081 , 2022	Published
5	Ultra -wide band hybrid antenna sensor for wban applications, .Parikshit Vasisht, Taruna Parashar, Prof. Sudhakar Ranjan, Dr. Atul Kathait, Dr. Neela Chattoraj, BIT Mesra, Jaimini Shah(Apeejay Stya University)	202211031056, 2022	Published
6	Multisegment ultra wide band antenna for 5g Prof. Parikshit Vasisht, Ekta Bhayana, Prof. Sudhakar Ranjan, Pro Moin Uddin, Dr. Neela Chattoraj,BIT Mesra, Taruna Sharma, D Svav Prasad(Apeejay Stya University)	202211026805, 2022	Published
7	Ultrawideband rrda with a bevel -shaped patch and a method of development thereof, Prof. Parikshit Vasisht, Prof. Sudhakar Ranjan, Dr. Atul Kathait, Anuranjan Sharma, Dr. Neela Chattoraj BIT Mesra, Robert Mark(Apeejay Stya University)	202211021299, 2022	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
MEMS based piezoelectric harvester for implanted medical devices, Dr. Neela Chattoraj	Co-PI	SERB	38,86,020(INR) 38.86lakh	2017-2020
Scalable assembly of Painless Hollow Microneedle Array, Dr. Richa Mishra	PI	SERB	29.15 Lacs	2022-2025 (ongoing)
High Speed Two Photon Polymerisation based Fabrication of Hollow Microneedles, Dr. Richa Mishra	PI	BIT Mesra	5 Lacs	2022-2024
DST FIST 2022 Sensor Fabrication Facility Fund, Dr. Neela Chattoraj, Dr. Richa Mishra	Co-PIs	DST	178 Lacs	2023-28

Industry/Academia Collaborations: 1. IISc Bangalore

2. IIT Kharagpur

3. CSIR National Metallurgical Laboratory, Jamshedpur

4. Pricon International, Jodhpur

5. Specialse Services, Mumbai

Targeted Application Area: MEMS Sensors and Actuators, Drug delivery devices, Wearable Healthcare devices

Achievements:

1. 1st Prize, Research Project Poster Exhibition & Presentation for SERB POWER project (2022-2025) titled "Scalable assembly of Painless Hollow Microneedle Array", National Technology Day-25, 7th & 8th May 2025, Birla Institute of Technology, Mesra awarded to Research Scholar-Sachin Kumar Singh, Supervisor - **Dr. Richa Mishra**

2. Winner Team (Vinod Belwanshi, **Neela Chattoraj, Richa Mishra**), IISc Bangalore INUP Hackathon 2025, Topic: SOI-MEMS Hackathon: Pioneering Innovations in Microelectromechanical Systems, Project – Development of MEMS Pressure Sensors Intended for Subsonic Wind Tunnel Applications, 2025

3. 1st position in Oral Presentation Award, "Hollow Microneedle Mediated Painless Drug Delivery, 4th Research Colloquium, BIT Mesra, 15th-17th July 2024, awarded to Research Scholar-Sachin Kumar Singh, Supervisor - **Dr. Richa Mishra**

4. 1st Position in Innovative Protype Product Model Display Exhibition & Competition on the occasion of "National Technology Day 24" , 8th May 2024 organized by Institution's Innovation Council, Birla Institute of Technology, Mesra awarded to Research Scholar-Sachin Kumar Singh, Supervisor - **Dr. Richa Mishra**

5. 'Best Paper Award at International Conference on Recent Trends in Engineering and Sciences (RTES-2024), India to **Dr. Richa Mishra** for paper "Feasibility study on hollow steel microneedle assembly and IOT enabled Peristaltic Pump", 29th-30th March, 2024, Birla Institute of Technology, Mesra, Ranchi.

Scalable assembly of Painless Hollow Microneedle Array

Problem Statement:

Microneedles (MNs) are employed for the painless transdermal delivery of drugs, effectively addressing the limitations associated with traditional methods. This work is supported by Department of Science and Technology, India Scientific and Engineering Research Board Promoting Opportunities for Women in Exploratory Research (SERB POWER grant) entitled, " Scalable assembly of Painless Hollow Microneedle Array", 2022-25.

Applications:

➢ Transdermal Drug delivery
➢ Painless Injection
➢ Self administrable vaccination

Graphical Abstract
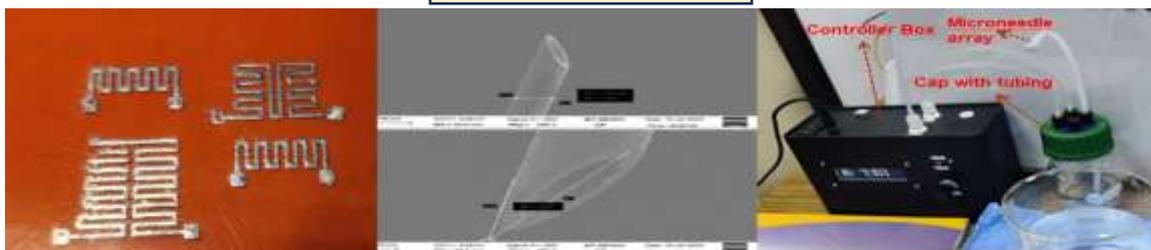
Steps of hollow steel microneedle fabrication

- MN sample manufacturing
- Incoming Raw material inspection
- Raw material issue(size, quality etc)
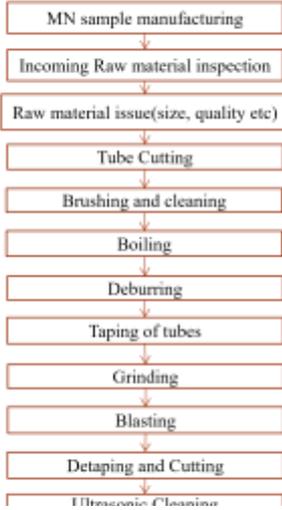- Tube Cutting
- Brushing and cleaning
- Boiling
- Deburring
- Taping of tubes
- Grinding
- Blasting
- Detaping and Cutting
- Ultrasonic Cleaning

Graphical Abstract

Figure 1

Figure 2

Figure 3

MEMS based piezoelectric harvester for implanted medical devices

Problem Statement:

In this project, a MEMS based energy harvester device integrated with efficient power conditioning system was developed. The main focus of research was on 1) design of MEMS based PZT cantilever structure for maximum power output at low frequency vibration which is available within the human body and 2) design of a monolithic power conditioning circuit to extract the generated electrical power from the piezoelectric cantilever and make it suitable for charging a battery.

Applications:

- Energy harvesting
- Battery charging
- Energy source for implanted devices like pacemaker

Strategy/ Approach/ Technique/ Experiments used to solve

1. Selection of biocompatible piezoelectric material
2. Power Conditioning circuit

Group Members

Research Group -Microwave Imaging

- **Name of Principal Investigator/ Group Leader**: Dr. Prajna Parimita Dash
- **Research Theme**:
   1. Microwave Imaging
   2. Image Analysis
   3. Artificial Intelligence and Machine Learning
- **Broad Area of Research and Scope:**
- Artificial Intelligence and Machine Learning for Biomedical Applications.
- RF & Microwave Circuit Design for Biomedical Applications.
- Medical Image Analysis

Schematic Representation of Broad Area of Research:
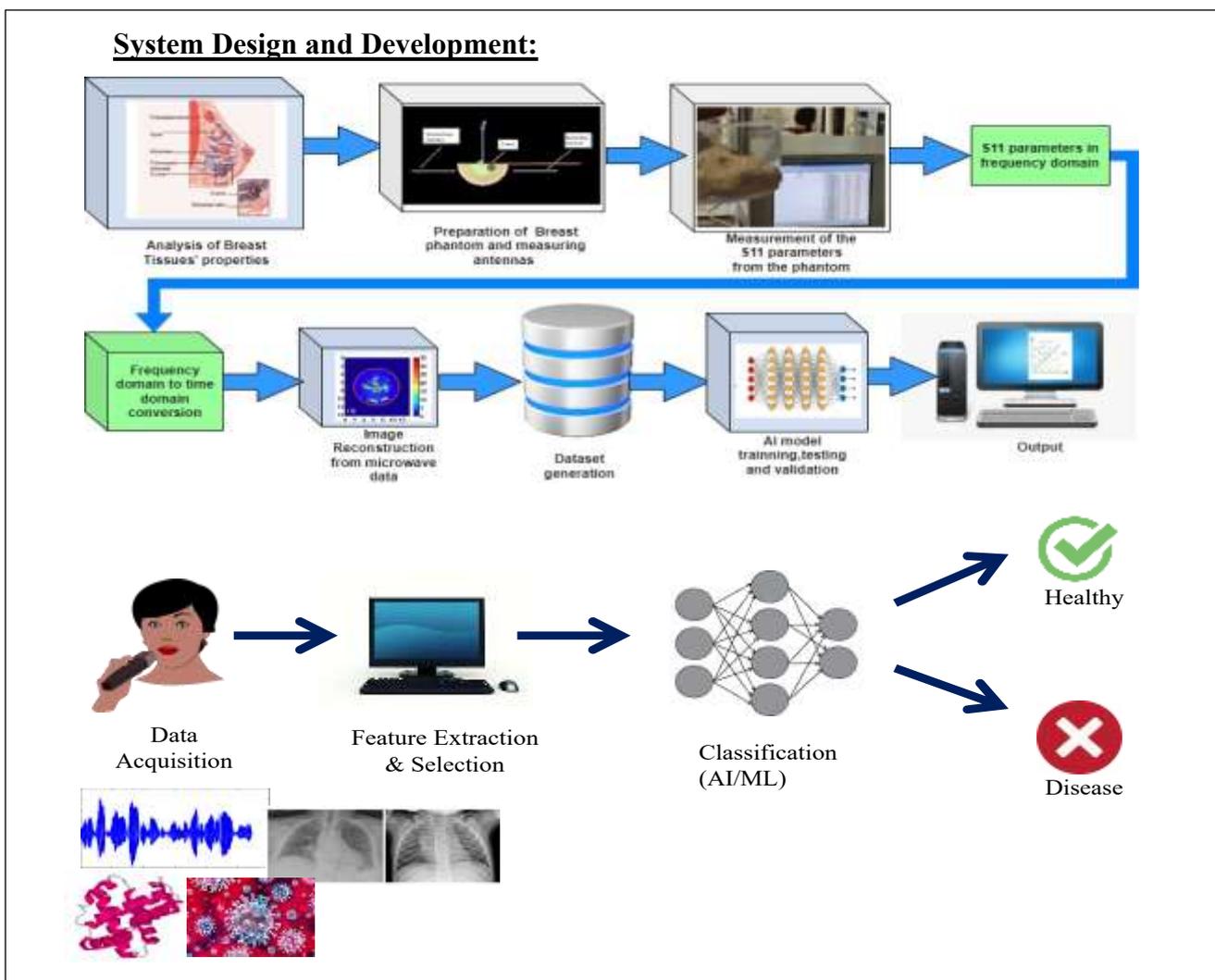
Total Number of Publications by the group: Journal: 112

Top 5 Article with impact factor: (Vancouver Style)

1. Karan B., Sahu S. S., Orozco-Arroyave J R, Mahto K., Non-negative matrix factorization-based time-frequency feature extraction of voice signal for Parkinson's disease prediction. Computer Speech and Language. 2021; 69:101216.
2. Srivastava, Saurabh, Prajna Parimita Dash, Deepak Kumar Rout, Dinesh Madhukar Chandwadkar, Sunita Pandit Ugale. Constellation design for PD-NOMA-based mmWave inter-satellite communication. Computers and Electrical Engineering.2024;116:109187.
3. Chanchala Kumari and Neela Chattoraj. Miniaturized Vivaldi Tapered Slot Antenna (VTSA) with Microstrip to SIW Feed Structure for X Band. IETE Journal of Research. 2024:70(2):1283-9.
4. Sashi Shankar, Dileep Kumar Upadhyay, A Fractal Monopole Antenna with Dual Polarization Reconfigurable Characteristics for X-Band Application.,IEEE Access. 2023; 11:95667-80.
5. Vupputuri A, Ashwal S, Tsao B, Ghosh N. Ischemic stroke segmentation in multi-sequence MRI by symmetry determined superpixel based hierarchical clustering. Computers in Biology and Medicine. 2020 Jan 1;116:103536.

Patents by the group:

Sl. N	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	A photo biomodulation device for attenuating obesity, and method thereof; Tuhin Mukherjee, Ashok Kumar Pattnaik, Sitanshu Sekhar Sahu	Application No:202331057280 Dt: 25/08/2023	Granted (Patent No. 564886)
2	A Piezoelectric based Energy Harvesting System and Method There of; Sitanshu Sekhar Sahu, Sweta Kumari, Subrat Kumar Swain, Sudhansu Kumar Mishra, Mayank Singh.	Application No: 202331057064 Dt: 25/08/2023	Published
3	An intelligent irrigation system and method thereof; Prity Soni, Rohit Kumar, Sudhansu Kumar Mishra, Subrat Kumar Swain, Sitanshu Sekhar Sahu.	Application No: 202331060280 Dt: 07/09/2023	Published
4	An autonomous vehicle navigation system and method thereof; Ankit Kumar, Abhishek Thakur, Sudhansu Kumar Mishra, Subrat Kumar Swain, Sitanshu Sekhar Sahu.	Application No: 202331066870 Dt: 05/10/2023	Published
5	Rectangular dielectric resonator antenna (RDRA) and method thereof; Parikshit Vasisht, Taruna Sharma, Sudhakar Ranjan, Moin Uddin, Neela Chattoraj, Atul Kathait, Varuna Tyagi.	202211027164 2022	Published
6	Multiband rectangular dielectric resonator antenna (RDRA) for ultra-wideband applications; Parikshit Vasisht, Ekta Bhayana, Sudhakar Ranjan, Moin Uddin, Neela Chattoraj, Taruna Sharma, Svav Prasad.	202211027160 2022	Published
7	Wideband rdra covering dielectric resonator, matching dielectric slab, copper gnd plane, chamfered edges; Parikshit Vasisht, Neela Chattoraj, Sudhakar Ranjan, Atul Kathait, Anuranjan Sharma.	202211031081 2022:	Published
8	Ultra -wide band hybrid antenna sensor for WBAN applications Parikshit Vasisht, Taruna Parashar, Sudhakar Ranjan, Atul Kathait, Neela Chattoraj, Jaimini Shah.	202211031056 2022	Published
9	Multisegment ultra-wide band antenna for 5G; Parikshit Vasisht, Ekta Bhayana, Sudhakar Ranjan, Moin Uddin, Neela Chattoraj, Taruna Sharma, Dr. Svav Prasad.	202211026805 2022	Published

10	Ultrawideband RRDA with a bevel -shaped patch and a method of development thereof; Parikshit Vasisht, Sudhakar Ranjan, Atul Kathait, Anuranjan Sharma, Neela Chattoraj, Robert Mark.	202211021299 2022	Published
11	A frequency reconfigurable multiple-input multiple-output (MIMO) antenna system for wireless communication; Sashi Shankar, Dileep Kumar Upadhyay.	Application No. 202431091330 Dt:22/2224	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Computational identification and validation of genome wide protein-protein interaction network in rice and rice blast	Sitanshu Sekhar Sahu (PI)	SERB, DST, Govt. of India	21.626	3.6 years
Electroencephalogram based Sleep Stages Detection using Advance Wavelet Techniques	Sitanshu Sekhar Sahu (Co-PI)	NPIU, MHRD, Govt. of India	14.42	2 years
Development of end-to-end speech-based AI system for Parkinson's Disease Prediction	Sitanshu Sekhar Sahu (PI)	IDEAS, TIH, ISI Kolkata	5.14	2.10 years
MEMS based piezoelectric harvester for implanted medical devices	N. Chattoraj (Co-PI)	SERB	38.86	3 years
Big Data Analysis of 5G Network based Autonomous Drone Swarm System: A prototype	D. K. Upadhyay (Co-PI)	IDEAS, TIH, ISI Kolkata	14.4	2.10 years

Industry/Academia Collaborations:
- Research collaboration with DigiToad Technologies Pvt. Ltd., Bangalore and Voice and Speech Systems, Bangalore
- Dr. Juan Rafael Orozco-Arroyave, School of Engineering, Universidad de Antioquia, Medellín, Colombia
- Dr. Sumit Chakravarty, Department of Electrical Engineering, Kennesaw State University, USA
- Dr Nirmalya Ghosh, Associate Professor, Department of EE, IIT Kharagpur
- Dr Sobhan Kanti Dhara, Assistant Professor, Department of ECE, NIT Rourkela
- Dr Rachana Sathish, Senior Data Scientist, GE Healthcare
- Dr Padam Priyal Soundararajan, Senior Manager, MathWorks India
- Dr. Xiang Chen, University of Windsor (UOW) Canada, Intelligent Control.
- Dr. Haewon Byeon, Professor in the Department of AI-software at Inje University and Department of Digital Anti-Aging Healthcare at the Graduate School (BK-21)

Targeted Application Area:
- Healthcare Industries, Clinicians/ healthcare agencies and Tele-health monitoring
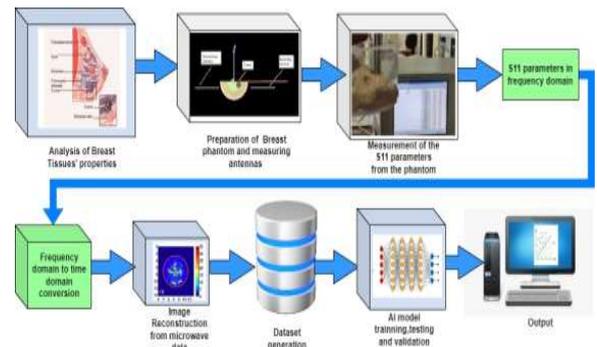
Problem Statement:

Breast cancer is a significant global health concern, and early detection is crucial for successful treatment and improved patient outcomes. Though some radiation-based diagnosis techniques like magnetic resonance imaging (MRI), computed tomography (CT), positron-emission tomography (PET) etc. has been widely used for breast tumor detection, the microwave imaging-based detection could be a safe and easily accessible technique. The development of AI-based noninvasive breast tumor detection technology will offer several distinct advantages over traditional MRI-based techniques.

Strategy/ Approach/ Technique/ Experiments used to solve

The following approach will be followed to develop the system: 1. Development of breast phantom. 2. Designing of microwave antenna 3. Development of the imaging system 4. collection of the receiver antenna data 5. Pre processing and annotation 6. AI Algorithm Development 7. System Integration and 8. Performance Evaluation and Optimization

2. Problem Statement:

Parkinson's disease (PD) is a degenerative disorder of the central nervous system and affects the lifestyle of millions of people worldwide. The clinical diagnosis is clear-cut in the advanced stages of the disease when the symptoms are full-blown. PD detection in multiclass and multilingual framework with severity level remains unexplored However, analyzing the speech dysarthria leads to early diagnosis of Parkinson's disease which help in the easy management and treatment planning.

Strategy/ Approach/ Technique/ Experiments used to solve

Advanced signal processing techniques along with feature embeddings are used for effective features extraction (Language independent) of speech signal relevant to PD. Machine learning/Deep learning models/ Large language models are used to accurately predict the PD and its severity.

Applications:

Applications:

➢ Healthcare Industries
➢ Clinicians/ healthcare agencies

Graphical Abstract

Applications:

Applications:

➢ Healthcare Industries
➢ Clinicians/ healthcare agencies
➢ Tele-health monitoring

Group Members

125

Research Group - Multi-Signal Intelligence and Recognition (MSIRG)

- **Name of Principal Investigator/Group Leader:** Dr. S. K. Dash
- **Name of Co-Principal Investigators:** Dr. S. S. Solanki
                                                                    Dr. S. S. Tripathy
- **Research Project Title**: "AI-Based Acoustic Surveillance System for Wild Animal Trespassing Detection in Rural India"
- **Research Theme**:
  This research focuses on the design and development of an AI-powered acoustic surveillance system tailored to detect and classify wild animal vocalizations, particularly from species like Tigers, Asian elephants, Wild boars, and Sloth bears, to prevent their trespassing into rural and agricultural areas of India. Leveraging deep learning techniques, low-power edge computing, and real-time alert mechanisms, the project aims to offer a cost-effective, scalable, and community-centric solution to reduce human-wildlife conflict and enhance forest-fringe area safety.
- **Broad Area of Research and Scope:**
  - Scale up to cover more species and more zones.
  - Detect illegal logging or Poaching in Indian forests.
  - Integrate with national forest management systems.
  - Enable predictive wildlife movement analysis via AI.
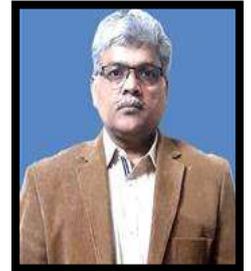
Schematic Representation of Broad Area of Research:
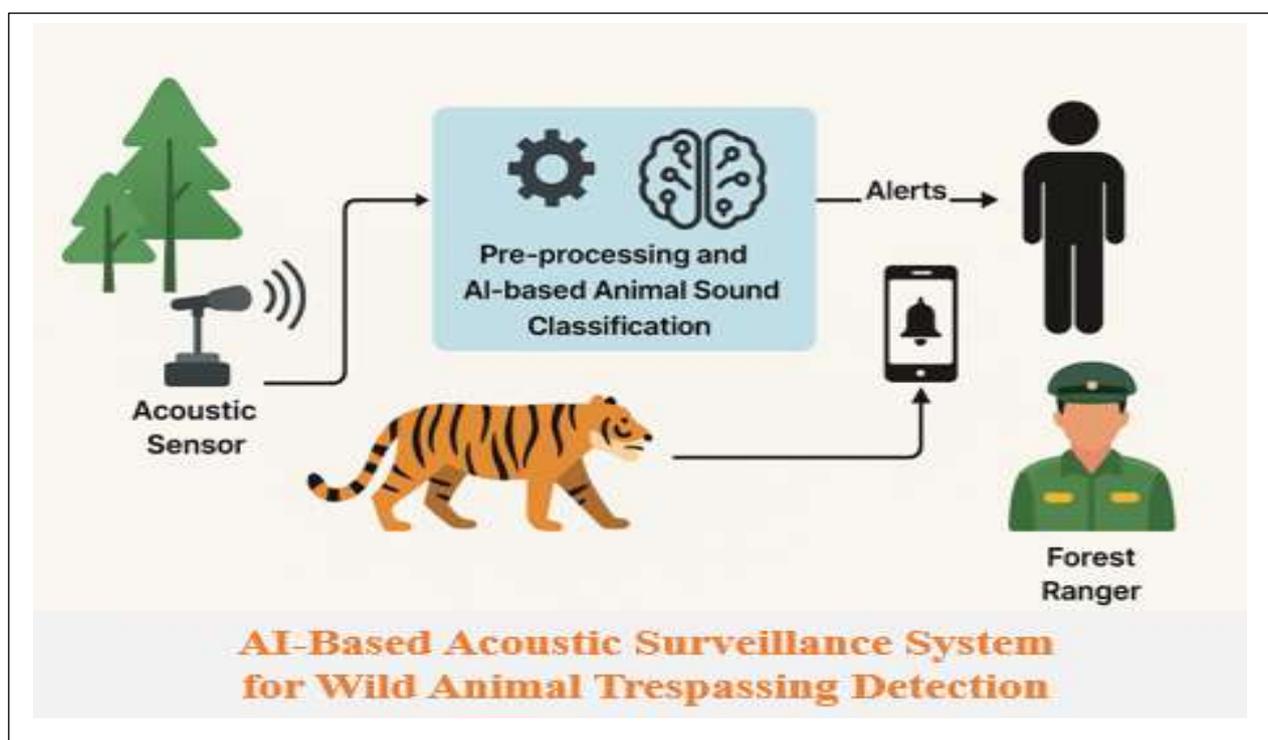
AI-Based Acoustic Surveillance System for Wild Animal Trespassing Detection

1. Problem Statement:

Parkinson's disease (PD) is a degenerative disorder of the central nervous system and affects the lifestyle of millions of people worldwide. The clinical diagnosis is clear-cut in the advanced stages of the disease when the symptoms are full-blown. PD detection in multiclass and multilingual framework with severity level remains unexplored However, analyzing the speech dysarthria leads to early diagnosis of Parkinson's disease which help in the easy management and treatment planning.

Applications:

Applications:

➢ Healthcare Industries
➢ Clinicians/ healthcare agencies
➢ Tele-health monitoring

- **Total Number of Publications by the group:**
- **Top 5 Articles with impact factor:**

1. S. K. Dash, S. S. Solanki, and S. Chakraborty, "S. K. Dash, S. S. Solanki, and S. Chakraborty, "Deep Convolutional Neural Networks for Predominant Instrument Recognition in Polyphonic Music Using Discrete Wavelet Transform," Circuits, Systems, and Signal Processing, vol. 43, no. 7, pp. 4239–4271, Mar. 2024. https://doi.org/10.1007/s00034-024-02641-1, IF: 1.8

2. S. K. Dash, S. S. Solanki, and S. Chakraborty, "A Comprehensive Review on Audio based Musical Instrument Recognition: Human-Machine Interaction Towards Industry 4.0," Journal of Scientific & Industrial Research, vol. 82, no. 01, pp. 26-37, Jan. 2023. https://doi.org/10.56042/jsir.v82i1.70251, IF: 0.555

3. Kumar, A., Karan, B., Solanki, S. S., Chandra, M., & Singh, D. K. (2024). Automatic tuning of radio stations based on listener's preference using Software Defined Radio and MATLAB. Engineering Applications of Artificial Intelligence, 137, 109117–109117. https://doi.org/10.1016/j.engappai.2024.109117, IF: 7.5

4. Upadhyay, S., Tripathy, S.S. Bidirectional cascaded multimodal attention for multiple choice visual question answering. Machine Vision and Applications 36, 41 (2025). (SCIE) https://doi.org/10.1007/s00138-025-01661-4, IF: 2.4

5. Reva Nagi, Sanjaya Shankar Tripathy, 'Deep convolutional neural network based disease identification in grapevine leaf images", Multimedia Tools and Applications (indexed in SCIE) , DOI: https://doi.org/10.1007/s11042-022-12662-0, IF: 3.0

Project Proposal Details:

- **Research Project Title**: "AI-Based Acoustic Surveillance System for Wild Animal Trespassing Detection in Rural India"

- **Brief Description of Projects :**
  - Human-wildlife conflict poses a serious threat to both rural livelihoods and wildlife conservation in India, especially in forest-fringe villages located near protected reserves and national parks. Incidents involving tigers, elephants, wild boars, and sloth bears frequently lead to crop destruction, livestock loss, and even human fatalities.
  - This project aims to develop an AI-powered acoustic surveillance system capable of detecting wild animal intrusions in real time using their unique vocalizations. By deploying a network of solar-powered acoustic sensors integrated with deep learning models, the system will capture, analyze, and classify animal sounds (e.g., roars, trumpets, growls) to generate early warning alerts for villagers and forest officials.
  - Using publicly available wildlife acoustic datasets and region-specific sound recordings, the system will be trained using advanced models such as CNNs, LSTMs, and Transformers optimized for edge devices. The alerts will be disseminated through SMS, mobile apps, or loudspeakers in local languages, ensuring community accessibility and fast response.

127

- This project has the potential to significantly reduce human-wildlife conflict, safeguard agricultural produce, and support wildlife conservation efforts. It aligns with the broader objectives of Digital India, Wildlife Protection, and Rural Safety Infrastructure development.

- **Problem Statement:**
  - India witnesses thousands of incidents of wild animal intrusions into rural and agricultural regions every year, leading to crop destruction, property damage, injuries, and loss of human and animal life. Forest-fringe communities, particularly in states like Odisha, West Bengal, Jharkhand, Chhattisgarh, and Karnataka, face increasing threats from species such as tigers, Asian elephants, wild boars, and sloth bears.
  - Despite various mitigation efforts, real-time and early-warning systems for detecting wild animal movements remain inadequate, cost-intensive, and often reactive rather than proactive. Traditional surveillance methods, like manual patrolling, camera traps, or electric fencing, are either delayed, easily bypassed, or not feasible at scale.
  - Meanwhile, wild animals produce distinctive acoustic signatures during movement, communication, or distress. These audio cues remain underutilized in detection systems due to the absence of robust, scalable AI-based solutions.
  - Thus, there is a critical need for a cost-effective, scalable, and autonomous acoustic surveillance system that can detect the presence of specific wild animals in real time using deep learning algorithms on bioacoustics data and trigger immediate alerts to safeguard human lives and property in rural India.

Group Members

Research Group -Nano Device Simulation

- ▪ **Name of Principal Investigator/ Group Leader**: **Dr. Kalyan Koley**
- ▪ **Research Theme**: Reliability Analysis, Modeling and Simulations of MOSFET
- ▪ **Broad Area of Research and Scope:**
- ➢ Reliability Analysis
- ➢ Modelling and Simulations of Emerging MOSFET
- ➢ CMOS RF Modeling and Simulations

Schematic Representation of Broad Area of Research:
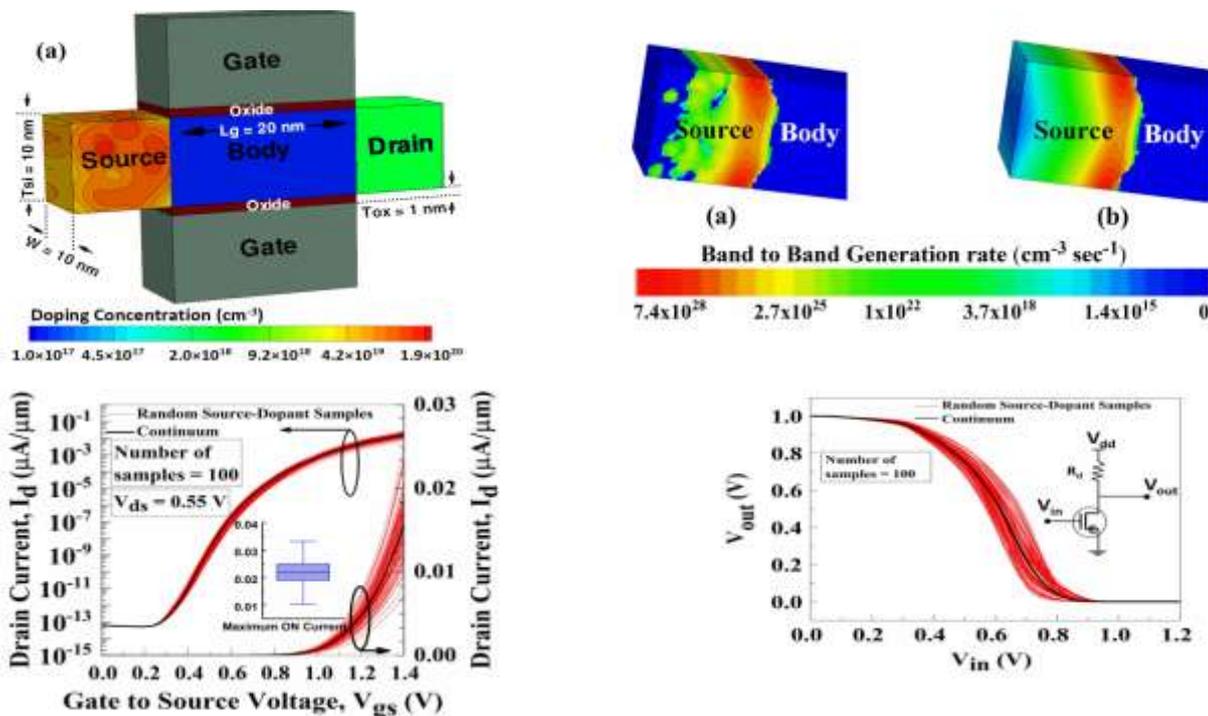
Total Number of Publications by the group: Journal – 40; Conference – 11; Book – 01

Top 5 Article with impact factor: (Vancouver Style)

1. Koley K, Dutta A, Saha SK, Sarkar CK. Analysis of high-κ spacer asymmetric underlap DG-MOSFET for SOC application. IEEE Trans Electron Devices. 2015 Jun;62(6):1733-8.
2. Koley K, Dutta A, Saha SK, Sarkar CK. Effect of source/drain lateral straggle on distortion and intrinsic performance of asymmetric underlap DG-MOSFETs. IEEE J Electron Devices Soc. 2014 Nov;2(6):135–44.
3. Koley K, Dutta A, Saymal B, Saha SK, Sarkar CK. Subthreshold analog/RF performance enhancement of underlap DG FETs with high-k spacer for low power applications. IEEE Trans Electron Devices. 2013 Jan;60(1):63–9.
4. Kumar P, Koley K, Askari SS, Maurya A, Kumar S. Assessment of Negative Bias Temperature Instability due to Interface and Oxide Trapped Charges in Gate-all-around TFET Devices. IEEE Trans Nanotechnol. 2023 Mar;22:157-65.
5. Maurya A, Koley K, Mech BC, Kumar J, Kumar P. Investigation of Source Region's Random Doping Fluctuation Effects on Analog and RF Performance in All-Si DG-TFET. IEEE Trans Electron Devices. 2022 Sep;69(9):5330-6.

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	**Title :**A System and Method for Analysing Radiation Effect on Gate-All-Around Tunnel Transistor **Inventors :** Pankaj Kumar, Kalyan Koley, Subindu Kumar	Application Number 202411028791 Application Filing Date 09/04/2024	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
RF, Noise, and Harmonic Distortion Analysis of Structurally Modified Germanium on Insulator MOSFETS	PI	Department of Science and Technology, Government of India	35 (Thirty-Five Lakhs)	5 years (February 2017 – January 2022)

Industry/Academia Collaborations: NA
Targeted Application Area: VLSI
Achievements: Published Research article in Highly cited Journal

Brief Description of Projects : Reliability analysis of Tunnel FET

Problem Statement:

Negative Bias Temperature Instability (NBTI) is a key reliability concern for analog and digital circuits using advanced devices like gate-all-around (GAA) Tunnel FETs (TFETs). This study investigates NBTI effects on GAA TFETs under varying stress durations and temperatures. Unstressed device characteristics are calibrated with experimental data for accurate modeling. Charge trapping mechanisms—oxide, interface, and channel—are thoroughly analysed. Notably, NBTI does not degrade the sub-threshold slope, highlighting the potential of TFETs for reliable circuit applications.

Strategy/ Approach/ Technique/ Experiments used to solve

Use TCAD device simulator to simulate the device under different conditions.

Applications:

- Helps evaluate and improve the reliability of analog and digital circuits using TFET devices under prolonged operation.
- Enables the study of TFET behavior under different stress durations and temperatures to predict long-term performance.
- Assists in optimizing TFET design by understanding how charge trapping affects device characteristics over time.
- Provides insights essential for designing durable, energy-efficient semiconductor devices for future technologies. Medical devices and Orthopedics, Assistive technology
- Healthcare and rehabilitation centers foramputees
- Physical therapy and mobility assistance -sports, elderly and disability services
- Prosthetics manufacturing and development Retail and consumer good.

Graphical Abstract

130
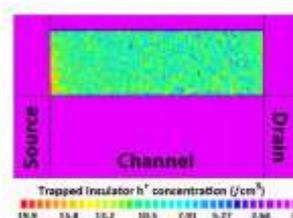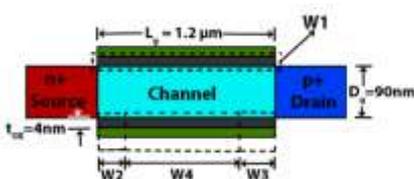
Research Group -Signal Processing and Computer Vision

- **Name of Principal Investigator/ Group Leader**: Dr. Sitanshu Sekhar Sahu
- **Research Theme**: Acoustic, Speech and Image Analysis
- **Broad Area of Research and Scope:**
  - Speech and Acoustic Pathology
  - Medical Image Analysis
  - Artificial Intelligence and Machine Learning
  - Genomic Signal Processing and Bioinformatics

Schematic Representation of Broad Area of Research

Total Number of Publications by the group:

Journal: 58   Conference: 80   Book Chapter: 10

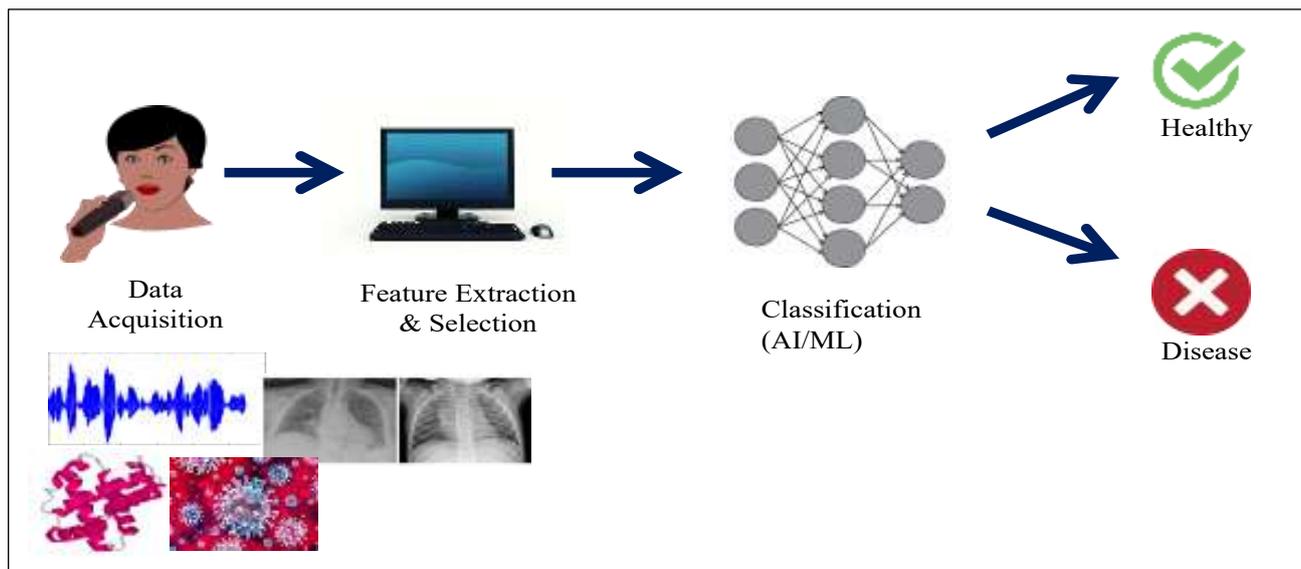## Top Articles with impact factor: (Vancouver Style)

1. Karan B., **Sahu S. S.**, Orozco-Arroyave J R, Mahto K., Non-negative matrix factorization-based time-frequency feature extraction of voice signal for Parkinson's disease prediction. Computer Speech and Language. 2021; 69:101216.

2. Karan B., **Sahu S. S.**, Mahto K. Parkinson disease prediction using intrinsic mode function-based features from speech signal. Biocybernetics and Biomedical Engineering. 2020; 40: 249-264.

3. Karan B., Mahapatra S., **Sahu S S.**, Pandey D M., Chakravarty S. Computational Models for Prediction of Protein-Protein Interaction in Rice and Magnaporthe grisea. Frontiers in Plant Science.2023; 13:5656,

4. **Vupputuri A**, Ashwal S, Tsao B, Ghosh N. Ischemic stroke segmentation in multi-sequence MRI by symmetry determined superpixel based hierarchical clustering. Computers in Biology and Medicine. 2020 Jan 1;116:103536.

5. **Vupputuri A**, Ghosh N. Multi-view iterative random walker for automated salvageable tissue delineation in ischemic stroke from multi-sequence MRI. Journal of Neuroscience Methods. 2021 Aug 1;360:109260.

6. Srivastava S., **Dash P. P.** ML-based reconfigurable symbol decoder: An alternative for next generation communication systems. Engineering Applications of Artificial Intelligence, 2023; 114: 105123

131

7. Shah V H, **Dash P. P.** Two Stage Self-Adaptive Cognitive Neural Network for Mixed Noise Removal from Medical Images. Multimedia Tools and Applications. 2023, 1-23.
8. **Sinha R.K.,** Sahu S.S. Adaptive Firefly Algorithm Based Optimized Key Generation for Image Security. Journal of Intelligent & Fuzzy Systems. 2019; 36 (5):4437-4447
9. Raju D, Eleswarapu L, Pranav M S, **Sinha R.K**. Multi-level image security using elliptic curve and magic matrix with advanced encryption standard. Multimedia Tools and Applications 2022.

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	A photo biomodulation device for attenuating obesity, and method thereof; Tuhin Mukherjee, Ashok Kumar Pattnaik, **Sitanshu Sekhar Sahu**	Application No:202331057280 Dt: 25/08/2023	Granted (Patent No. 564886)
2	A Piezoelectric based Energy Harvesting System and Method There of; **Sitanshu Sekhar Sahu**, Sweta Kumari, Subrat Kumar Swain, Sudhansu Kumar Mishra, Mayank Singh	Application No: 202331057064 Dt: 25/08/2023	Published
3	An intelligent irrigation system and method thereof; Prity Soni, Rohit Kumar, Sudhansu Kumar Mishra, Subrat Kumar Swain, **Sitanshu Sekhar Sahu**	Application No: 202331060280 Dt: 07/09/2023	Published
4	An autonomous vehicle navigation system and method thereof; Ankit Kumar, Abhishek Thakur, Sudhansu Kumar Mishra, Subrat Kumar Swain, **Sitanshu Sekhar Sahu**	Application No: 202331066870 Dt: 05/10/2023	Published
5	Switching System Operating Automatically Based on Real Time Light Intensity in all Weather Condition" **Rupesh Kumar Sinha,** Sandeep Singh Solanki, Rajesh Kumar, Preeti Lakhani, Hari Mohan Saini, Deepak Chhabra.	Application No: 202211056938 Dt: 04.10.2022	Published
6	An Interactive artificial Intelligence-based child surveillance device, Gajendra Kant Mishra, **Rupesh Kumar Sinha**, Kiran Anisha, Chouhan Ashish	Application No: 202431004558 A Dt: 09.02.2024	Published
7	An intelligent traffic control system, a communication system and method thereof, for prioritizing emergency vehicles, Nahar Jainam, Priyank Kumar, Sinha, **Rupesh Kumar Sinha**	Application No: 202431004557 A Dt: 09.02.2024	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Computational identification and validation of genome wide protein-protein interaction network in rice and rice blast	Sitanshu Sekhar Sahu (PI)	SERB, DST, Govt. of India	21,62,600	3.6 years
Electroencephalogram based Sleep Stages Detection using Advance Wavelet Techniques	Sitanshu Sekhar Sahu (Co-PI)	NPIU, MHRD, Govt. of India	14,42,000	2 years
Development of end-to-end speech-based AI system for Parkinson's Disease Prediction	Sitanshu Sekhar Sahu (PI)	IDEAS, TIH, ISI Kolkata	5,14,000	2.10 years
AI based interactive toy for child surveillance	Rupesh Kumar Sinha (Co-PI)	IDEAS, TIH, ISI Kolkata	5,69,000	2.10 years

Industry/Academia Collaborations:

- Research collaboration with DigiToad Technologies Pvt. Ltd., Bangalore and Voice and Speech Systems, Bangalore
- Dr. Juan Rafael Orozco-Arroyave, School of Engineering, Universidad de Antioquia, Medellín, Colombia
- Dr. Sumit Chakravarty, Department of Electrical Engineering, Kennesaw State University, USA
- Dr Rachana Sathish, Senior Data Scientist, GE Healthcare
- Dr Padam Priyal Soundararajan, Senior Manager, MathWorks India
- Dr Nirmalya Ghosh, Associate Professor, Department of EE, IIT Kharagpur
- Dr Sobhan Kanti Dhara, Assistant Professor, Department of ECE, NIT Rourkela
- Dr. Xiang Chen, University of Windsor (UOW) Canada

Targeted Application Area:

- Development of Signal Processing and Machine Learning based algorithms for solving problems related to speech and acoustic pathology.
- Development of Machine Learning based algorithms for solving Medical Imaging problems.
- Data & Image Security

Achievements:

Sitanshu Sekhar Sahu

- Received Postdoctoral Fellowship (2012-2014) from Oklahoma State University, USA.
- Received DFAIT-GSEP (October, 2008 – March, 2009) scholarship, Canadian Government
- Jury Member, National wide Edge AI Innovation Challenge in Collaboration with DigiToad Technologies Pvt. Ltd. and ST Microelectronics, 2024.

Vupputuri A

- Gandhian Young Technological Innovation (GYTI) Appreciation Award- 2021 by SRISTI and Dept. of Science and Technology (DST)-India.
- Augmenting Writing Skills for Articulating Research (AWSAR) award- 2020 (PhD category) by the Dept. of Science and Technology (DST)-India.

Brief Description of Projects : **(Maximum 2 project in the following format highlighting your research theme mentioned earlier)**

| **Problem Statement 1:**	Applications:
Parkinson's disease (PD) is a degenerative disorder of the central nervous system and affects the lifestyle of millions of people worldwide. The clinical diagnosis is clear-cut in the advanced stages of the disease when the symptoms are full-blown. PD detection in multiclass and multilingual framework with severity level remains unexplored However, analyzing the speech dysarthria leads to early diagnosis of Parkinson's disease which help in the easy management and treatment planning.	➢ Healthcare Industries ➢ Clinicians/ healthcare agencies ➢ Tele-health monitoring ➢ Medical Imaging Protocol and Imaging Software ➢ Healthcare and rehabilitation centers for Stroke patients

Strategy/ Approach/ Technique/ Experiments used to solve

Advanced signal processing techniques along with feature embeddings are used for effective features extraction (Language independent) of speech signal relevant to PD.

Machine learning/Deep learning models/ Large language models are used to accurately predict the PD and its severity.

Problem Statement 2:

Ischemic stroke injury can be characterized by a central core tissue severely deprived of blood flowand surrounded penumbra tissue with collateral blood flow. As time-window is narrow to identify ischemic territory from multi-parametric MRI and re-establish the tissue perfusion, the immediate objective of ischemic stroke therapy is automatic identification and salvaging of penumbra before it degenerates into necrotic tissue.
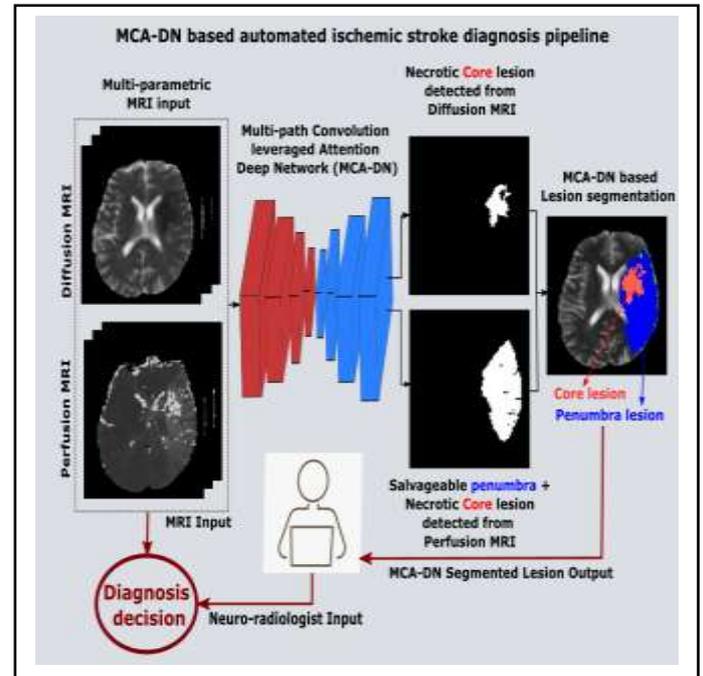
Strategy/ Approach/ Technique/ Experiments used to solve

Manual tracing of injury on multiple slices and multiple modalities is limited by varying lesion shape, observer fatigue and inter and intra-observer variabilities. In this line, this research targets accurate and reproducible methods based on classical computer vision and state of the art deep learning techniques for automatic segmentation of ischemic lesions followed by core-penumbra differentiation.

MCA-DN based automated ischemic stroke diagnosis pipeline

Group Members

Research Group-Advanced Device Modelling Group

- **Name of Principal Investigator/ Group Leader**: Dr. Aminul Islam
- **Research Theme**: Low power Device Modeling and Nonvolatile memory device modeling
- **Broad Area of Research and Scope:**
  - Tunneling Field Effect Transistor (TFET) modeling
  - Modeling of spin-filter magnetic tunnel junctions (sf-MTJs)
  - Modeling of High Field Effect Transistor (HEMT)

Schematic Representation of Broad Area of Research
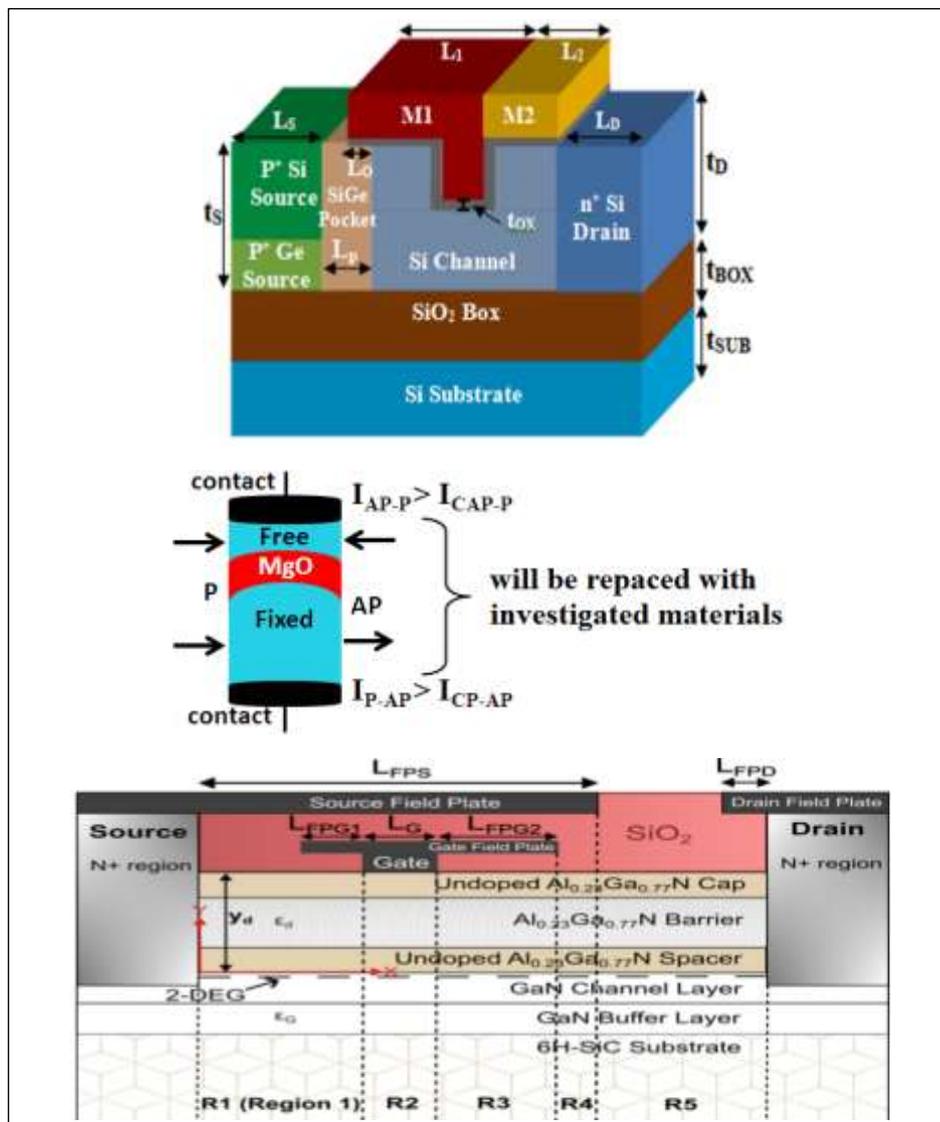
Total Number of Publications by the group: 315

Top 5 Article with impact factor:

1. S. Nandi, S. K. Dubey, M. Kumar, A. K. Dwivedi, M. Guduri and A. Islam, "Design and Investigation of a Metamorphic InAs Channel Inset InP HEMT for Cryogenic Low-Noise Amplifiers," in *IEEE Access*, vol. 11, pp. 133115-133130, 2023, doi: 10.1109/ACCESS.2023.3337036. https://ieeexplore.ieee.org/document/10328869, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=10328869 **(IF: 3.9)**

2. S. Pal, S. Mohapatra, W. -H. Ki and A. Islam, "Soft-Error-Aware Read-Decoupled SRAM With Multi-Node Recovery for Aerospace Applications," in *IEEE Transactions on Circuits and Systems II: Express Briefs*, vol. 68, no. 10, pp. 3336-3340, Oct. 2021, doi: 10.1109/TCSII.2021.3073947. https://doi.org/10.1109/TCSII.2021.3073947, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9406943 **(IF: 3.7)**

3. S. Pal, S. Mohapatra, W. -H. Ki and A. Islam, "Soft-Error-Immune Read-Stability-Improved SRAM for Multi-Node Upset Tolerance in Space Applications," in *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 68, no. 8, pp. 3317-3327, Aug. 2021, doi: 10.1109/TCSI.2021.3085516. https://doi.org/10.1109/TCSI.2021.3085516, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9472876 **(IF:4.14)**

4. S. Pal, D. D. Sri, W. -H. Ki and A. Islam, "Highly Stable Low Power Radiation Hardened Memory-by-Design SRAM for Space Applications," in *IEEE Transactions on Circuits and Systems II: Express Briefs*, vol. 68, no. 6, pp. 2147-2151, June 2021, doi: https://doi.org/10.1109/TCSII.2020.3042520, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9281113 **(IF: 3.7)**

5. S. Pal, D. D. Sri, W. -H. Ki and A. Islam, "Soft-Error Resilient Read Decoupled SRAM With Multi-Node Upset Recovery for Space Applications," in *IEEE Transactions on Electron Devices*, vol. 68, no. 5, pp. 2246-2254, May 2021, DOI: https://doi.org/10.1109/TED.2021.3061642, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9385706 **(IF: 3.2)**

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status
1	Islam, A. Dubey, S.K., Mishra, M AlGaN/GaN based HEMT for RF and Low Noise Application	202141025986 A/ 511487	Granted on 16/02/2024
2	Aminul Islam, S. S. Solanki, Maherukh Design of Embedded Radiation Hardened Cache Memory Cell	202141025985 A	Granted on 10/06/2021
3	Munaganuri Vishnuvardhan, Dr. Manisha Gudur Dr. Aminul Islam, Dr. Amit Krishna Dwivedi 13.9 Tera Hertz Resonant Tunneling Diode Based Oscillator.	202241068436 A	-

▪ **Research Projects:**

Sl. No.	Title of the project	Role	Funding agency	Status	Amount
1	Study of HEMT and its performance in amplifier circuit	PI	DRDO	Completed	23.742 lakh
2	BCI enabled electric wheelchair control for neurorehabilitation	CO-PI	DST	Ongoing	5.72 lakh for 1 year

136

- **Industry/Academia Collaborations:**
1. Dr. Amit Krishna Dwivedi, Assistant Professor, School of Engineering, University of Warwick, UK
2. Dr. Shashank Kumar Dubey, Assistant Professor, Dept. of ECE, Global Academy of Technology, Bengaluru
3. Dr. Chandramauleshwar Roy, Associate Professor, School of Electronics Engineering (SENSE), Vellore Institute of Technology (VIT), Chennai
- **Targeted Application Area:** MRAM
- **Achievements:** Published papers in SCI Journals
-

Project: Study of 2D van der Waals (vdW) materials WSe_2/MoS_2 for tunnel barrier (TB) instead of MgO for modeling spin-filter magnetic tunnel junctions (sf-MTJs)

Problem Statement:

Since in today's era almost all electronic gadgets are portable and battery operated, reduction of leakage power is inevitable for prolonging the battery life. This demands innovative circuit-level techniques to extend the battery life for portable applications. Several techniques, such as dynamic body biasing, dynamic voltage scaling, transistor stacking, transistor sizing, and power gating, have been used in the industry. Several gadgets such as disks, wired and wireless interfaces, mobile phone, etc. operate in a busty fashion. For example, a mobile phone is mostly in standby mode, and becomes active when a call comes, or a user calls. If such systems can tolerate the wake-up delay and area overhead, then the power gating technique is the most efficient method to reduce power consumption. The power gating technique with sleep transistors can be adopted to reduce power consumption only if the system can wake up with its previous state. It is possible for a system to wake with its previous state if it has nonvolatile memory elements in its design. Magnetic tunnel junction (MTJ) is such a memory element, which utilizes spin rather than charge of electrons for its operation.

Applications
➢ Nonvolatile memory design such as MRAM,
➢ Digital circuit design using memory based lookup table
➢ Analog to digital converter, etc.

Strategy/ Approach/ Technique/ Experiments used to solve
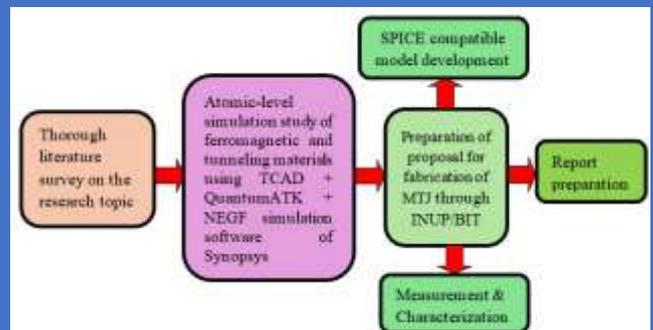
Group Members

Research Group- Aero vision

- **Name of Principal Investigator/ Group Leader**: Dr. Priyank Saxena

- **Research Theme**: Integrating UAVs with Vision, IoT, and Embedded Systems

- **Broad Area of Research and Scope:**

  - Design and Development of UAV Systems for Environmental and Societal Applications

- **Total Number of Publications by the group:** 20

- **Top 5 Articles with impact factor:**

1. Kumari P, Saxena P. Pathologic Myopia Diagnosis and Localization from Retinal Fundus Images using Custom CNN. Neural Comput Appl. 2024;36:14309–25. doi:10.1007/s00521-024-09851-3. **(IF-4.5)**

2. Kumari P, Saxena P. Cataract detection and visualization based on multi-scale deep features by RINet tuned with cyclic learning rate hyperparameter. Biomed Signal Process Control. 2024 Jan;87(Pt B):105452. doi:10.1016/j.bspc.2023.105452. **(IF-4.9)**

3. Diwakar R, Kumari P, Saxena P, Poddar R. An efficient multitasking cascade network for arteriovenous segmentation using dual-modal fundus images. Multimed Tools Appl. 2024;83:48399–48414. doi:10.1007/s11042-023-17343-0. **(IF-3.0)**

4. Kumari P, Saxena P. Disease localization and its prediction from retinal fundus images using explicitly designed deep learning architecture. Multimed Tools Appl. 2024;83:28461–78. doi:10.1007/s11042-023-16585-2. **(IF-3.0)**

5. Kumari P, Saxena P. Automated Diabetic Retinopathy Grading based on the Modified Capsule Network Architecture. IETE J Res. 2023 Mar. doi:10.1080/03772063.2023.2185304. **(IF-1.5)**

- **Research Projects:**

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Deep learning-based healthcare framework or IoT-based assistance of Alzheimer's patients	CO-PI	DST Under National Mission on Cyber-Physical Systems	5.64	2022-2025
Development of a fire announcement system for mining applications. (Completed)	PI	MIMEC Electronics Pvt. Ltd., Ranchi.	2.0	2023-2025
Development of a prototype for Obstacle Detection in a predefined zone around a railway track	PI	Specialty Products & Services (India) LLP, Jamshedpur	4.0	2025-2026
Development of an HDMI-Based GUI for Real-Time Fire Alarm Monitoring for Mining Applications	PI	MIMEC Electronics Pvt. Ltd., Ranchi.	3.0	April 2025-Dec-2025

- **Industry/Academia Collaborations:**
    1. Specialty Products & Services (India) LLP, Jamshedpur
    2. Garuda Aerospace Pvt. Ltd

- **Targeted Application Area:** Agriculture, Surveillance, Human Tracking

- **Achievements:** Designed an AI-enabled Multipurpose Agriculture Drone
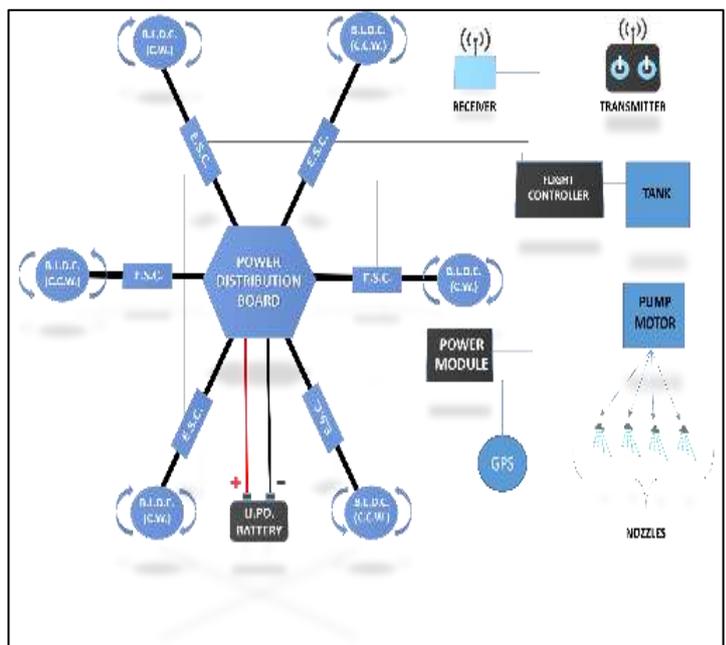
Project 1

Problem Statement:
In the ever-evolving landscape of agriculture, efficiency, precision, and sustainability are paramount. Introducing the AI-enabled Multipurpose Agriculture Drone – an innovative solution to revolutionise modern farming. This cutting-edge drone seamlessly integrates seed dropping, pesticide spraying, soil analysis, and crop disease detection, offering farmers a versatile and powerful tool to enhance productivity in a sustained manner.

Applications:
- Seed dropping
- Pesticide spraying
- Monitoring & detection of crop disease
- Soil Health Monitoring

Strategy
An AI-enabled drone for agricultural applications, targeting pesticide spraying, seed spreading, and real-time plant health monitoring will utilise two separate containers. One for pesticide spraying and the other for seed planting. A 3D-designed pump will be connected to each container to control the spraying and planting processes precisely. The drone will be equipped with a 5-megapixel camera and use a Convolutional Neural Network (CNN) for plant disease detection, specifically identifying diseases like apple scab or litchi scab using the YOLO (You Only Look Once) real-time object detection algorithm.

Project 2

Problem Statement:

Nowadays, reservoirs face a significant decline in water storage capacity due to multiple environmental and human-induced challenges. With limited groundwater reserves, over-extraction from surface water bodies has accelerated depletion. One of the primary issues is siltation and sedimentation, where excessive soil and debris from upstream areas get deposited in the reservoir bed, reducing the adequate storage volume. Most reservoirs are experiencing a decline in storage efficiency, posing a threat to sustainable water management.

Strategy/ Approach/ Technique/ Experiments used to solve

An energy-efficient solar-powered UHV will be designed. The vehicle can be controlled remotely through an RC transmitter. A multi-beam sonar transducer shall be mounted at the bottom of the UHV for underwater profiling. It emits multiple acoustic beams in a fan-shaped pattern perpendicular to the vehicle's path. The beams reflect off the reservoir floor, sediment layers, and underwater structures. The sonar receiver captures the return echoes, measuring time delay and intensity to determine depth and material characteristics.that provides a more natural walking experience and reduces these issues.

Applications
➢ Sediment profiling
➢ Water quality assessment
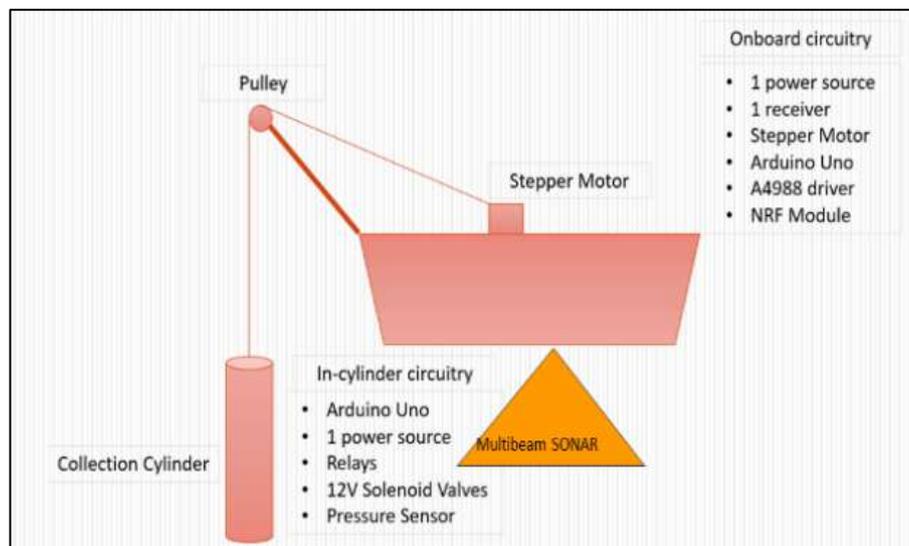
Group Members

Dr. Sandeep Singh Solanki
Professor, Department of ECE
BIT, Mesra

140

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Research Group -Brain Computer Interface Laboratory

- **Name of Principal Investigator/ Group Leader**: Dr. P. K. Upadhyay
- **Research Theme**: Development of a Brain–Computer Interface (BCI)-Based Wheelchair for Assistive Mobility in Motor-Impaired Individuals
- **Broad Area of Research and Scope:**
  - **Neurotechnology and Brain–Computer Interfaces (BCIs):**
    Development of non-invasive EEG-based control systems to assist individuals with motor disabilities.
  - **Signal Processing and Machine Learning:**
    Application of advanced filtering, feature extraction, and deep learning techniques (e.g., CNN-LSTM) for accurate classification of motor imagery signals.
  - **Assistive Robotics and Mobility Solutions:**
    Design and integration of brain-controlled wheelchair systems using embedded hardware for real-time control.
  - **Clinical Applications in Neurology and Rehabilitation:**
    Supporting patients with paralysis, spinal cord injury, or neurodegenerative diseases through intelligent neuro-assistive technologies.

Schematic Representation of Broad Area of Research:
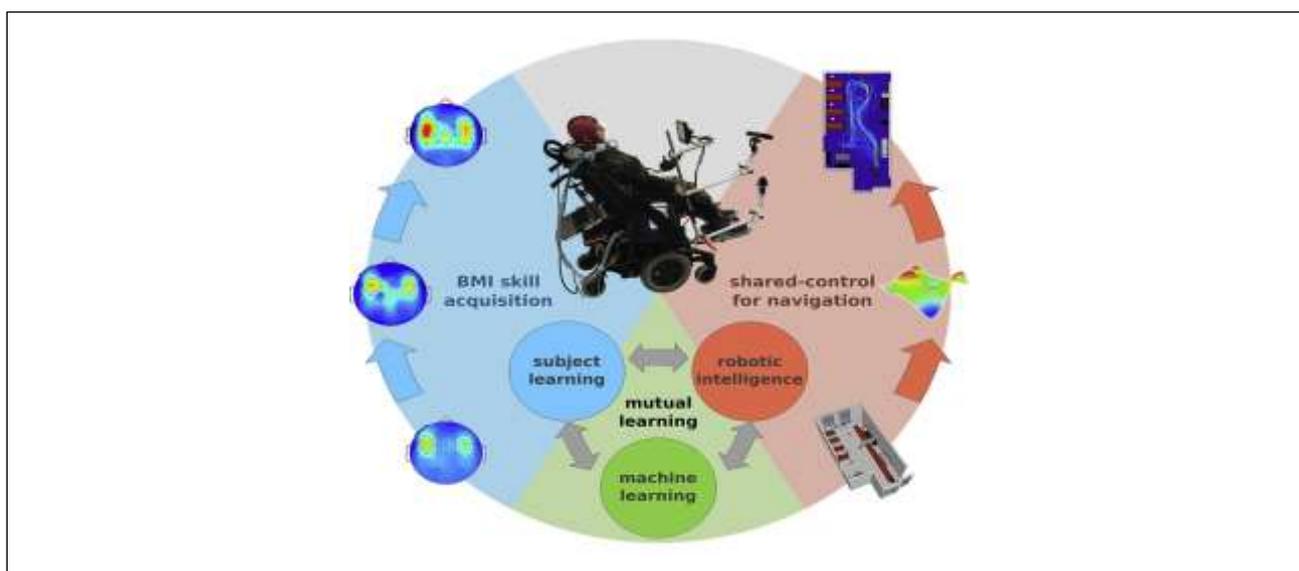
Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Brain Signal Controlled Wheel Chair	Dr. P. K. Upadhyay	ICMR, New Delhi	31.01	3

Industry/Academia Collaborations:

Targeted Application Area: The targeted application area is assistive mobility for individuals with severe motor impairments, such as those with paralysis, spinal cord injuries, or neurodegenerative disorders. The system aims to restore independent movement through brain-controlled wheelchair technology, enhancing quality of life and promoting autonomy in daily activities.

Achievements:

Brief Description of Projects : Brain Signal Controlled Wheel Chair

Problem Statement:

Patients suffering from paralysis, neurodegenerative diseases, or severe motor impairments often face challenges in performing basic mobility tasks. Conventional assistive devices either require residual physical movement or lack adaptability to patients with complete immobility. There is a need for an affordable, non-invasive, brain-signal-controlled wheelchair system that responds to motor imagery commands and adapts to individual neural profiles, possibly enhanced through natural neurotherapeutics.

Applications:

➢ Medical Assistive Devices
➢ Neurorehabilitation
➢ Clinical Trials of Herbal
➢ Neuroenhancers
➢ Affordable Healthcare Technology
➢ Smart IoT-Based Caregiving

Strategy/ Approach/ Technique/ Experiments used to solve

The project uses a non-invasive EEG-based Brain–Computer Interface (BCI) to capture motor imagery signals such as left, right, and rest. These signals are preprocessed using filters and artifact removal techniques like ICA and wavelet denoising. Features are extracted using methods like Common Spatial Patterns (CSP) and Power Spectral Density (PSD), followed by classification through a deep learning model (CNN-LSTM). The output commands are used to control a wheelchair in real time via Raspberry Pi and motor drivers.

Graphical Abstract
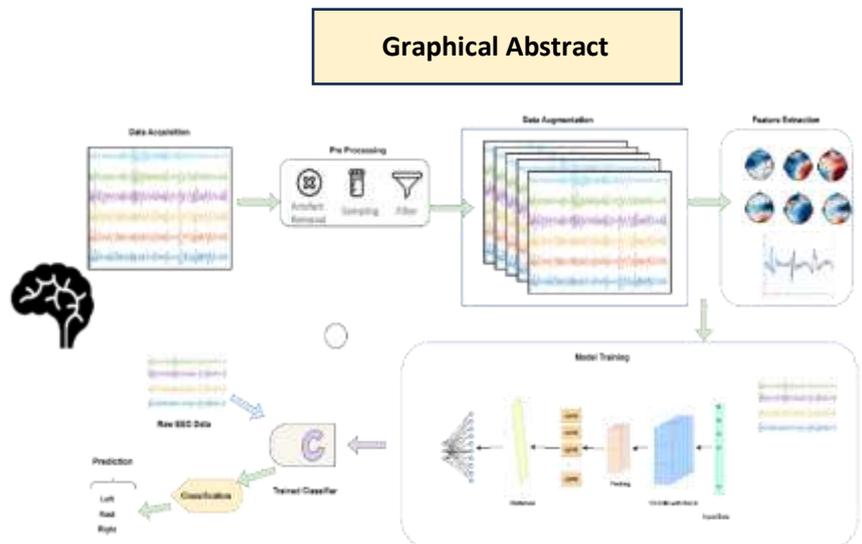
Group Members

Research Group -Control Systems

- ▪ **Name of Principal Investigator/ Group Leader**: Dr. Subrat Kumar Swain
- ▪ **Research Theme**: **Shared Control for Intelligent Vehicles using Learning based techniques**
- ▪ **Broad Area of Research and Scope:**
  - ➢ Driver Vehicle Cooperation/Cooperative Control
  - ➢ Intelligent Transportation Systems
  - ➢ Learning Based Control

Schematic Representation of Broad Area of Research:
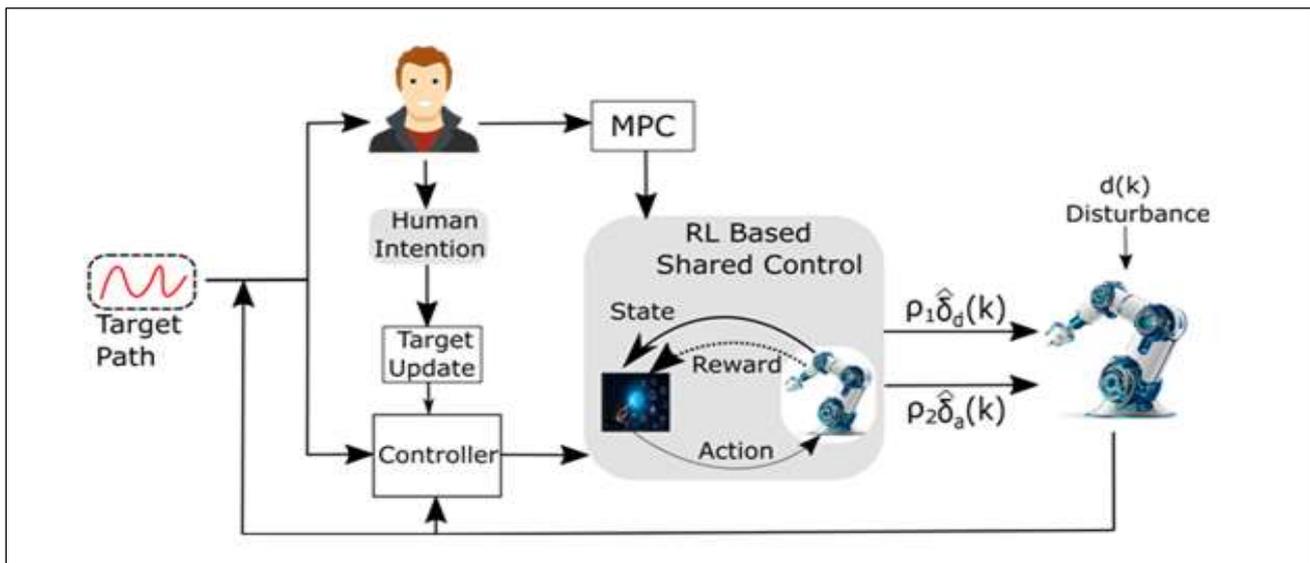
Total Number of Publications by the group: 10

Top 5 Article with impact factor: (Vancouver Style)

1. Swain SK, Lee S, Veluvolu KC. Reinforcement Learning based shared control for Driver Vehicle Interactions. *IEEE Transactions on Intelligent Transportation Systems* (Accepted, May 4, 2025).
2. Kumar B, Swain SK, Ghosh S, Mishra SK, Singh YK. Radial Basis Function-Based Adaptive Gain Super-Twisting Controller for Magnetic Levitation System With Time-Varying External Disturbance. *IEEE Transactions on Transportation Electrification*. 2024 Dec;10(4):9121–32.
3. Swain SK, Rath JJ, Veluvolu KC. Cooperative Game Theory based robust shared lateral control for Driver Vehicle Interactions. *Control Engineering Practice*. 2023 Sep 26;141:105678–8.
4. Acharya DS, Mishra SK, Swain SK, Ghosh S. Real-Time Implementation of Fractional-Order PID Controller for Magnetic Levitation Plant With Time Delay. *IEEE Transactions on Instrumentation and Measurement*. 2022 Jan 1;71:1–11.
5. Sony P, Kumar R, Mishra SK, Swain SK, Mishra P, Kumar SS. Self-Regulating Particle Swarm Optimization based Chebyshev Functional Link Artificial Neural Network for Prediction of Soil Moisture in Precision Agriculture. *Measurement* (Accepted, March 2025).

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	**Agricultural Health Monitoring Device,** Birla Institute of Technology, Rohit Kumar, Prity Soni, Sudhansu Kumar Mishra, Subrat Kumar Swain, Sitanshu Shekhar Sahu, Jagannath Sethi	Design number: 6300570	Granted on 11/08/2023
2	**A piezoelectric based energy harvesting system and method thereof,** Birla Institute of Technology, Sitanshu Sekhar Sahu, Sweta Kumari, Subrat Kumar Swain, Sudhansu Kumar Mishra, Mayank Singh	202331057064, 25/08/2023	Published, 13/10/2023
3	**An intelligent irrigation system and method thereof,** Birla Institute of Technology, Prity Soni, Rohit Kumar, Sudhansu Kumar Mishra, Subrat Kumar Swain, Sitanshu Shekhar Sahu	202331060280, 07/09/2023	Published, 20/10/2023
4	**An Autonomous Vehicle Navigation System and Method Thereof,** Birla Institute of Technology, Ankit Kumar, Abhishek Thakur, Sudhansu Kumar Mishra, Subrat Kumar Swain, Sitanshu Sekhar Sahu	202331066870, 05/10/2023	Published, 03/11/2023
5	**A Non-Integer Order Controlling System For Second Order System And Method Thereof,** Birla Institute of Technology, Deep Shekhar Acharya, Sudhansu Kumar Mishra, Subrat Kumar Swain	202331077668, 15/11/2023	Published, 24/11/2023

Targeted Application Area: Autonomous Vehicles, Robotics, Remote Surgical Applications, Lateral guidance and control of Unmanned aerial vehicles

Achievements:

1. **Best PhD thesis Gold Award** for the topic 'Shared Control for Intelligent Vehicles using Game Theory and Reinforcement Learning' at **KPIT Shodh Awards 2025** in Pune
2. **Gold award** winner in the student paper presentation titled 'A Framework for Evaluating Incident Management Strategies on Freeways' held in **2010 ITS Michigan Annual Meeting and Exposition**, Dearborn, MI, May 2010.
3. Nominated in the **Third Place** of the first Student Decision World Contest organized **by Expert Choice organization.**

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)

Problem Statement:

Existing studies face numerous challenges in achieving human-like driving behaviour in shared control systems. Most of the existing studies exhibit automation-oriented behaviour focusing on lane keeping aspects and less on achieving driver intended shared control thereby resulting in less driver comfort. Integration of human intention along with automation assistance to driver according to its intention in the driver vehicle shared control configuration is a challenging task which is not vividly available in the existing literature.

Applications:

➢ Driver Vehicle Shared Control in Intelligent Vehicles
➢ Robotics (Robot Teleoperation)
➢ Lateral guidance and control of Unmanned aerial vehicles
➢ Remote Surgical Applications

The implementation involves a Human-Machine Interface (HMI) that can interpret driver intentions and an Adaptive Control Module that adjusts its behavior accordingly. The major subsystems that will be developed are Driver Monitoring System, Intention Recognition Module, Cooperative
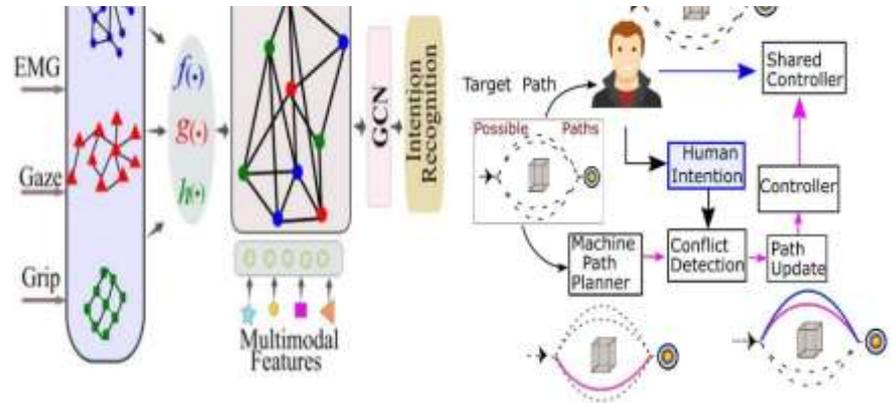
Group Members

Research Group- Smart Grid

- **Name of Principal Investigator/ Group Leader**: Prof. (**Dr.) Tirthadip Ghose**
- **Research Theme**: Renewable energy Sources (RES) integration, Grid Forming/Grid Following Inverter Control Design, AC/DC Microgrid, Blockchain Technology Application in Grid, Cyber Physical Power, WAMS, AC/DC Circuit Breaker, Protection, Demand side management, PMU, BESS Optimal sizing etc.
- **Broad Area of Research and Scope:**
  - Grid tied inverter for RES integration, Development of a Hybrid PV-BESS Distribution System
  - P2P Energy trading using Blockchain Technology
  - Optimal Rating of BESS Ensuring Dispatchability and Profitability of the WES-PV-BESS System
  - AC/DC Microgrid, PMU, Wide area Monitoring System, Power System Protection and Reliability,
  - Cyber Physical System in Smart Grid, State Estimation and Power Quality

Schematic Representation of Broad Area of Research:

Total Number of Publications by the group: Around 260 Publications including Journals, conferences, book, book chapters and Patents

Top 5 Article with impact factor:

1. R. Debnath, **Deepak Kumar***, G. S. Gupta, S. R. Samantaray and E. F. El-Saadany, "A Unified Novel Koopman Based Model Predictive Control Scheme to Achieve Seamless Stabilization of Nonlinear Dynamic Transitions in Inverter Based Stochastic Microgrid Clusters," in **IEEE Transactions on Smart Grid, 2024**, doi: 10.1109/TSG.2024.3402315. **[I.F-8.6]**

2. Shubham Kashyap, **Tirthadip Ghose*** "An Iterative Heuristic Optimization Method for the Optimum Sizing of Battery Energy Storage System to Augment the Dispatchability of Wind Generators" **IEEE Access**, Vol. 216, No. 109025 March 2023. **[IF: 3.9]**

3. Abdullah Umar, **Deepak Kumar***, **Tirthadip Ghose**, "Blockchain-based decentralized energy intra- trading with battery storage flexibility in a community microgrid system," **Applied Energy**, **Elsevier**, Volume 322, 2022, 119544. DOI: https://doi.org/10.1016/j.apenergy.2022.119544. **[I.F-11.2]**

4. Rajesh Saikrishna, Nilesh Kumar Rajalwal , **Debomita Ghosh***, "Adaptive relay co-

ordination using a busbar splitting approach for a system integrity protection scheme*", Protection and control of modern power systems, IEEE*, Vol. 7, No. 1, January. 2022. **[IF: 11]**

5. Sonal, **Debomita Ghosh***, "Impact of Situational Awareness Attributes for Resilience Assessment of Active Distribution Networks Using Hybrid Dynamic Bayesian Multi Criteria Decision-making Approach", *Reliability Engineering and System Safety, Elsevier,* Vol. 228, No. 108772, December 2022. **[IF: 8.1]**

<p style="text-align:center; color:red;">**Patents by the group:**</p>

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Inventors: A Umar, **Deepak Kumar, and T Ghose** Title: A decentralized peer-to-peer energy trading system for a community microgrid and method thereof	**Application Number: 202431051818, 13/09/2024**	Published
2	Inventors: Sumit Kr. Jha, and **Deepak Kumar**, Title: Demand Side Management Development System for Self-Sustained Droop based Microgrid using Conservation Voltage Reduction	**[German Utility Model Patent:** Application Number: 20 2023 104 604 **and 13/09/2023**	Published
3	Agricultural Equipment Control Box, Investigators: **Dr. Debomita Ghosh**, Ms. Divyangini Gyani, Dr. Tirthadip Ghose, Dr. Sonal, Dr. Saptak Bhattacherjee, Mr. Tapan Das,	Indian Design patent Application No: 446163-001 27/03/2025	Published
4	Method for Assessment of Hosting Capacity and Voltage Stability for Renewable Energy Integrated EV Charging Station, Inventors: Birla Institute of Technology, Mesra, Mr. Sourav Kumar Sahu, Ms. Sonal, **Dr. Debomita Ghosh**, Dr. Dusmanta Kumar Mohanta,	Indian Utility Patent Application No. 202231065637, 29/10/2024	Granted
5	System for analysing the impact of situational awareness attributes for the resilience assessment of active distribution networks, Inventors: **Dr. Debomita Ghosh,** Dr. Sonal,	**German Utility Model Patent** Application No.202023105081.6, IPC: G06Q 10/0635, 18/09/2023	Granted
6	A system for the promotion and management of renewable energies, Inventors: **Dr. Debomita Ghosh,** Mr. Sourav Kumar Sahu, Ms. Sonal	**German Utility Model Patent** Application No. 202022103951.8, IPC: H02J 3/24, 31/08/2022	Granted

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Secured Data Analytics for Microgrid Energy Management System through Blockchain Technology	(PI) Dr. Deepak Kumar Dr. T. Ghose (Co-PI)	DST-SERB/CRG	25.21 Lakhs	2022-2025
Test bench development for investigating the performance of battery energy storage as ancillary services	Dr. T. Ghose (PI), Dr. Debomita Ghosh, (PI) and Dr. Md.Junaid Akhtar (PI)	ERLDC, Grid Controller of India Limited, Govt. of India	41.8 Lakhs	2023-2025
Analysis, design and verification of coordinated control for laboratory prototype hybrid AC-DC microgrid with IOT-based cloud computation platform.	PI (Dr. T. Ghose)	AICTE	11 Lakhs	2020-2023

Adaptive Irrigation Management System using Sustainable Energy	. Debomita Ghosh (PI) Dr. T. Ghose (Co-PI)	Coal India Limited, Govt. of India	20.06 Lakhs	2023-2025
Solar Powered Hydrogen Electrolyzer for Hydrogen Generation to be used for Fuel Cell	Dr. S. Shiva Kumar and Dr. T. Ghose	RUHRPUMPEN(RP) India pvt. Limited	7 Lakhs	2025-2026

Industry/Academia Collaborations:

- Laval University, Canada, AALTO University, Finland, ERLDC, Grid Controller of India Limited, Govt. of India, Coal India Limited, Govt. of India, Typhoon HIL, Switzerland, *QUARBZ Info Systems,* TATA Motors, IIT Bhubaneswar, IIT ISM Dhanbad, NIT Trichy

Targeted Application Area: Analyses on different challenges to make power system grid smarter

Achievements:

1. Accumulation of almost rupees 1 crore in Last 5 years.
2. Prestigious POSOCO Power system Awards under Masters' category
3. Best paper awards in different IEEE Conferences.

1. **Test bench development for investigating the performance of Battery energy storage as ancillary services:** This R&D project is adhered to develop a test bench for investigating the performance of 92V, 110Ah battery energy storage system as ancillary services in the 3-phase, 110V, 50Hz A.C. power systems as requested and funded by Eastern Region Load Dispatch Center, Grid-India, Ministry of Power. The outcome of this project will be a cutting-edge optimized controller for the operation of battery energy storage to facilitate the Indian electrical grid in terms of ancillary services.

2. **Blockchain Technology for Secured Energy Management:** The work explores the possibility of blockchain technology based power market for community microgrid. To address these, a blockchain-based framework for community microgrids was developed, utilizing smart contracts and a Proof-of-Stake (PoS) mechanism. A novel energy trading model on the basis of P2P transaction is done, incorporating Power Transfer Distribution Factor (PTDF)-based congestion management and the results demonstrated enhanced transparency, lower transaction costs, improved DR participation, and the overall feasibility of decentralized, scalable energy trading in community microgrids.


Group Members

Research Group - Smart Electrical Mobility

- ▪ **Name of Principal Investigator/ Group Leader**: Dr. Aftab Alam
- ▪ **Research Theme**: Electric Vehicles, EVTOL and Autonomous Navigation, along with Charging Infrastructure
- ▪ **Broad Area of Research and Scope:**
  - ➢ Battery Management System
  - ➢ Wireless Power Charging Infrastructure
  - ➢ Drive Train with Electric Vehicle (EV) Motor Design
  - ➢ Power Converters and SoftSwitching Converters
  - ➢ Vehicle to Grid and Grid To Vehicle DC Microgrid

Schematic Representation of Broad Area of Research:
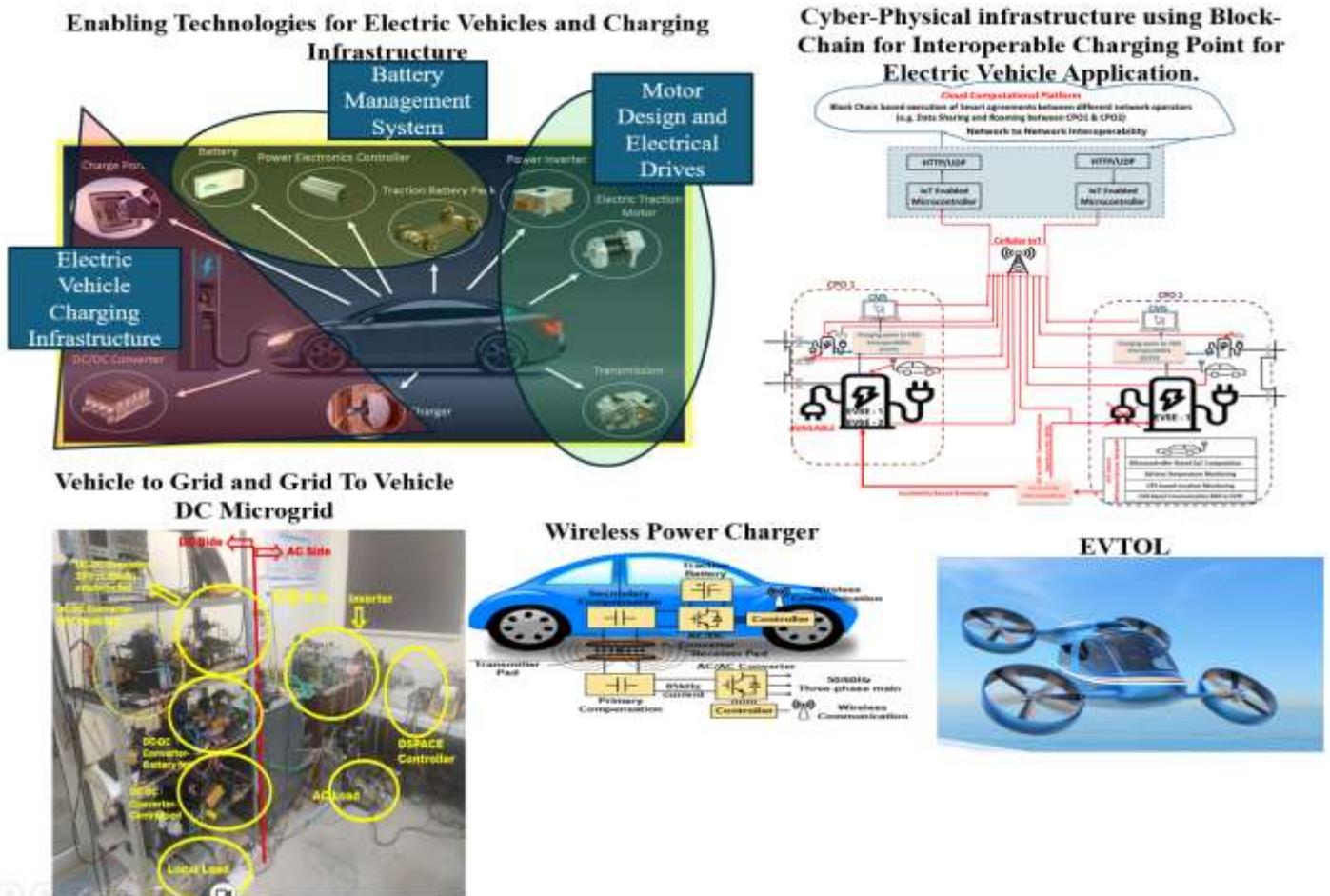
Total Number of Publications by the group:16

Top 5 Article with impact factor: (Vancouver Style)

1. Karan, V.K., Shekhar, S., Alam, A. "Elimination of torque ripples by multiple slope ST-DTC vectors in PM-BLDC drive." *Electr Eng* (2023).
2. S. Shekhar and A. Alam, "A Transient-Adaptive Droop Control Strategy for Better Current Sharing, Robustness, and Stability in DC-MGs," *IEEE Transactions on Industry Applications, (2025)*

3. A. Alam, M. K. Mukul and P. Thakura, "Wavelet Transform-Based EMI Noise Mitigation in Power Converter Topologies," *IEEE Transactions on Electromagnetic Compatibility*, (2016)

4. A. Mittal, Z. Xu, K. Du, S. S. Kumar and A. Shrivastava, "An Ultralow-Power Closed-Loop Distributed Beamforming Technique for Efficient Wireless Power Transfer," *IEEE Internet of Things Journal*, vol. 11, no. 19, pp. 31301-31316, 1 Oct.1, (2024)
5. U. R. Muduli, B. Chikondra, M. J. Akhtar, O. Al Zaabi, K. Al Hosani and R. K. Behera, "Comparison of SVPWM Techniques Under Switching Loss Control for Induction MotorDrive With LC Filters," *IEEE Transactions on Industry Applications*, (2023)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
01	Battery management system, Aftab Alam, Shashank Shekhar, Amit Kumar De	Indian Patent. Appl No. 202331089296 dated 28.12. 2023	Published
02	Smart Energy Nanagement and Control System and Method, Aftab Alam, Alakshendra Singh, Abheet Pandey	Indian Patent. Appl No. 202331006354 dated 31.01. 2023	Published
03	An improved squirrel cage induction motor with enhanced efficiency and wide range of operating speed for application in electric vehicle, Ranjan Kumar Behara, Mohammad Junaid Akhtar, Sanjoy Kumar Parida	Indian Patent No. 354017	Granted

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
EV Charging Infrastructure , High Power Charging Methods, High Power Density Static wireless Charging - Design of 50kW Wireless Power Transfer	Dr. Aftab Alam, Dr. S. Shiva Kumar	MAHA-EV Mission, ANRF	144	5 Years
Electric Vehicle Design and Autonomous Navigation	Dr. Aftab Alam	L&TTS	97	2 Years
Design of IoT Based Energy Management System Using Cloud Computing Platform.	Dr. Aftab Alam	ECRA, SERB	38.7	3 Years
Development of Fault-Tolerant Open-End Winding Induction Motor Drive for Electric Vehicle Application	Dr. Junaid Akhtar, Dr. Aftab Alam	CSR	7.6	2 Years

**Industry/Academia Collaborations:** (1) MoU with L&TTS (2) MoU with TATA Motors

Targeted Application Area: Electric Vehicles

Achievements:

FAST EV CHARGING USING WIRELESS POWER TRANSFER

Problem Statement:	Applications:
Design of 50kW static wireless power transfer for fast charging of Electric Vehicles	➢ Electric Vehicle Charging ➢ Vehicle to Vehicle Charging

Revolving EM field-based Coil Design

Tripolar polarized pad design ensures high power density, enhancing coupling efficiency, and effective misalignment tolerance. High coupling efficiency and power density with optimized resonant converters will increase efficiency to above 95%
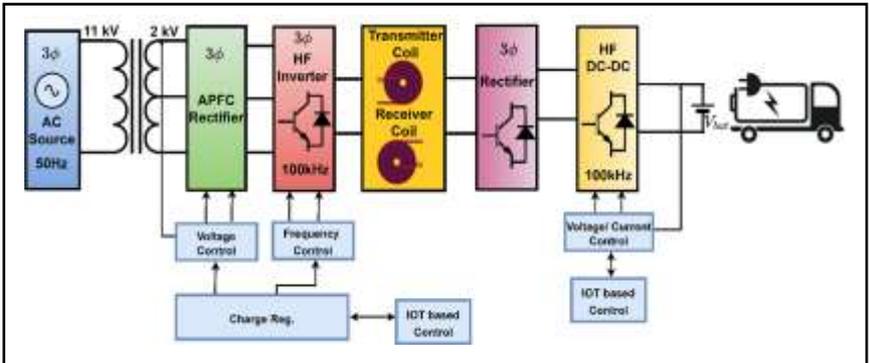
Fault Tolerant Electrical Drives for Electric Vehicles

Problem Statement:

One of the major bottlenecks for EV-based transportation systems is the fault in the traction drive train. In an EV, the traction motor is powered through an inverter. Inverters are built using semiconductor switches. The failure of these semi-conductors' switches will deteriorate the performance of EV, which is not desired.

Fault Tolerant Design

In this project fault-tolerant, open-end winding induction motor (OEWIM) drive fed by three single-phase H-bridge inverters (TSPHBI) is implemented. The control is simple without requiring any additional leg. The fault phase is connected to the mid-point of the dc-link for giving the path to the phase current. DTC technique is implemented for control of the motor.

Applications:

➤ Electric Vehicle Traction
➤ Reliable Industrial Drives

Group Members:

152
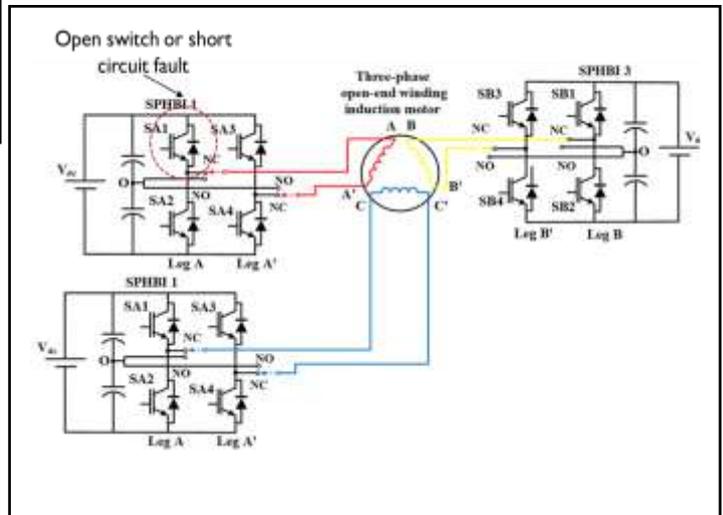
DEPARTMENT OF MATHEMATICS

Research Group -Complex Dynamics Group

- **Name of Principal Investigator**: Dr. Dinesh Kumar
- **Research Theme**: Complex Transcendental Dynamics
- **Broad Area of Research and Scope**: *Complex Dynamics*
  - Modelling disease spread using complex dynamics and Julia sets
  - Bungee set and its topological properties
  - Bungee set of transcendental semigroup and related results
  - Escaping set, Filled Julia set and its topological properties

Schematic Representation of Broad Area of Research:
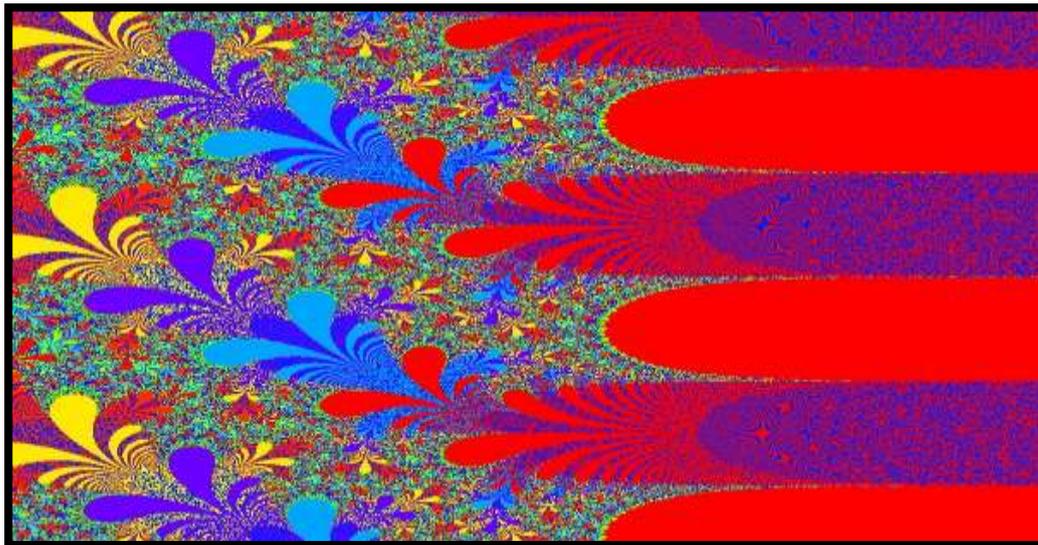
Total Number of Publications by the group: 4

Top 5 Article with impact factor:

1. Kumar D, Saini M. The Growth of Solutions of Non-Homogeneous Linear Differential Equations. Kodai Math. J. 2021;44(3): 556-574.
2. Kaur R, Kumar D. Results on escaping set of an entire function and its composition. Indian J. Pure Appl. Math. 2021;52: 79-86.
3. Kumar D, Kaur R. Dynamics on bungee set, escaping set and filled Julia set of composite transcendental entire functions. Bull. Cal. Math. Soc. 2024;116(5): 463-474.
4. Kaur R, Kumar D. Dynamics of nearly abelian transcendental semigroup (accepted in Journal of Analysis (2025)).

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Topological Investigation of the Escaping set of a Transcendental Semigroup and Wandering domains in Quasiregular Dynamics	PI	ANRF(SERB)	1005000	3 years

Industry/Academia Collaborations: IIT Bhubaneswar, IISER Mohali, University of Delhi

Targeted Application Area: Modelling disease spread using complex dynamics

Achievements: Recently, one research article has been communicated for publication in the area of modelling disease spread using complex dynamics and one book chapter has been communicated for publication.

Brief Description of Projects

Problem Statement:
We would like to explore the topological properties of an important subset of the complex plane known as Bungee set of an entire function f denoted by BU(f). Not much has been explored for escaping set of a transcendental semigroup and the field is widely open. Not much is known about the topological aspects of Julia set and escaping set of a transcendental semigroup.

Applications:

➢ Modelling disease spread using Julia set.
➢ Understanding fractal and chaotic phenomenon.
➢ Understanding sensitive dependence to initial conditions.
➢ Finding stable and unstable regions.
➢ Connectedness properties of these sets.

Strategy/ Approach/ Technique/ Experiments used to solve

We will be using Fatou-Julia theory and Montel's theory of normal families for our investigations. These two theories are the firm foundation of complex dynamics. This will be used to investigate the topological properties of the Bungee set of an entire function in addition to what has already been done. We would like to provide conditions under which Bungee set of two permutable entire functions.
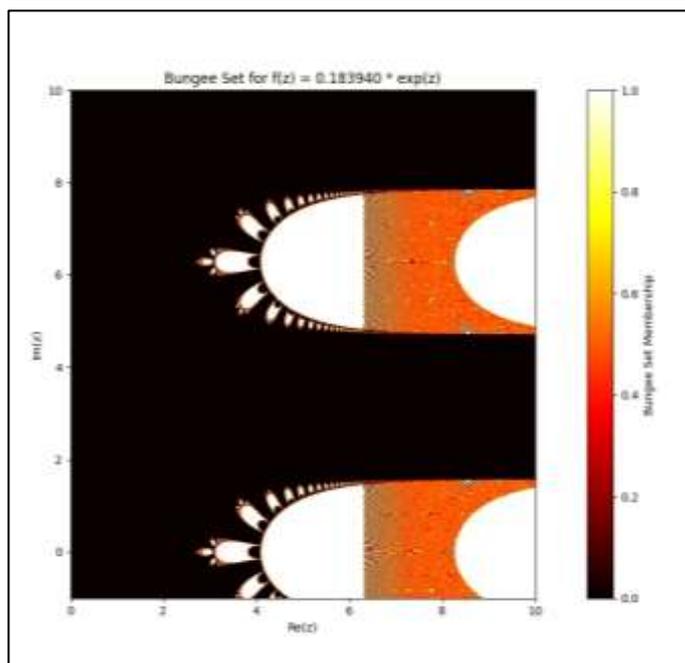
Group Members

Research Group- Fractional Differential Equations

- **Name of Principal Investigator/ Group Leader**: Dr. S. Padhi
- **Research Theme**: Vallee-Poussin Type Results for Fractional Differential Equations
- **Broad Area of Research and Scope:**
  - Fractional Differential Equations
  - Ordinary and Delay Differential Equations

Total Number of Publications by the group: 12

Top 5 Article with impact factor:

1. Alexander Domoshnitsky, Seshadev Padhi, Satyam Narayan Srivastava, Vallee-Poussin theorem for fractional functional differential equations, Fract Calc Appl Anal., 25(4)(2022), 1630–1650. doi: 10.1007/s13540-022-00061-z.

2. Alexander Domoshnitsky, Satyam Narayan Srivastava and Seshadev Padhi, Existence of solutions for a higher orderRiemann–Liouville fractional differential equation by Mawhin's coincidence degree theory, Math Methods Appl Sci. 46(11) (2023) 12018-12034. https://doi.org/10.1002/mma.9005

3. Satyam Narayan Srivastava, Alexander Domoshnitsky, Seshadev Padhi and V. Raichik, Unique solvability of fractional functional differential equation on the basis of Vall\'{e}e-Poussin theorem. Arch Math (Brno), 59(1)(2023), 117–123.

4. Satyam narayan Srivastava, Smita Pati, Seshadev Padhi and Alexander Domoshnitsky, Lyapunov inequality for a Caputo fractional differential equation with Riemann-Stieltjes integral boundary conditions, Math Methods Appl Sci. 46(12) (2023). 13110-13123. https://doi.org/10. 1002/mma.9238

5. Martin Bohner, Alexander Domoshnitsky, Seshadev Padhi and Satyam Narayan Srivastava, Vallee-Poussin theorem for equations with Caputo fractional derivative, Math Slovaca, 73(3)(2023), 713-728.

Industry/Academia Collaborations: 1. Ariel University, Israel, 2. Missouri S&T, Rolla, MO 65409, USA

3. University of Tennessee at Chattanooga, Chattanooga, Tennessee, USA

Targeted Application Area: Applications of Fractional Differential Equations in Real World Models using Physics Informed Neural Networks

Brief Description of Projects

Problem Statement:

Continuation of the research in fractional functional differential equations on the basis of VallÅLee-Poussin theorem: For nonlinear functional equations, I plan to use the VallÅLee- Poussin theorem technique combined with the upper and lower solution method. Myproposed idea is to take two corresponding functions as upper and lower solution and apply them to the differential inequality stated in the VallÅLee-Poussin theorem. Previously,

We utilized the monotone iteration method along with the upper and lower solution method to establish the existence of a positive solution for a fractional differential equation]. Merging these two techniques for fractional functional equations would be of great interest. In all our previous articles, I worked with operators T that were considered positive, which was a significant limitation. Therefore, I plan to study equations involving nonpositive operators. We have recently developed an interest in applying physics-informed neural networks to fractional partial differential equations. I am particularly interested in combining analytical methodologies with numerical simulations through physics-informed neural networks.

Applications:

➢ Applications of PINN to Fractional Cantilever Beam Equations
➢ Applications in Cancer Related Problems
➢ Applications in Physics

Strategy/ Approach/ Technique/ Experiments used to solve

PINN will be used with different networks to solve fractional differential equations and their applications.

Group Members

Research Group- Mathematical Modeling In Ecology, Environment and Biology Group (MMEEBG)

- **Name of Principal Investigator/ Group Leader**: **Dr. Abhinav Tandon**
- **Research Theme**: Differential Equations and its applications in Ecology, Environment & Biology
- **Broad Area of Research and Scope:**
  - Mathematical Modeling of Ecological, Environmental and Biological Systems
  - Mathematical Population dynamics
  - Qualitative theory of differential equations and nonlinear dynamical theory

Schematic Representation of Broad Area of Research
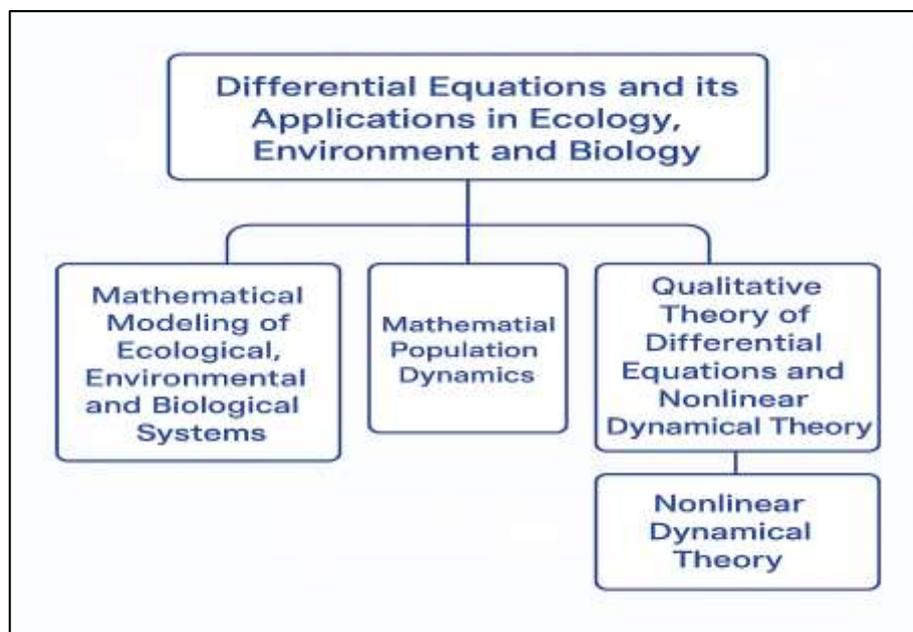
Top 5 Article with impact factor:

1. Nivetha S, Karthik A, Tandon A, Ghosh M. Mathematical modeling and optimal control of depression dynamics influenced by saboteurs. Scientific Reports. 2025 Feb 25;15(1):6773.(I.F. 3.8)

2. Tandon A, Dutta V, Mishra Y. Stability and bifurcation analysis of a nonlinear dynamical model studying the decline of vulture population. International Journal of Biomathematics. 2025 Jan 24;18(01):2350090. (I.F. 2.4)

3. Tandon A, Dutta V. Invertebrates and cattle population dynamics in a grassland environment: a nonlinear inter-specific competition model. Journal of Biological Systems. 2024 Mar 30;32(01):37-74. (I.F: 1.3)

4. Bansal R, Tandon A. Unveiling the dynamic interrelationship between urbanization and carbon emissions: an interactive nonlinear mathematical model. Modeling Earth Systems and Environment. 2024 Jun;10(3):3665-80. (I,F. 2.7)

5. Tandon A, Verma P.R. Human population induced urban developments and their effects on temperature rise: a nonlinear mathematical model. Ecological Complexity. 2021 Sep 1;47:100947. (I.F. 3.1)

Targeted Application Area:

The research aims to provide predictive insights, control strategies, and policy-relevant tools for addressing real-world challenges in ecology, environmental science, and biology using the lens of applied mathematics.

Group Members

Research Group-Soft Computing & Optimization

- **Name of Principal Investigator/ Group Leader**: Dr. Syeda Darakhshan Jabeen

- **Research Theme**: Development of Optimization Algorithms and its Application in real-world problems

- **Broad Area of Research and Scope:**

  - Soft Computing & Optimization
  - Vehicle Ride Comfort and Dynamic Stability
  - Chaos and multi-stability of nonlinear dynamical systems

Schematic Representation of Broad Area of Research
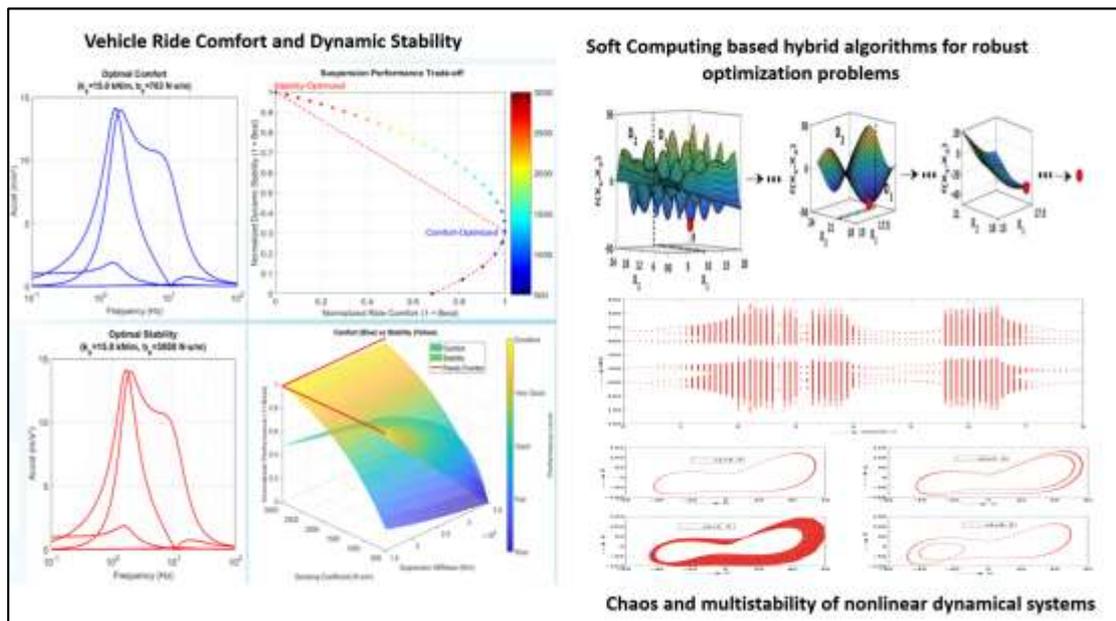
Total Number of Publications by the group: 20

Top 5 Article with impact factor:

1. Ahmed Shehata Gad, Wael Galal Ata, Haytham M El-Zomor, Syeda Darakhshan Jabeen, Optimizing Driver Comfort: Magnetorheological Damper Seat Suspension for Internal Combustion and Electric Vehicles Under Uncertain Conditions, Journal of Vibration Engineering & Technologies. 2025; 13(2): 157 (SCIE IF 2.1)

2. Dhirendra Sharma, Syeda Darakhshan Jabeen, Hybridizing interval method with a heuristic for solving real-world constrained engineering optimization problems, Structures. 2023; 56: 104993 (SCIE IF 3.9)

3. Mohammad Ali Khan, Gopal Mahapatra, Jayanta Kumar Sarkar, Syeda Darakhshan Jabeen, Design of multistability of chaotic systems via self and cross coupling, The European Physical Journal Plus. 2021; 136: 1-12 (SCIE IF 2.8)

4. Syeda Darakhshan Jabeen, Multi-section-oriented robust algorithm for unconstrained global optimization, Arabian Journal for Science and Engineering. 2019; 43(9): 7315-7342 (SCIE IF 2.6)

5. Mohammad Ali Khan, Debjani Maity, Syeda Darakhshan Jabeen, Spatiotemporal synchronization in asymmetrically bidirectionally coupled neurons over a complex network, International Journal of Modern Physics B. 2019; 33(19): 1950213 (SCIE IF 2.6)

Industry/Academia Collaborations:

- Dr. Ahmed Shehata Gad, Associate Prof., Department of Automotive & Tractor, Faculty of Engineering at Mataria, Helwan University, Cairo, Egypt
- Dr. Oscar Castillo, Professor, Computer Science in the Graduate Division Tijuana Institute of Technology Tijuana, Mexico
- Dr. Wael Galal Ata, Associate Prof., Head of Tanks Department, Mechanical Engineering Branch, Military Technical College, Cairo, Egypt
- Haytham M. El-Zomor, Associate Prof., Mechanical Engineering Department, Mechatronics, Arab Academy for Science, Technology and Maritime Transport, Smart Village Campus, Giza, Egypt
- Dr. Mohammad Ali Khan, Associate Prof., Department of UG and PG Mathematics, Ramananda College, Bankura University, India
- Dr. Jyotirmoy Saha, Prof., Department of Production Engineering, Jadavpur University, India
- Dr. Asoke Kumar Bhunia, Professor, Department of Mathematics, University of Burdwan, Burdwan, India
- Dr. Rathindra Nath Mukherjee, Professor, Department of Mathematics, University of Burdwan, Burdwan, India
- Dr. Javid Ali, Associate Prof., Department of Mathematics, Aligarh Muslim University Aligarh, India
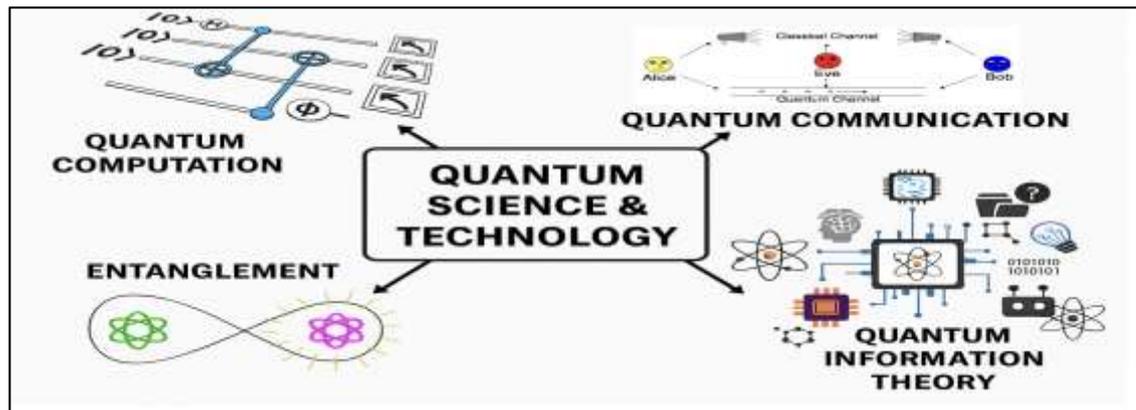
Group Members

Research Group- Quantum @BIT (QBIT)

- **Name of Principal Investigator/ Group Leader**: Dr. Anindita Bera

- **Research Theme**: Quantum Information and Computation

- **Broad Area of Research and Scope:**

  - ➢ Quantum information and computation
  - ➢ Quantum communication
  - ➢ Entanglement and its detection

Schematic Representation of Broad Area of Research

Total Number of Publications by the group: 23

Top 5 Article with impact factor:

1. Anindita Bera, Joonwoo Bae, Beatrix C. Hiesmayr, and Dariusz Chruscinski, "On the structure of mirrored operators obtained from optimal entanglement witnesses", Scientific Reports 13, 10733, Impact factor: 4.6, DOI: https://doi.org/10.1038/s41598-023-37771-0

2. Anindita Bera, Gniewomir Sarbicki, and Dariusz Chruscinski, "A class of optimal positive maps in Mn", Linear Algebra and its Applications 668, 131, Impact factor: 1.307, DOI: https://doi.org/10.1016/j.laa.2023.03.015

3. Anindita Bera, Filip A. Wudarski, Gniewomir Sarbicki, and Dariusz Chruscinski, "Class of Bell-diagonal entanglement witnesses in $\mathbb{C}^4 \otimes \mathbb{C}^4$: Optimization and the spanning property", Physical Review A 105, 052401 Impact factor: 2.971, DOI: https://doi.org/10.1103/PhysRevA.105.052401

4. Anindita Bera, Shiladitya Mal, Aditi Sen De, Ujjwal Sen, "Witnessing bipartite entanglement sequentially by multiple observers", Physical Review A 98, 062304, Impact factor: 2.971, DOI: https://doi.org/10.1103/PhysRevA.98.062304

5. Anindita Bera, Tamoghna Das, Debasis Sadhukhan, Sudipto Singha Roy, Aditi Sen De, Ujjwal Sen, "Quantum discord and its allies: a review of recent progress", Reports on Progress in Physics 81, Impact factor: 19, DOI: 10.1088/1361-6633/aa872f

Group Members

DEPARTMENT OF MECHANICAL ENGINEERING

Research Group- Cardiac Simulation and Valve Testing

- **Name of Principal Investigator/ Group Leader**: Dr. Nirmal Kumar
- **Research Theme**: Biomechanical modeling and simulation of human cardiac function for the performance evaluation of mechanical heart valves under realistic physiological conditions.
- **Broad Area of Research and Scope:**
  - Development of physiologically accurate heart simulators for mechanical and tissue valve testing under realistic pressure and flow conditions.
  - Study of nonlinear membrane mechanics and material modeling for simulating left ventricular function using hyperelastic biomaterials.
  - Evaluation of hemodynamic performance and hemolysis metrics to assess the safety and efficacy of heart valves.
  - Integration of experimental and computational techniques, including control systems and fluid–structure interaction (FSI), for cardiac device validation.

Schematic Representation of Broad Area of Research
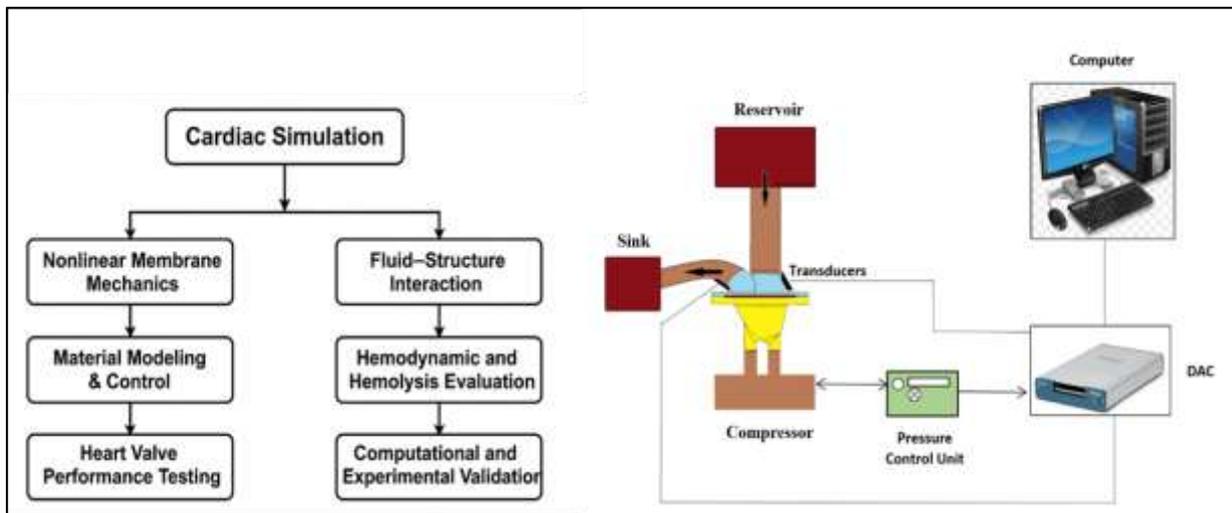
Top 5 Article with impact factor:

1. Kumar M, Saha I, Pandey S, Prakash O, Elsayed K, Brar LS. Analysis and optimization of cyclone separators with bulged conical segments using large-eddy simulation and artificial neural network. Separation and Purification Technology. 2025 Apr 27:133247.
2. Prakash O, Pandey VK, Kumar L, Brar LS, Chakraborty S, Kumar N, Kumar A, Ahmad A, Irshad K. Computational and Experimental Analysis of Thermal Oil-Based Parabolic Trough Collector. Journal of Enhanced Heat Transfer. 2025;32(3).
3. Kumar N, Vishwakarma U, DasGupta A. On the mechanics of inflated hyperelastic membrane–membrane contact problem. International Journal of Non-Linear Mechanics. 2021 Dec 1;137:103805.

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Novel Heart Simulator to test Heart Valves		Under review

- **Industry/Academia Collaborations:** Collaborative research work with Dr. Anirvan DasGupta, Professor in the Department of Mechanical Engineering IIT Kharagpur.

- **Targeted Application Area:** Pre-clinical testing and performance evaluation of mechanical and tissue heart valves under physiologically realistic conditions.

Brief Description of Projects : Design and Development of a Heart Simulator for Valve Testing

Problem Statement

Existing heart valve testing machines induce non-physiological effects such as fluid stagnation, water hammering, and excessive shear stress, which can lead to misleading hemolysis data and inaccurate valve assessment.

Applications

➤ Evaluation of mechanical and bioprosthetic heart valves for hemodynamic and hemolysis performance.
➤ Development and optimization of artificial left ventricles and membrane-based cardiac assist devices.
➤ Pre-clinical testing platform for regulatory assessment of cardiovascular implants.
➤ Training and simulation tool for biomedical engineering and cardiology research.

Strategy/ Approach/ Technique/ Experiments used to solve

A circular membrane inflation problem was solved under constrained and unconstrained conditions using finite element simulations. Silicone rubber was characterized through tensile testing and modeled using the Ogden material model. Numerical predictions were validated against experimental results at different pressures, achieving excellent agreement and supporting realistic simulator design.


Fabricated Heart Simulator
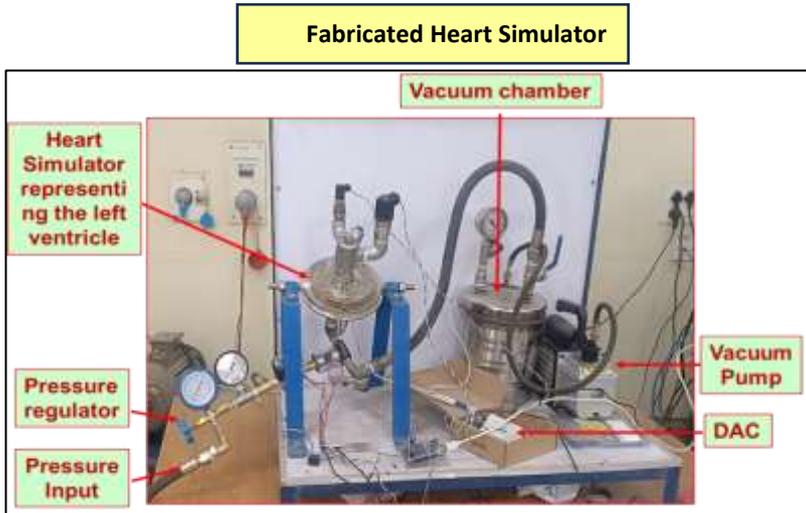
Group Members

Research Group- GranFlow Group (Granular Flow and Particle Technology)

- **Name of Principal Investigator/ Group Leader**: Dr. Ritwik Maiti
- **Research Theme**: Granular Flow and Particle Technology for Industrial and Geophysical Applications
- **Broad Area of Research and Scope:**
  - Experimental Fluid Dynamics / Multiphase Flows
  - Granular Mixing & Segregation
  - Impact Crater
  - Geophysical Flows
  - Granular Avalanche
  - Discrete Element Model (DEM)

Schematic Representation of Broad Area of Research
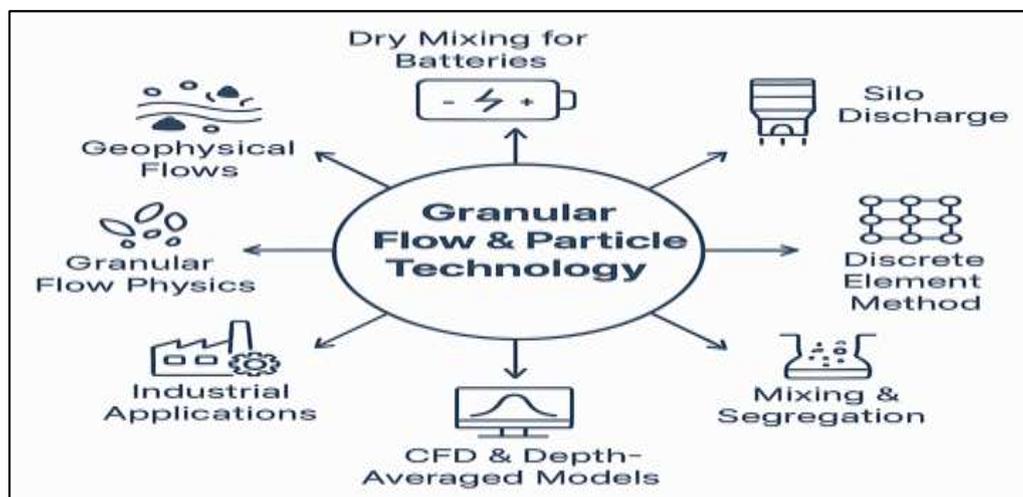
- **Total Number of Publications by the group:** 04

- **Top 5 Article with impact factor:**

1. Maiti R, Das G, Das PK. Bubbling Phenomena during Granular Drainage from an Inclined Closed-top Quasi-Two-Dimensional Conduit. Particuology. 2025;(Accepted).
2. Maiti R, Shepley P. Penetration of jet piles on submerged granular beds. Ocean Engineering 2025;315:1–17.
3. Maiti R, Roy AK. Discrete element model of low-velocity projectile penetration and impact crater on granular bed. Powder Technol 2024;448:1–13.
4. Maiti R, Das G, Das PK. Gravity-driven granular drainage from a closed top quasi-two-dimensional rectangular channel. Physics of Fluids 2024;36.
5. Maiti R, Das G, Das PK. Self organization of granular flow by basal friction variation: Natural jump, moving bore, and flying avalanche. AIChE Journal 2023;69:1–15.

- **Targeted Application Area:** Battery manufacturing, Pharmaceutical industry, Food processing, Geophysical Hazards, Agricultural Engineering, Mining Industry

Project 1: Development of Dry Mixing Process for the Preparation of Cathode Composite Powder for Next-Generation Solid-State Batteries
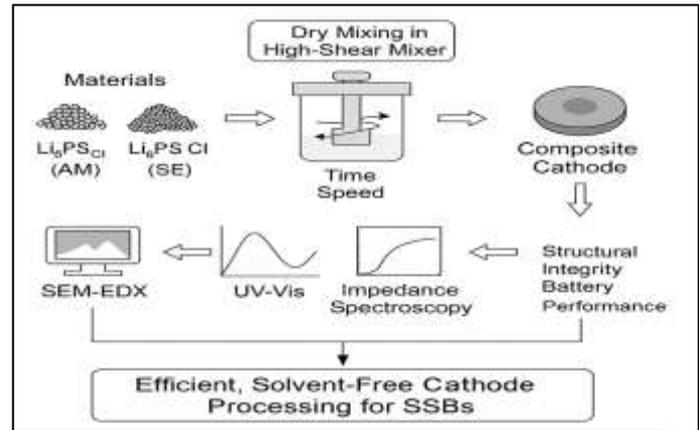
Problem Statement:
Achieving uniform mixing of active material (AM) and solid electrolyte (SE) in cathode composites is a critical challenge in solid-state battery (SSB) fabrication, affecting ionic conductivity and electrochemical performance.

Applications
The developed dry mixing process is intended for next-generation solid-state lithium batteries used in electric vehicles, grid storage, and portable electronics, offering improved safety, energy density, and lifecycle

Strategy/ Approach/ Technique/ Experiments used to solve
A high-shear mixer will be employed for dry blending AM (NCM523) and SE (Li_6PS_5Cl). The process will be optimized experimentally and analyzed through SEM-EDX, UV-vis, and impedance spectroscopy. Discrete Element Method (DEM) simulations will be used to model particle interactions and mixing behavior.

Project 2: Assessment of Impact Dynamics of Dry Granular Avalanches on Rigid Walls- an Approach to Catastrophe Prevention

Problem Statement
The Himalayan regions of India are increasingly experiencing landslides, debris flows, and snow avalanches due to climate change and rapid urbanization. These events pose significant threats to infrastructure and human safety. Current protective measures often rely on oversimplified models that may overestimate impact forces, leading to inefficient or overly conservative designs. There is a pressing need to accurately understand and mitigate the impact dynamics of dry granular avalanches on rigid structures to develop effective and economical protection systems.

Applications
- Infrastructure Protection
- Military Safety
- Disaster Risk Reduction

Strategy/ Approach/ Technique/ Experiments used to solve
- Conduct scaled laboratory tests using inclined chutes and a rigid wall instrumented with force sensors. Use granular materials to simulate avalanches and capture impact data via high-speed imaging.
- Develop a Discrete Element Method (DEM) model to replicate and extend experimental scenarios, enabling detailed force and flow analysis.
- Validate simulations with experimental results.
- Use findings to propose practical design guidelines for avalanche protection systems.

167

Research Group- Non-linear Mechanics and Design of Engineered Lattice Metamaterials and Structures (NMDELMS)

- **Name of Principal Investigator/ Group Leader**: Dr. Sushanta Ghuku
- **Research Theme**: Proposal of novel large deforming and stimuli-active lattice metamaterials and advanced engineering structures, development of semi-analytical frameworks analysing their non-linear multi-scale and multi-physical mechanics, and proposal of optimized designs
- **Broad Area of Research and Scope:**
  - Large deforming novel lattice metamaterials with engineered microstructure
  - Stimuli-active lattice metamaterials with modulated non-linear mechanical properties
  - Stimuli-active large deforming flexible structures with tailored non-linear stiffness and strength
  - Novel hard magnetic soft continuum robots

Schematic Representation of Broad Area of Research
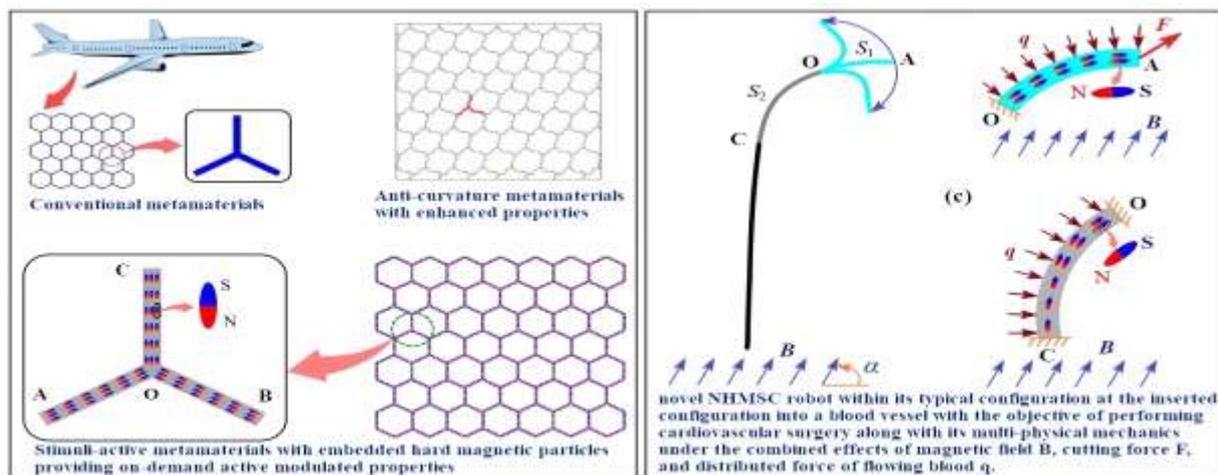
Total Number of Publications by the group: 11

Top 5 Article with impact factor:

1. Ghuku S, Naskar S, Mukhopadhyay T. Stimuli–responsive programmable mechanics of bi-level architected nonlinear mechanical metamaterials. Mechanics of Materials. 2025;206:105333. [SCIE, Impact factor: 3.4]
2. Ghuku S, Sahoo S, Mukhopadhyay T. Nonlinear elasticity tailoring and failure mode manipulation of functionally graded honeycombs under large deformation. International Journal of Non-Linear Mechanics. 2025;168:104935. [SCIE, Impact Factor: 2.8]
3. Ghuku S, Mitra A, Sahoo P. Theoretical analysis and a parametric study on forced vibration of large statically deformed curved beam with rigid links and moving support. Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science. 2024;238(8):3348-72. [SCI, Impact Factor: 2]
4. Kundu D, Ghuku S, Naskar S, Mukhopadhyay T. Extreme specific stiffness through interactive cellular networks in bi-level micro-topology architected metamaterials. Advanced Engineering Materials. 2023;25(8):2201407. [SCIE, Impact Factor: 4.122]

5. Ghuku S, Mukhopadhyay T. On enhancing mode-dependent failure strength under large deformation: The concept of anti-curvature in honeycomb lattices. Composite Structures. 2023;305:116318. [SCI, Impact Factor: 6.3]

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
A novel hard magnetic soft continuum curved robot: multi-physical mechanics, active control, modulation, and optimized design (Acronym: NHMSC robot)	Principal Investigator	ANRF (formerly SERB)	23.75934 Lacs	3 Years (19/02/2024- 18/02/2027)

Academia Collaborations: Collaborative research work with Dr. Tanmoy Mukhopadhyay and Dr. Susmita Naskar, Faculty of Engineering and Physical Sciences, University of Southampton, Southampton, UK

Targeted Application Area: Precise minimally invasive treatments of cardiovascular diseases

Achievements: Novel exploitable dimensions have been added into the design space of MSC robot with the objective of developing novel optimized design for precise minimally invasive cardiovascular treatments. Developments of multi-physics frameworks provide insights leading towards rigorous design of complex multi-physics structures.

Brief Description of the Project

Problem Statement:

The existing models of magnetically actuated soft continuum robots (MSC robots) lack in: (i) considering effect of initial curvature at the inserted configuration, (ii) considering the interactive combined effect of the distributed load coming from the flowing blood with the cutting force required for surgery and the external magnetic field, and (iii) delivering the required force for operating the blood clots along with withstanding the operating force and pressure of the flowing blood. Optimized design considering all the mentioned effects as proposed in the present work is very challenging but essential for efficient minimally invasive surgery.

Applications

➢ Introduced novel exploitable dimensions into the foundational research on MSC robots lead towards rigorous optimized design

➢ Proposed optimized design of novel MSC robot would be ready to fabrication

➢ Readily implementable design of novel MSC robot for precise minimally invasive treatments of cardiovascular diseases

➢ Developed physically insightful multi-physics framework provides foundation for analysing other complex multi-physics problems

Strategy/ Approach/ Technique/ Experiments used to solve

For analysing multi-physical large deformation mechanics of the proposed novel MSC robot, variational energy principle based semi-analytical framework will be developed with integrated iterative shooting algorithm. Based on the parametric investigations on tailoring stiffness and workspace, optimized design of the novel MSC robot will be proposed employing an efficient optimization algorithm.

Graphical Abstract

Group Members

170
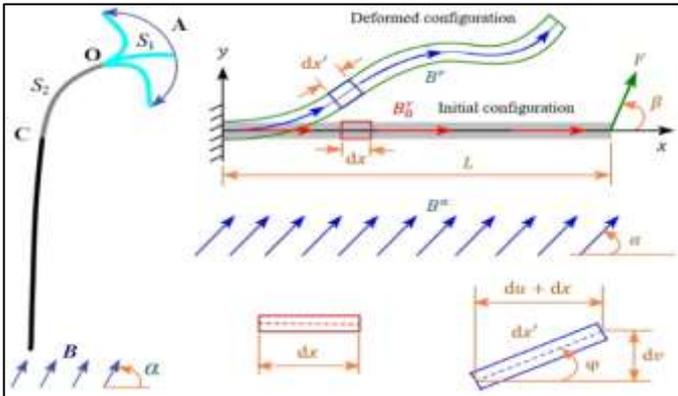
Research Group-Thermo-Fluid and Energy Engineering

- **Name of Principal Investigator/ Group Leader**: Dr. D. P. Mishra
- **Research Theme**: Thermo-Fluid and Energy Engineering
- **Broad Area of Research and Scope:**
  - Heat transfer enhancement in energy
  - Advanced fluid flow modeling techniques
  - Renewable energy thermal system analysis
  - Energy efficiency in thermo-fluid applications

Schematic Representation of Broad Area of Research
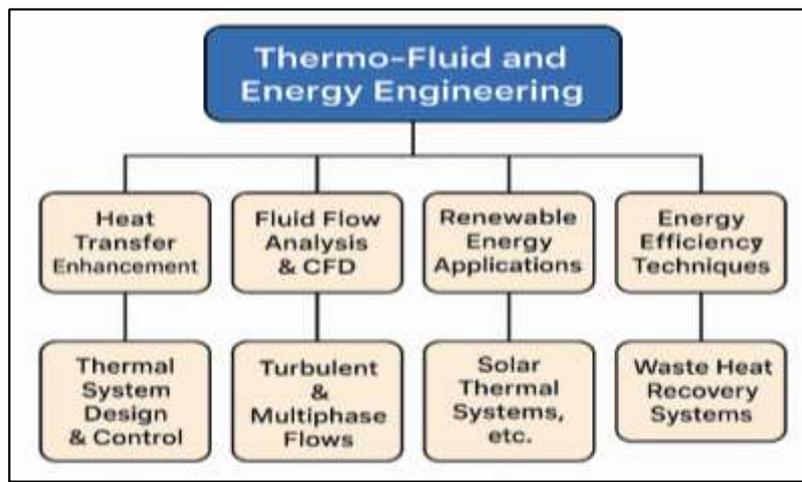

Total Number of Publications by the group: 20

Top 5 Article with impact factor: (Vancouver Style)

- Kumar M, Saha I, Pandey S, Prakash O, Elsayed K, Brar LS. Analysis and optimization of cyclone separators with bulged conical segments using large-eddy simulation and artificial neural network. *Sep Purif Technol.* 2025;370:133247. **Impact Factor:** 8.2
- Maiti R, Shepley P. Penetration of Jet Piles on Submerged Granular Beds. *Ocean Eng.* 2025;315:1–8. doi:10.1016/j.oceaneng.2024.119914. **Impact Factor:** 4.6
- Kunal, Dhiman SK. An experimental study on effect of curvatures of upstream tube on thermal performance of downstream tube in cross-flow of air. *Sci Rep.* 2025;15:14669. doi:10.1038/s41598-025-99239-7. **Impact Factor:** 3.8
- Sharma R, Mishra DP, Chakraborty S, Prakash O, Brar LS. Multi-objective optimization of fin and tube heat exchanger with triple inclined straight winglets for performance enhancement. *J Enhanc Heat Transf.* 2025;32(3):61–87. **Impact Factor:** 1.5
- Prakash O, Pandey VK, Kumar N, Brar LS, Chakraborty S, Kumar A, Ahmad A. Computational and experimental analysis of thermal oil-based parabolic trough collector. *J Enhanc Heat Transf.* 2025;32(3):19–35. doi:10.1615/JEnhHeatTransf.2024054134 **Impact Factor:** 1.5

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	A Fin and Tube Heat Exchanger, Applicant Name: Birla Institute of Technology, Inventor Name: Dr. L.S. Brar, Dr. D.P. Mishra, R. Sharma, Dr. Om Prakash and Dr. Nirmal Kumar.	202331078668 dated 24.11.2023	Published
2	A Fin and Tube Heat Exchanger with Inclined Continuos Vertex Generator, Applicant Name: Birla Institute of Technology, Inventor Name: Dr. L.S. Brar, R. Sharma and Dr. D.P. Mishra.	202431035393 dated 10.05.2024.	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Nanofluids based solar heat harvesting through modified hybrid PV-TEG panel for sustained solar output and extended life span	Dr. SK Dhiman (PI)	SERB CRG (CRG/2023/ 008865)	. 37.12	2024-27
Development of abrasion-resistant electroless Ni-B-W coating on cyclone separator walls and design optimization for longevity with enhanced performance.	Dr. LS Brar (PI) and Dr. Om Prakash (Co-PI)	CRG/2023/0021 16, funded by SERB	48.64	2024-27
Development of High Angle of Attack CFD Aerodynamic Database & Behaviour Model of Missile Configuration at Varying Geometric and Flow Parameters.	Dr. LS Brar (Co-PI)	Sl. No.: 3.1 of DRDO/DFMM/P L/83226/M/01/ 1976/D, funded by AR&DB, DRDO	39.8	2024 -26
Investigation of Stones as Sensible Thermal Heat Storage Materials for Concentrated Solar Power Applications.	Dr. Om Prakash (PI), Dr. LS Brar (Co-PI) and Dr. DP Mishra (Co-PI)	CRG/2021/0037 05/MMM funded by SERB	24.86	2022-25

Industry/Academia Collaborations: MIR Lab, UP.

Achievements: Dr. Om Prakash and Dr. Lakhbir Singh Brar recognized by **Stanford University, USA**, among the **Top 2% Scientists** in their respective research fields.

Group Member

Research Group-Wealth Through Waste

- **Name of Principal Investigator/ Group Leader**: Dr. Richa Pandey
- **Research Theme**: Waste Management for Circular Economy through Additive Manufacturing
- **Broad Area of Research and Scope:**
  - Additive Manufacturing
  - Waste Management of Plastic
  - Application of Shredded Plastic for new product development
  - Development of Shredder and Extruder

Schematic Representation of Broad Area of Research
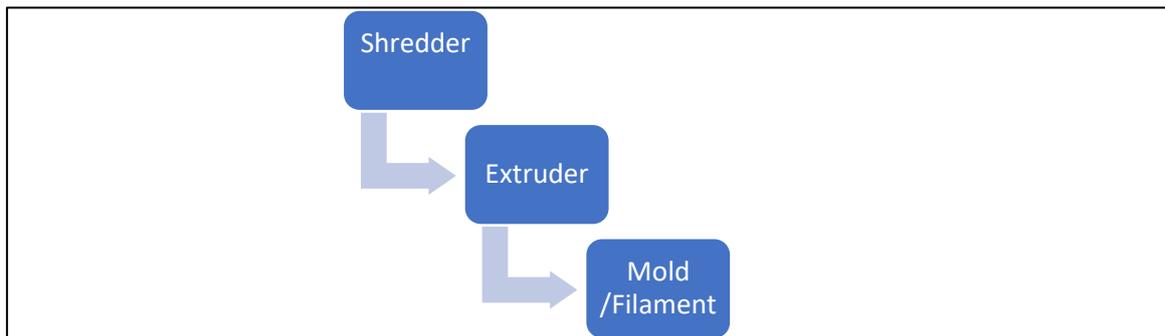
- **Total Number of Publications by the group:**

- **Top 5 Article with impact factor:**

1. Pandey, R., Singh, R., Ranjan, R. (2024). Design and Development of a Shredder Machine for Efficient Recycling of Waste Plastic in India. Advances in Manufacturing Engineering. ICFAMMT 2024. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-97-4324-7_30

2. Phuleshwar Baitha and Richa Pandey, "Post Processing of Waste Plastic after Shredding from a Shredder for Efficient Use in Construction Materials", International Conference on Thermo-Fluids and System Design (ICTFSD 2024) BIT Mesra,4-5 April 2024

3. Phuleshwar Baitha and Richa Pandey, "Post Processing Construction Materials Through Post-Shredding Processing of Waste Plastic", International Conference on "Advances in Materials and Chemical Sciences" (AMCS-24), BIT Mesra,18th-20th Dec 2024.

4. Phuleshwar Baitha, Richa Pandey, Abhinav Amr Thakur and Preety Aruna Kerketta, "Process Parameter Analysis of 3D Printing for Better Product Quality", International Conference on Recent Advances in Mechanical Infrastructure (ICRAM 2025), IITRAM, 10-12 Jan, 2025

5. Singh, Rahul; Singh, Bhushan; Chandra, Sunny; Kumar, Shiv Ray; Pandey, Richa. Evaluation ofwind energy-based electricity potential at 40m height in 3 districts of Bihar. Transactions on Energy Systems and Engineering Applications, 5(2): 658, 2024. DOI:10.32397/tesea.vol5.n2.658Trans.

6. **Targeted Application Area:** Tourist Places, SC, ST, Women, Lower Economy Group

Brief Description of Projects

Problem Statement:
(i) Promoting the adoption of 6 R's of Sustainability by effective plastic waste management
(ii) Awareness creation and Technological Intervention for Eradication of Plastic and other waste.
(iii) Upgradation of tiny, small and medium enterprises run by local women entrepreneurs for making small artifacts, toys, jewellery etc.
(iv) Showcasing of appropriate technologies and organizing demonstration programmes for benefit of empowerment of local women and men.
(v) Development for creation of new composites for various uses and challenges.

Broadly, the implementation of a circular economy in a rural area could address multiple facets of the plastic economy and plastic usage from the manufacture of plastics to their eventual disposal, including:

➢ Eliminating the Plastics from the Tourist Places of Jharkhand.
➢ Replacing conventional plastics with reusable, renewable, and/or biodegradable alternatives that provide a suitable function and are able to be handled by local recycling and/or composting infrastructure.
➢ Redesigning products with optimal recyclability, reuse, and repair in mind.
➢ Promoting reuse and return schemes by providing local infrastructure and incentives (refilling schemes, deposit-refund systems, zero-waste shops) and enforcing Extended Producer Responsibility (EPR) policies regarding plastic packaging waste.
➢ Collecting and recycling plastic through informal and formal waste collection schemes.
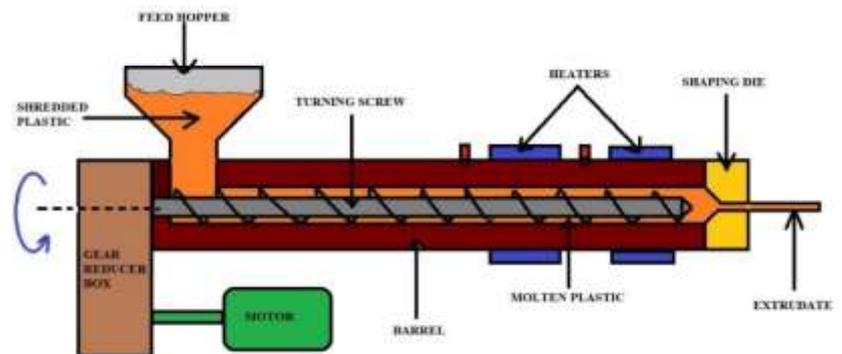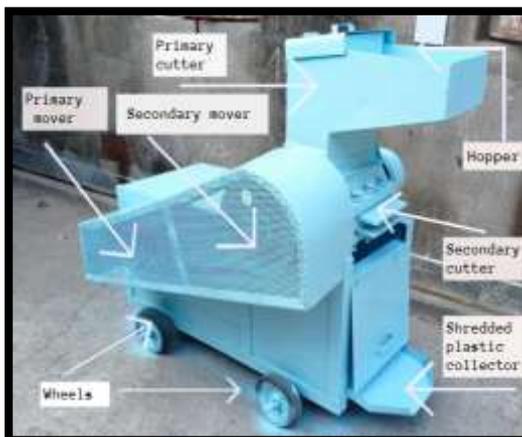
Group Members

DEPARTMENT OF MANAGEMENT STUDIES

Research Group- Corporate Sustainability

- **Name of Principal Investigator**: Dr. Anupam Ghosh
- **Research Theme**: Corporate Social Responsibility & Sustainable Business
- **Broad Area of Research:**
  - Sustainable Business, Entrepreneurship
  - Corporate Social Responsibility (CSR) & Artificial Intelligence (AI)
  - Ethical Benchmarking of CSR

  Scope:

- ✓ **Environmental Sustainability**: Encompasses practices like reducing carbon footprints, adopting renewable energy, and implementing circular economy principles to minimize ecological harm and promote long-term resource conservation.
- ✓ **Social Impact**: Addresses initiatives such as fair labor practices, diversity and inclusion, community development, and philanthropy to enhance societal well-being and address inequalities.
- ✓ **Ethical Governance**: Focuses on establishing robust policies for ethical conduct, anti-corruption measures, and compliance with regulations to ensure integrity in business practices.
- ✓ **Economic Viability**: Integrates sustainability into core business models, such as developing sustainable products or services, to drive long-term profitability while addressing global challenges like climate change and resource scarcity.

Schematic Representation of Broad Area of Research
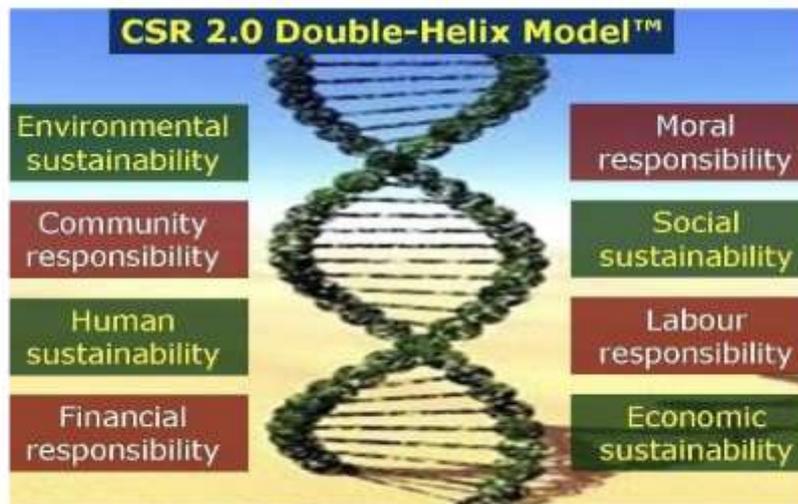
Źródło: Visser W., The Evolution and Revolution of... (op.cit).

- **Total Number of Publications by the group:** 41

  Top 5 Article with impact factor:

1. Mukherjee, A, Dasgupta Ghosh, B, Ghosh, A & Roy S. (2024). "Polyvinylidene fluoride nanocomposites as piezoelectric nanogenerator: properties, fabrication and market applications". Advanced Engineering Materials 26 (12), 24-45. (IF-3.76)

2. Sodhi,S and Ghosh, A. (2023)."Sustainability reports: a thematic analysis related to sustainability factors - Manufacturing perspective", International Journal of Process Management and Benchmarking Development, Vol 15(2), pp. 149-181. (IF- 1.26)

3. Malpani, R & Ghosh, A.(2023)."Corporate Social Responsibility (CSR) practices: A strategy for Indian Startups to sustain", Business Perspective and Research, DOI: 10.1177/22785337211070357. (IF- 2.711)

4. Patra, S.P. & Ghosh, A. (2021). Relative Innovation Index: State of Patent Examination in India. Journal of Intellectual Property Rights. 26(5), pp. 277-285. (IF- 1.34)

5. Choudhury, S. & Ghosh,A.(2015), "Development through Prime Minister Employment Generation Programme in India". Mediterranean Journal of Social Sciences, 6(3), 435- 444. (IF- 0.235)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Granted)
1	A system and a process for preventing electronic fuel injection (EFI) dry running in a two-wheeler Inventors: Dr. Anupam Ghosh, Dr. Soumya Prakash Patra, Dr. Rohit Agrawal	**Application No.:** 202331070663 **Date of Filing:** 17-10-23	**Date of Grant:** 20/02/2025

- **Industry/Academia Collaborations:**
  - With IIM Bodh Gaya for patent and IP protection
  - With Sri. Arjun Malhotra (Co-Founder of HCL Technologies Ltd)
  - Consultancy done as "Visiting Faculty" invited & granted by **IIM Ranchi (Rs. 1,50,000/-)** for the period *January-February 2020*
- **Targeted Application Area:** Society, Natural Environment & Business.

Research Group - Supply Chain Analytics

Name of the Principal Investigator: Professor Supriyo Roy

Research Group: Professor Supriyo Roy, Dr. Niraj Mishra, Dr. Satyajit Mahato

Research Theme / Broad Area: Supply Chain Analytics

AREA FOCUSED

- Supply Chain Management,
- Marketing Operations Interface,
- Business Model Optimisation,
- Behavioural (Humanitarian) Supply Chain
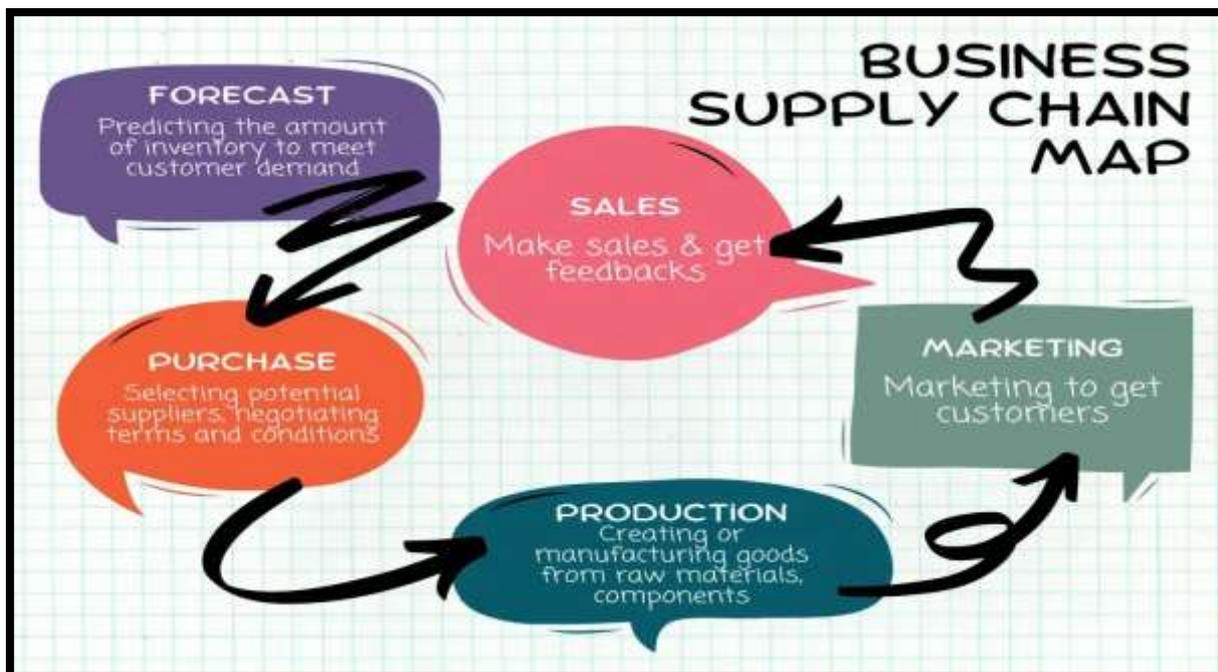
RESEARCH FOCUS

- Supply Chain Analytics research focuses on leveraging data, technology, and smart analytics to optimise various aspects of supply chain, including demand forecasting, risk management, and overall efficiency.
- This field is rapidly evolving with the integration of traditional technologies like Artificial Intelligence and Machine Learning to create more resilient and responsive supply chains.
- Key Areas of Supply Chain Analytics Research covers business problems with Resilience and Risk Management, Demand Forecasting, Optimisation, Cognitive Technologies, and Blockchain Integration.
- When successfully implemented, this will add value to Increased Efficiency, Greater Transparency and Traceability, Enhanced Resilience, and Improved Decision-Making. This, in turn, affects increased financial investments and sustainability.

- **TOTAL PUBLICATIONS BY THE GROUP: 150 +**

- **TOTAL NUMBER OF RESEARCH PROJECTS: 04**

- **TOTAL NUMBER OF CONSULTANCY: 03**

RECENT PUBLICATIONS (TOP 5: LATEST TO OLDER)

1. Swarup Mukherjee, Anupam Dey & *Supriyo Roy** (2025). "Risk Prioritisation in Enterprise Supply Chains: Application of Fuzzy Analytic Hierarchy Process" **Accepted; Business Process Management Journal**, **Emerald, Q1**, **Impact Factor: 8.4** (ABDC/SCOPUS/ SSCI)

2. Swarup Mukherjee, Anupam Dey & *Supriyo Roy** (2024). Service Quality Management under Risk Prioritisation and Imprecise Information: A Hybrid Fuzzy Approach. **Accepted; The TQM Journal, Emerald, Q1, Impact Factor: 9.1** (ABDC/WOS/SCOPUS)

3. Swarup Mukherjee, Anupam Dey & *Supriyo Roy** (2024). Enterprise Risk Management in Supply Chain Operation: A Fuzzy Risk Prioritisation Approach. **Accepted;** [*Benchmarking: An International Journal*](https://doi.org/10.1108/BIJ-04-2024-0308), *Emerald*, **Q1,** **Impact Factor: 9.7.** https://doi.org/10.1108/BIJ-04-2024-0308 (ABDC / SCIE / WOS)

4. Satyajit Mahto & *Supriyo Roy** (2024). Optimising Defect Rework for Software Start-Up Schedule Variation: A Six-Sigma-Based Approach. **Published,** *International Journal of Quality & Reliability Management (IJQRM), Emerald,* Vol. 41, No. 14, pp. 2549-2578, **Impact Factor: 5.8** (ABDC/ESCI/SCOPUS)

5. Swarup Mukherjee, Anupam Dey & *Supriyo Roy** (2024). Supply chain risk prioritisation: Multi-criteria based intuitionistic fuzzy TOPSIS approach. *Accepted for Publication*, **International Journal of Quality & Reliability Management, Emerald,** **Article ID:** 716178. IJQRM-07-2023-0214, Online early View: w.e.f: 05.2.2024. **Impact Factor: 5.8,** (ABDC/ESCI/SCOPUS).

6. *Supriyo Roy** & R.P.Mohanty (2023). Green Logistics Operations and its impact on supply chain sustainability: An empirical study. *Published Business Strategy and the Environment,* **Wiley**. DOI: 10.1002/bse 3531. Indexed at: SSCI/ABDC/WOS. 7th Best in Management Category, **Impact Factor: 13.4** (2022). **Q1** Category, Vol. 33, Issue 2, pp. 1447-1476. (ABDC-A/ SSCI/ SCOPUS).

7. Mishra, N., Srivastava, P., Mahato, S. and Shivani, S. (2023), "Use and acceptance of crypto currencies in India: an evaluation of block chain application in financial sector using PLS SEM and ANN approach", **Published, International Journal of Quality & Reliability Management,** Vol. 41 Issue 8, pp. 2027-2054, **Impact Factor: 5.8** (ABDC/ESCI/SCOPUS)

RESEARCH PROJECTS: RECENT 5 IN CHRONOLOGICAL ORDER

- Satyaki Sarkar & **Supriyo Roy*** (2023). Interrelationship Between Socio-Economic Development, Social Innovation and Entrepreneurship Development: An Empirical Study on Small Heritage Town. Indian Council of Social Science Research, New Delhi, **Amount: 8.06Lakhs**. Completed.

- Shradha Shivani, **Niraj Mishra,** Anand Kumar & Praveen Srivastava **(2022).** Possibilities of Inclusion of Tribal Languages in the Curriculum of DoW- run Residential Schools for STs and Assessment of Learning Aptitude of Students. Ram Dayal Munda Tribal Research Institute, Govt. of Jharkhand. **Amount: 9 Lakhs,** Completed.

- **Niraj Mishra** & S.L Gupta **(2019).** Study for Investigating Factors Influencing Student Preference of Private Higher Education Institutes in Oman, The Research Council, Government of Oman, Amount: 19.25 Lakhs, Completed.
- **Niraj Mishra** & S.L Gupta **(2019).** DEEPeduOM: A Novel prediction approach using Deep learning for academic quality evaluation in Oman. The Research Council, Government of Oman, **Amount: 19.25 Lakhs,** Completed.

- **INDUSTRY/ACADEMIA COLLABORATIONS**

  1. Guest Faculty / Academic Association with IIM Ranchi, NIT Durgapur.

  2. Working with Durgapur Cement under Birla Corporation Limited.

  3. Worked on research-based work with Production Planning Unit of Durgapur Steel Plant.

- **TARGETTED AREA**

  - Climate Change Modelling,
  - Modelling on Water Resource Management

Group Members

Research Group – Technology Management/Service Innovation & Sustainable Development

Name of the Principal Investigator: Dr. Anand Pd Sinha

Research Group: Ms. Neha Choudhary/ K.M. Nidhi Singh/ Pawan Kr. Tiwari

Research Theme / Broad Area: Technology Management in Mining Industry

AREA FOCUSED

- Antecedents and Impact of Service Innovation on Customer Satisfaction on Retail Banking Sector
- Modelling and Analysing AI-Driven HRM Strategies
- Waste Management and Impact Assessment for Creating of Livelihoods Generation for Sustainable Development

---

Schematic Representation of Broad Area of Research
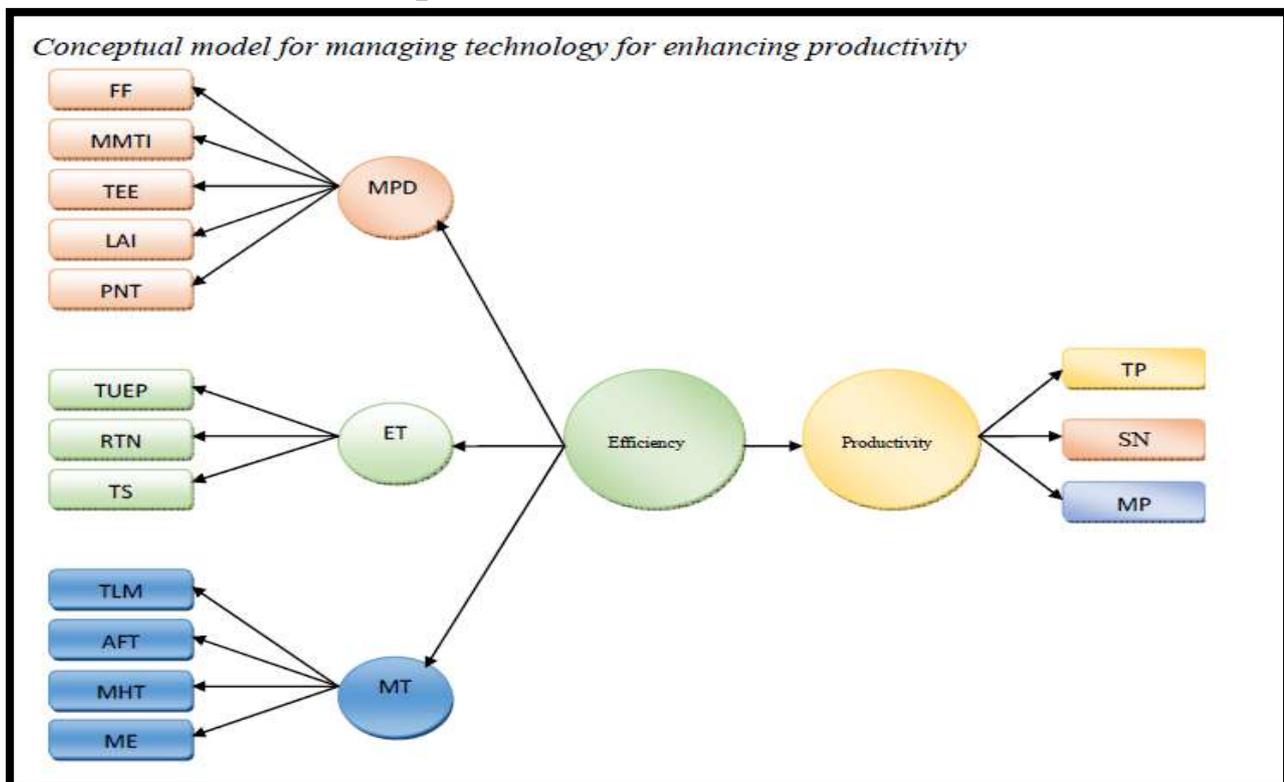
Research Focus

- Technology Management in mining sector which is highlighting the problems encountered in context to management of the installed technology its adoption, implementation to productive utilization. Background of this research is based on the managerial issues related to the effective management of technology to enhance the production of coal.
- Technology and service innovation allow banks to offer better consumer services, they have fundamentally changed how Indian banks operate both internally and externally and How to design an organizational model that fully utilizes the benefits of technology innovation srvices in banking sector.

- The study based on how Artificial Intelligence (AI) can be used to design and implement Human Resource (HR) strategies that pro mote environmental sustainability in organizations. It involves creating models to understand and improve AI-enabled HR practices, such as green recruitment, training, and performance management.
- Waste management and impact assessment focus on reducing waste, protecting the environment, and creating jobs, supporting sustainable livelihoods and economic growth.

- **Total Publications by PI : 24**
- **Top 5 Article with impact factor:**

1. Choudhary, Neha, Sinha, Anand Prasad, Mukherjee Somnath (2025). Identifying Key Success Factors and Challenges for Service Innovation in the Indian Banking Sector- A Critical Review in Journal of Civil and Environmental Engineering, Vol. 13 (5), pp. 74-96. (Scopus, UGC Care)
2. Choudhary, Neha, Sinha, Anand Prasad, Mukherjee Somnath (2025). Impact of Logistic Flows of Service Quality and Delivery Dimension Towards Customer Satisfaction: An Empirical Study" in International Journal of Electronic Customer Relationship Management Vol. 15, Nos. 1/2, 2025 **(Non-Paid Scopus)**
3. Aditi Nag, Neha Chaudhary, **Anand Prasad Sinha**, Divya Sinha, Smiriti Mishra **(2023).** Predictive Analytics- New Business Intelligence in SCM, International Journal Value Chain Management, (Inder science) Vol.14 (3) pp. 325-345. **(Non-Paid Scopus)**
4. **Sinha**, **Anand Prasad,** Srivastava, Praveen, Asthana, Ashok **(2021).** Customer Satisfaction and Loyalty for Online Food Services Provider in India: An Empirical Study., *The Journal of Business Perspective, Sage Vision* – Management Development Institute, (MDI, Gurgaon)., pp. 1–17. DOI: 10.1177/09722629211034405. **(Non-Paid Scopus)**
5. **Sinha, Anand, Prasad,** Chatterjee, P.K. Singh, Shailendra Kumar, Asthana, Ashok **(2020).** "Factors in technology management and its performance: A case study of Indian open cast coal mining., *International Journal Technology, Policy and Management,***(Inder Science)** Vol. 21, No. 4, pp.269-301. **DOI**: 10.1504/IJTPM.2021.10043451 **(Non-Paid Scopus)**

- **INDUSTRY/ACADEMIA COLLABORATIONS**

    1. Guest Faculty / Academic Association with National University of Study and Research in Law, Ranchi

    2. Research paper collaboration with NDIMS, New Delhi & Sarla Birla University and Mecon Ltd.

Group Members

Research Group – Women Leadership & Decision Making

- **Name of Principal Investigator/ Group Leader**: Dr. Sujata Priyambada Dash
- **Research Theme**: Women Leadership, Decision Making, and Political Participation

Broad Area of Research and Scope:

- Grounded in the Panchayati Raj System's democratic principles, this study emphasizes decentralized decision-making and community engagement. It aligns with Jharkhand's Gram Panchayat structure, where local leaders mobilize citizen participation and prioritize inclusive development.
- Examines how patriarchal norms in rural institutions limit women's agency. The proposed project would incorporate gender-sensitive approaches to dismantle systemic barriers, such as the *Sarpanch Pati* phenomenon, and strengthen women's roles in governance.
- The study would focus on SHGs and cooperatives as vehicles for economic self-reliance. Training in financial literacy, poultry farming, and market linkages fosters collective agency and leadership.

Schematic Representation of Broad Area of Research:
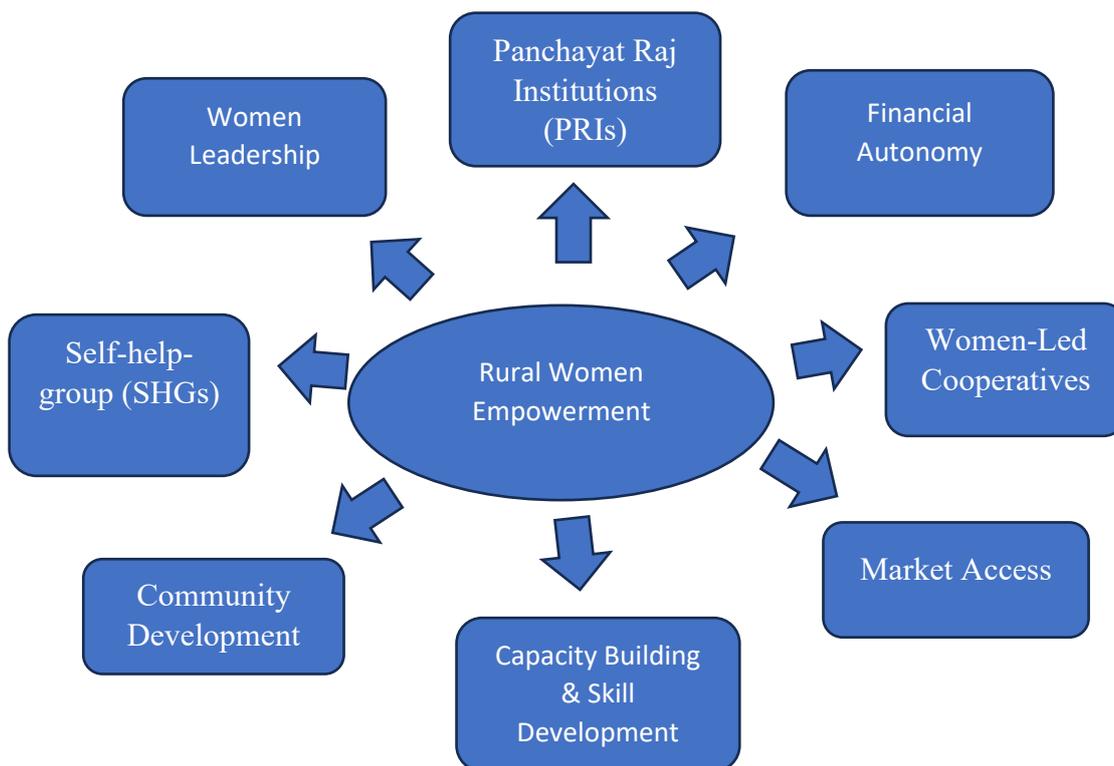
- **Number of Publications by the group: 82**
- **Top 5 Article with impact factor: (Vancouver Style)**

1. Kumari, R., **Dash, S. P.,** & Chatterjee, R. (**2025**). *A Bibliometric Analysis on Green Human Capital and Work Engagement with emphasis on Psychological Ownership.* Work: A Journal of Prevention,

Assessment and Rehabilitation, **Sage,Q2, DOI:** https://doi.org/10.1177/10519815251396929 IF:1.7

2. Kumari, R., **Dash, S.P., &** Chatterjee, R. **(2025***).* Advancing Circular Economy Through Green Human Capital: The Critical Role of Sustainability. *Circular Economy and Sustainability,* **Springer, USA, Q1** *https://doi.org/10.1007/s43615-025-00583-7* IF: 1.5

3. Murala, D.K., Panda, S.K., **Dash, S. P.** (**2023**), MedMetaverse: Medical Care of Chronic Disease Patients and Managing Data Using Artificial Intelligence, Blockchain, and Wearable Devices State-of-the-Art Methodology, **IEEE Access, USA Q1,** DOI:10.1109/ACCESS.2023.3340791 IF: 3.6

4. *Dash, Sujata Priyambada & Roy, Supriyo.* **(2021**). Performance Evaluation Under Human Capital Perspective: An Empirical Evidence. **Published in International Journal of Productivity and Performance Management, Emerald Publishers, UK, Q1,** (ISSN print: 1741-0401)**, Vol. 70 No.6, pp. 1336-1360**, **DOI:10.1108/IJPPM-07-2019-0334 IF: 7.04**

Patents by the group: NIL

Research Projects: Recent 5 in Chronological

Sl. No.	Project Title	PI / Co- PI/	Funding Agency	Year of Sanction	Sanctioned Amount	Project Duration
1	Designing and Evaluating a Holistic Leadership Program to Empower Rural Women for Gram Panchayat Governance and Cooperative Entrepreneurship Development	Project Director – Dr. Sujata Priyambada Dash, Co-Director – Dr. Rajeshwari Chatterjee	Indian Council of Social Science Research	2025	Rs. 10.00 L	1 year - Ongoing

Industry/Academia Collaborations: In collaboration with ICFAI University and XLRI Jamshedpur, three Edited Book volumes have been published with reputed publishers of the UK and the USA. Mentioned below:

(i) Digital Immune System: Principles and Practices, Wiley Scrivener Publishing, Wiley, USA,   ISBN:978-1-394-38376-4.
(ii) Metaverse and Blockchain Use Cases and Applications. In Series: Advances in Computational Collective Intelligence, An Auerbach Book, CRC Press, Taylor and Francis Group, UK.
(iii) Recent Advances in Blockchain Technology: Real World Applications. Intelligent Systems Reference Library (ISRL, Volume 237), Springer Cham, USA.

Targeted Application Area: Rural Women Development**,** Socio-Economic Development, and Cooperative Entrepreneurship Development

Group Members

DEPARTMENT OF PHYSICS

Research Group- Nanostructured Optoelectronic Materials and Devices (NOMAD)

- **Name of Principal Investigator/ Group Leader**: Dr. Dilip K. Singh
- **Research Theme**: Nanotechnology, Semiconducting Materials and Devices , Nano-Optics, Optical spectroscopy and electron microscopy
- **Broad Area of Research and Scope:**
  - 2D-Semiconductors for Electronic and Opto-electronic Devices
  - Light scattering spectroscopy based Optical Sensors and Techniques
  - Light-Matter interaction at Sub-wavelength scale
  - Raman and Photoluminescence spectroscopy
  - Novel Nano-fabrication Techniques
  - Physics and Applications of Carbon Nano-materials
  - (Nano-diamonds, Quantum dots, CNTs, Graphene, C_3N_4)
  - Machine learning methods for Surveillance and Security

Top 5 Article with impact factor: (*Total citations: 1519, h-Index: 19, i10 index: 28*)

1. Manisha Kumari, Rakesh K. Prasad, Manish K. Singh, Parameswar K. Iyer, **Dilip K. Singh** *Piezoresistive/Piezoelectric Pressure Sensor Based on CVD-Grown ZnO Nanowires on Polyethylene Terephthalate Substrate* ACS Applied Electronic Materials **2024**, 6, 8, 6165–6173, Impact factor: 4.7   Citations: 2

2. Rakesh Prasad, Koushik Ghosh, Pravat Giri, Dai-Sik Kim, **Dilip K. Singh** *High-Efficiency Photodetector Based on a CVD-Grown WS2 Monolayer* ACS Applied Electronic Materials **2023**, 5, 7, 3634-3640 Impact factor: 4.7   Citations: 24

3. Rakesh K. Prasad, Manisha Kumari, and **Dilip K. Singh** *Controlled Nucleation Sites with Large Coverage Area for Continuous Monolayered WS₂ Growth by Using the CVD Process* Crystal Growth & Design **2023**, 23, 11, 7744-7753. Impact factor: 3.8   Citations: 3

4. **Dilip K. Singh**, Parameswar K. Iyer, and P. K. Giri, *Role of molecular interactions and structural defects in the efficient fluorescence quenching by carbon nanotubes.* Carbon **2012**, 50, 4495. Impact factor: 10.5   Citations: 80

5. **Dilip K. Singh**, Parameswar .K. Iyer, and P. K. Giri, *Diameter dependence of interwall separation and strain in multiwalled carbon nanotubes probed by X-ray diffraction and Raman scattering studies* Diamond and Related Materials **2010**, 19, 1281 Impact factor: 4.3   Citations: 230

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Optimization of Chemical Vapor Deposition (CVD) growth conditions for defect free large crystallite 2D-Semiconductors and their hetero-structures for Opto-electronic applications	PI	UGC-DAE-CSR Indore	5.93	2022-25
Smart onboard big-data monitoring and processing tools for safer road transportation	PI	NM-ICPS, ISI Kolkata, DST Govt. of India	5.02	2022-25
Defect Engineered Fluorescence from "Nano-Diamond" for Nano-photonics and Bio-Imaging.	PI	DST, Govt. of India.	35.0	2014-2019
Faster and brighter single photons from 2D crystals and their interfacing with plasmonic waveguides	PI	CRS Scheme NPIU_TEQIP MHRD	13.69	2019-2020
Self-fitting 4-D printed smart scaffolds with efficient bone regenerative potential	Co-PI	SERB, Govt. of India.	40.26	2022-2025
Development of Ni reinforced Surface composite of AA5083 with high wear, tensile and fatigue resistance for modern transportation sector	Co-PI	SERB, Govt. of India.	52.00	2024-2027

Industry/Academia Collaborations:

1. Prof. Hyeong-Ryeol Park, UNIST, South Korea.
2. Dr. Kwanggeol Lee, Associate Professor, Hanyang University, South Korea
3. Prof. Monica Fleisher- Tubingen, Germany
4. Prof. P. K. Iyer, IIT Guwahati
5. Prof. P. K. Giri, IIT Guwahati
6. Dr. Vasant Sathe, UGC-DAE CSR, Indore
7. Dr. Christopher David, IGCAR Kalpakkam
8. Dr. Suraj Khanna, CSIR-NPL, Delhi
9. Dr. Sanjay R. Dhakate, CSIR-NPL, Delhi
10. Dr. Bipin Gupta, CSIR-NPL, Delhi
11. Dr. Prabir Pal, CSIR-CGCRI, Kolkata
12. Dr. Ambuj Tripathi, IUAC,New Delhi
13. Dr. Anchal Srivastava, BHU Varanasi
14. Dr. Richa Mishra, BIT Mesra
15. Dr. Sneha Singh, BIT Mesra
16. Dr. Arun Kadian, BIT Mesra

Targeted Application Area: Semiconductor devices, Health monitoring devices, Flexible materials and devices, Adulterant sensor, Non-destructive testing

Growth and Engineering 2D-Semiconductors for Opto-electronic applications

Problem Statement

The desire to miniaturize devices beyond Moore's scaling law requires integration of atomically thin semiconductors with existing CMOS technologies. For past nearly two decades 2D materials has been extensively explored as an alternative to the Silicon to realize ultra-small footprint size of the devices, low power consumption and high switching speed [1-6]. Monolayered two–dimensional (2D) semiconducting transition metal dichalcogenides (TMDs), MX_2 (M=Mo, W; X=S, Se) have attracted huge attention due to their direct band-gap type electronic structure, high electronic mobility and high quantum efficiency making them suitable for electronic and opto-electronic devices. Towards realization of efficient opto-electronic devices, growing large crystallite size of these materials with limited defects and continuous film compatible using technique compatible with CMOS fabrication procedure has remained a challenge for long. Additionally, opto-electronic devices based on these materials shows poor switching speed limiting commercial realization of optical modulators and switches based on them. For past few years, one of our major focus has been to explore the possibility to overcome these limits and realize efficient photo-detectors and optical modulators based on these monolayered semiconducting films.
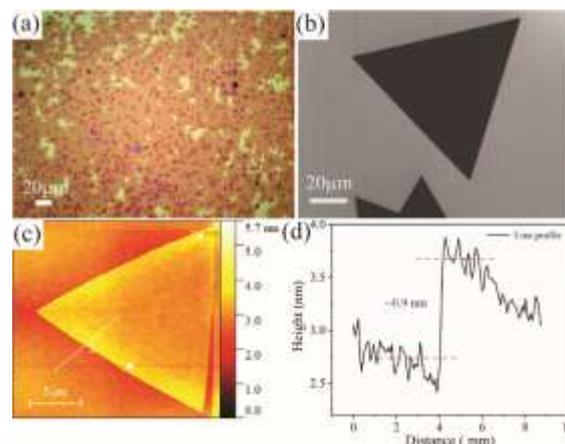

Figure-1 (a) Optical micrograph of as grown WS_2 showing continuous layer with coverage area ~ 97 %. (b) FESEM image of one of the isolated crystals of WS_2 with crystallite size ~60 □m. (c) Atomic Force Microscope (AFM) image of single layer of WS_2 (d) Thickness profile of WS_2 isolated crystal showing height = 0.9 nm indicating monolayer growth.

Applications:
- High speed MOSFETs
- Photodetectors, Optical Modulators, Sensors

Methods

We have established the recipe for growth of continuous films of monolayered MoS_2 and WS_2 using Atmospheric pressure chemical vapor deposition on SiO_2 (285 nm)/Si substrate with crystallite size as large as 80 µm (MoS_2) and 60 µm (WS_2) with coverage area of ~ 97 % and fewer grain boundaries. MoO_{3-x} and WO_{3-x} was found to be responsible for self-seeding nucleation and its amount decides the nucleation density resulting in coverage area while amount of sulphur was found to decide the crystallite size [2,3]. The developed method has potential to be integrated with in-line fabrication tools in semiconductor foundries.

Publications:
[1] Journal of Electronic Materials 2025 (In Press)
[2] ACS Omega **2023**, 8, 10930.
[3] ACS Crystal Growth & Design **2023,** 23, 7744.
[4] ACS Applied Electronic Materials **2023,** 5, 3634.
[5] Nanotechnology **2017,** 28(7), 075602.
[6] RSC Advances **2015,** 5, 69110.
[7] Int. J. Nanosci. 10, 39 (2011).

Nanostructured Photodetectors and CMOS based Biosensors

Problem Statement

At the heart of modern technologies whether it is related to image / video processing, communication, security and surveillance, microscopy and spectroscopy, medical diagnostics or digital economy there lies a photodetector / photo-sensor/ CCD array. There has been continuous demand to achieve better quality photodetectors in terms of responsivity i.e quantum efficiency, spectral responsivity, detectivity with reduced device size. Existing CMOS technology primarily relies on use of Silicon and germanium: the indirect band-gap semiconductor which have very poor quantum efficiency. Use of direct band-gap III-V or, II-VI semiconductors results into high device cost and incompatible fabrication procedure with silicon based CMOS technologies.

Due to large surface area, devices based on nanostructures are expected to show higher sensitivity to analytes under investigation. There has been ongoing effort to develop sensitivite CMOS based biosensor for diagnostics.
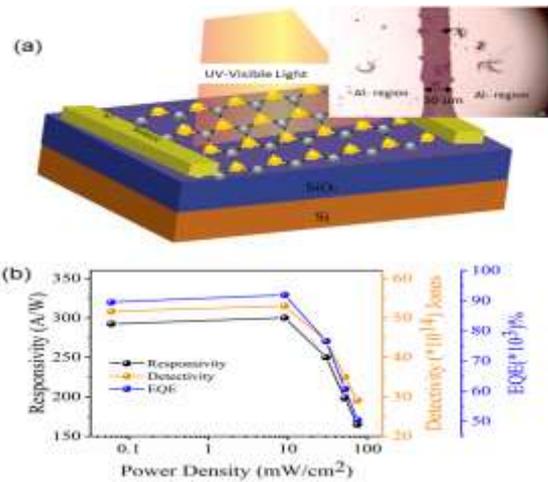
Figure-2 (a) Shows the schematic of Photodetector fabricated WS2 grown using Atmospheric pressure chemical vapor deposition (APCVD). Inset shows the photograph of the device with channel length 30 μm. (b) The device shows responsivity of 290 A/W at incident power density as low as 0.1 mW/cm².

Applications:
- Efficient broadband photodetectors.
- Ultrasensitive electronic biosensors.

Methods

Use of nanostructures particularly 1-D Nanowires and 2D semiconductors opens up possibility of achieving much higher performance parameters due to high surface to volume ratio, relaxation of requirement of epitaxial growth and possibility of using heterostructures of 2D semiconductors. Due to large surface to volume ratio, these devices are expected to show large modulation in device characteristics with ultralow concentration of analytes.

Publications:

[1] Journal of Electronic Materials (2025) 54, 3014–3023.
[2] Diamond and Related Materials (2025) 155, 112289.
[3] ACS Applied Electronic Materials (2023) 5, 7, 3634-3640.
[4] ACS Applied Nano-materials 2025 (Under revision)

Group Members

Research Group- Aerosol-Climate-Environment (ACE)

- **Name of Principal Investigator/ Group Leader**: Dr. Nishi Srivastava
- **Research Theme**: Aerosol-Climate interaction and Environmental Impact
- **Broad Area of Research and Scope:**
  - Atmospheric Aerosols; Aerosol Cloud Interaction
  - Urban Heat Island
  - Application of Artificial Neural Network in Atmospheric Physics
  - Numerical Modelling

Schematic Representation of Broad Area of Research
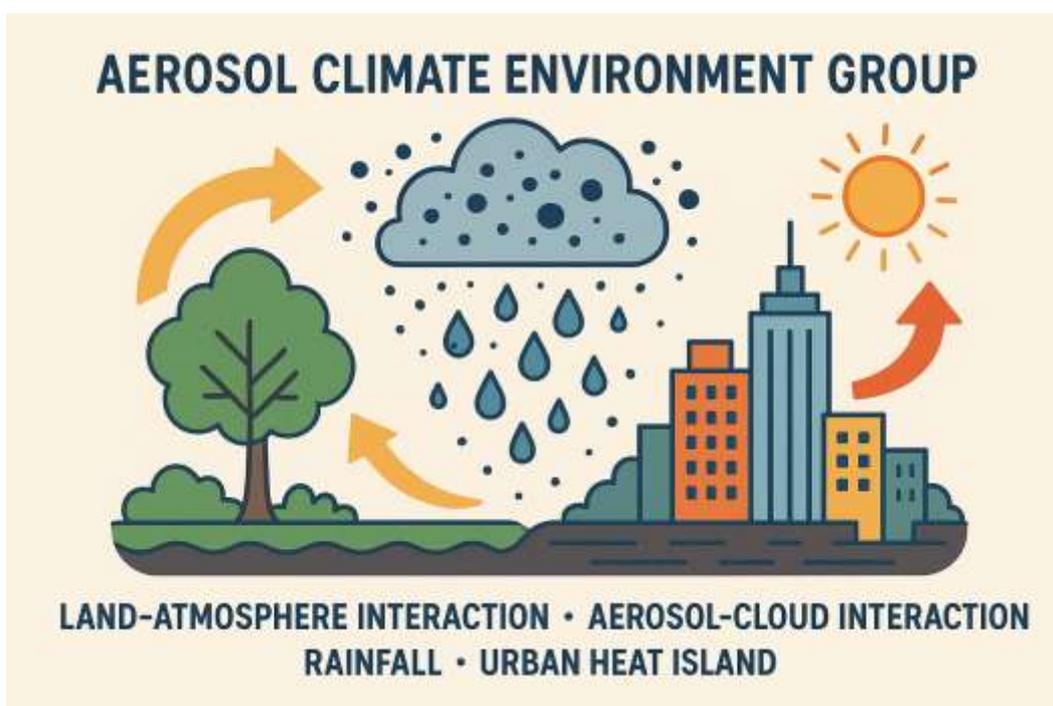
Total Number of Publications by the group: 15

Top 5 Article with impact factor:

1. Srivastava, N., Tewari, A. and Das, A. (2025). Associations of Trace Gases and Meteorological Parameters and Particulate Matter with Ozone under Smog Conditions. *Pollution*, (), -. doi: 10.22059/poll.2025.383221.2585 (IF: 1.1)
2. Gaurav T, Srivastava N. Assessment of health hazardous particulate matter (PM2. 5) from artificial neural network using meteorological and pollutant parameters. Theoretical and Applied Climatology. 2025 Jan;156(1):73. (IF: 2.8)
3. Tewari A, Srivastava N. Impact of COVID lockdowns on spatio-temporal variability in land surface temperature and vegetation index. Environmental Monitoring and Assessment. 2023 Apr;195(4):507. (IF: 2.9)

4. Srivastava N, Divyam J, Ghosh U, Priya M, Saxena N, Kumar M. Statistical and spectral analysis of wind over a strategic location. Journal of Water and Climate Change. 2022 Sep 1;13(9):3305-22. (IF: 2.7)
5. Srivastava N, Kumar M. Comprehensive study of aerosols properties over various terrain types. Environmental Monitoring and Assessment. 2022 Dec;194(12):924. (IF: 2.9)

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Impact of Meteorological model grid and parameter change in a Chemical Transport Model in terms of aerosols concentration and distribution	PI	DST Fast Track Project	20.5	3Yrs
Comparison of Aerosol Products Measure with Satellite against Ground Based Observations over Indian Sub-continent	PI	BIT Mesra	0.6	1Yrs
Modifications in Atmospheric Energetics over Indian domain during Monsoon in response to ENSO Phases	PI	SERB-MATRICS	6.6	3Yrs

Industry/Academia Collaborations:

1. Dr. Nadege Blond, City Environment Image Laboratory, Faculty of Geography and Planning, 3 rue de l'Argonne - 67000 STRASBOURG, France
2. Dr. Swagata Payra, Department of Remote Sensing, Birla Institute of Technology, Mesra, Ranchi

Targeted Application Area:

- Climate change prevention
- Strategies for mitigation of air pollution and Urbanization
- Atmospheric Dynamics

Achievements:

1. Organized one day (25 July 2020) Webinar on topic "Challenges Involved in Simulating the Complex Systems". TEQIP-III Sponsored
2. Organize a one-day symposium at Department of Physics with title "International conclave on atmospheric sciences" with a theme of "Know our atmosphere", 20th November 2024.

Brief Description of Project
Modifications in Atmospheric Energetics over Indian domain during Monsoon in response to ENSO Phases

Problem Statement:
The studies focused on the changes in the atmospheric energetics in the monsoon season in connection to ENSO phases is sparse. Therefore, we propose the study of variation of various components of atmospheric energetics during ENSO.

Applications:
The studies of atmospheric energetics provide us a powerful tool to diagnose the energy flows in the atmospheric system and in the specific atmospheric event such as cyclone. Cyclone and Monsoon, both affect drastic socio-economic impact on the Indian continent and on its inhabitant.

Strategy/ Approach/ Technique/ Experiments used to solve
Numerical simulations are used to achieve the proposed objectives.
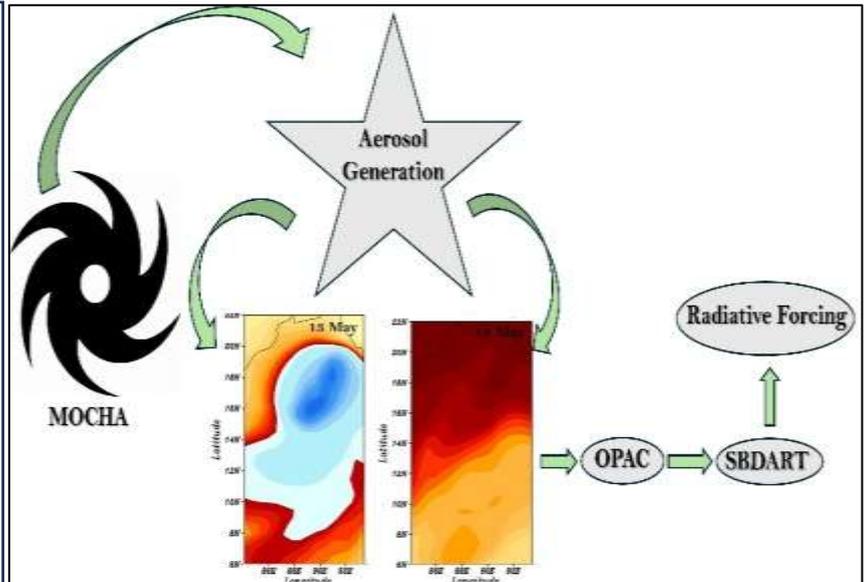
Group Members

Research Group- Biomaterial and Biophysics

- **Name of Principal Investigator/ Group Leader**: Dr. S. K. Sinha

- **Research Theme**: Phytochemistry and its functional Application in Electrotherapy

- **Broad Area of Research and Scope:**

  - Development of new materials to alter the physical properties of extracellular Matrix.

  - Application of nanoparticles and electromagnetic radiation in tumor therapeutics.

  - Investigation of nanoparticle conjugated and electromagnetic radiation interaction with the living cells utilizing machine learning techniques.

  - Devising a scheme to patent the research area scope and technology transfer.
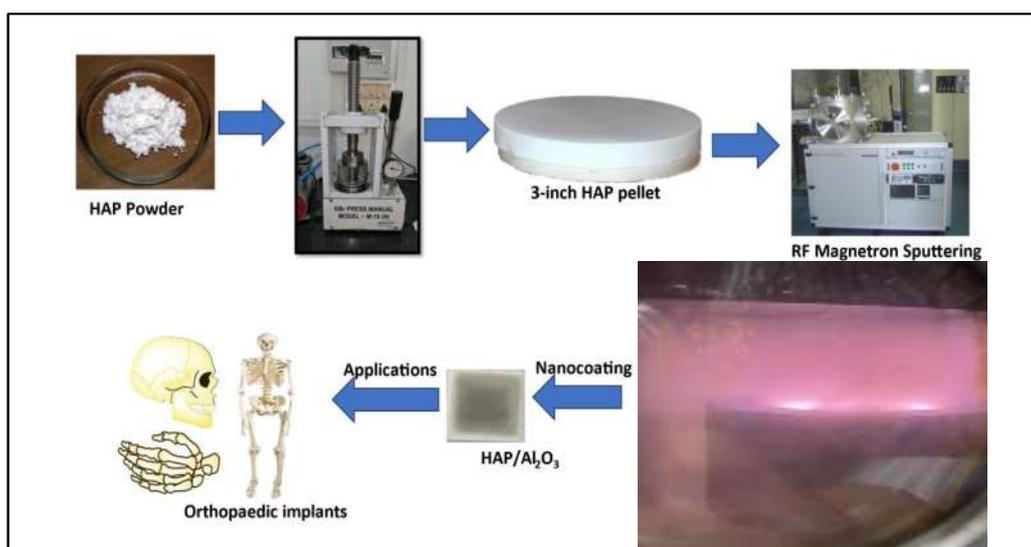
Schematic Representation of Broad Area of Research

Total Number of Publications by the group: 21

Top 5 Article with impact factor:

1. Ranbir Kumar, Deep Shikha, Smit Anand, Sanjay Kumar Sinha, Paresh Kumar Mohanty, Sanjay Mhaske, Abhinandan Kumar, Arkadeb Mukhopadhyay, Integration of 3% Silver-Doped Hydroxyapatite coated on alumina using Radio Frequency Magnetron Sputtering for Superior Bioactivity, Mechanical, Electrical and Wear Resistance, Accepted in ACS Biomaterials Science and Engineering, *18 April 2025;* doi.org/10.1021/acsbiomaterials.4c0247. IF 5.5

2. Estimation of Hematocrit Volume Using Blood Glucose Concentration through Extreme Gradient Boosting Regressor Machine Learning Model, Sharma, Kirti, Tiwari, Pawan K., Sinha, S. K.; ACS Journal of Chemical Information and Modeling, doi: 10.1021/acs.jcim.4c01423; American Chemical Society. IF = 5.6

3. Ranbir Kumar, Deep Shikha, Sanjay Kumar Sinha, Improvement in bioactivity, hardness and friction resistance of 3 % manganese-doped hydroxyapatite coated on alumina using radio frequency magnetron

sputtering, Surface and Coatings Technology, 494, Part 2, 2024, 131481, https://doi.org/10.1016/j.surfcoat.2024.131481. IF 5.4

4. Kumar, R., Shikha, D. & Sinha, S.K. Structural, mechanical, electrical, and biocompatibility investigation of nanostructured hydroxyapatite coating on alumina by radio frequency magnetron sputtering. J Mater Sci 59, 15764–15779 (2024). https://doi.org/10.1007/s10853-024-10132-6 . IF 4.5

5. Sharma, K., Tiwari, P., Sinha, S. (2024). 'Support Vector and Linear Regression Machine Learning Model on Amperometric Signals to Predict Glucose Concentration and Hematocrit Volume', Majlesi Journal of Electrical Engineering, 18(1), pp. 105-115. doi: 10.30486/mjee.2023.2004331.1339 .

<h2 style="text-align:center;">Patents by the group:</h2>

Title and Inventors	Application No. & Date	Status
Kumar Ranbir, Shikha Deep, Sinha Sanjay Kumar, Hydroxyapatite pellets and method of preparation thereof, and the hydroxyapatite pellets-based nanocoated substrate	No.: 02331073541, Dated 10/11/2023	Published

Industry/Academia Collaborations:
- Daegu Catholic University (DCU), Republic of Korea
- Rajendra Institute of Medical Sciences (RIMS), India
- SMT Pvt Ltd. Vasai, Mumbai

Targeted Application Area: Electrotherapy

Achievements: SCI publications in the domain of Electrotherapy

Brief Description of the Project

Problem Statement:
Electromagnetic radiation and gold nanoparticles (AuNPs) contribution towards hyperthermia with less intense electromagnetic waves and in less targeted time duration. The hyperthermia calculations are investigated through the implementation of specific absorption rate (SAR)

Strategy/ Approach/ Technique/ Experiments used to solve
- Nanoparticle synthesis through experimentation
- Optimization of frequency of the electromagnetic wave radiation
- Simulation using Python, etc.
- Therapeutics scheme development in the healthcare sector especially in the area of cancer treatment

Applications:
- Electrotherapy
- Cancer therapeutics
- **New medical equipment development.**

Schematic of the simulation model. Simulation domain in the Maxwell's finite element analyzer
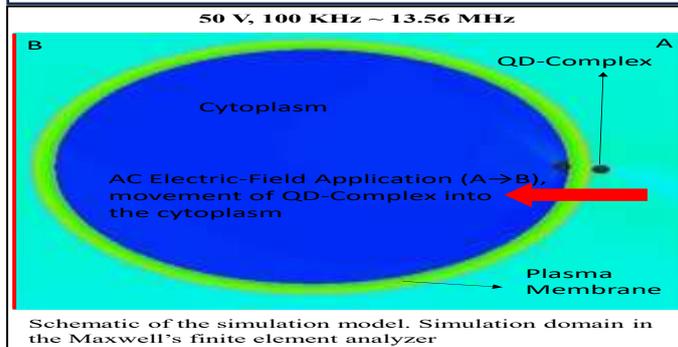
Group Members

Research Group- Experimental Particle Physics

- **Name of Principal Investigator/Group Leader**: Dr. Ram Krishna Dewanjee
- **Research Theme**: Experimental particle physics research in CMS experiment at LHC, CERN
- **Broad Area of Research and Scope:**
  - Collider Physics: Both current (LHC) and future facilities (e.g. FCC)
  - Higgs Physics
  - Top quarks Physics
  - Standard Model Precision measurements
  - Particle Physics detector research and development

Schematic Representation of Broad Area of Research

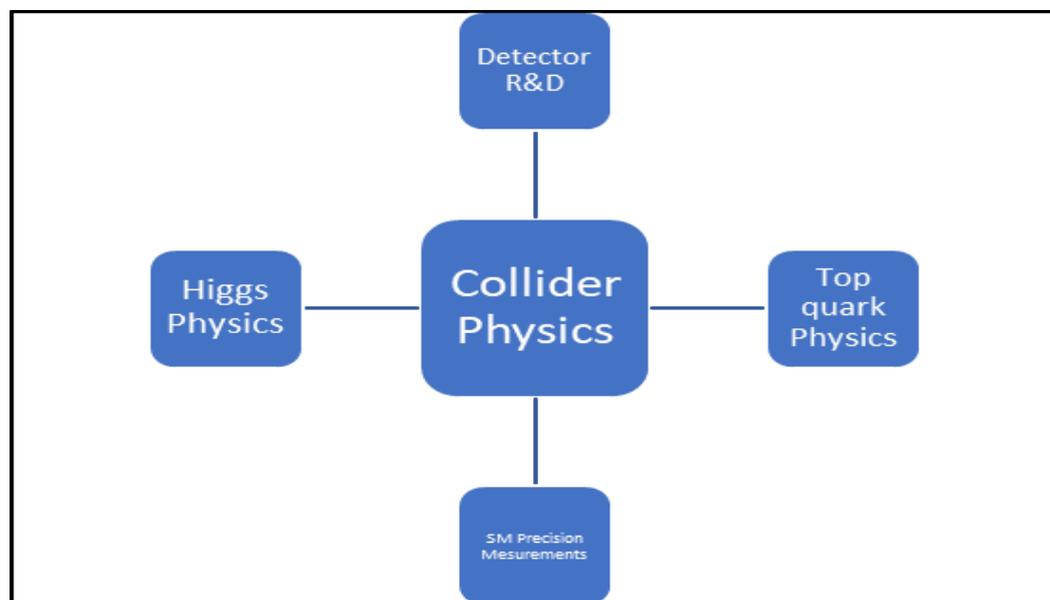**Total Number of Publications by the group:** 1065

Top 5 Article with impact factor:

1. Hayrapetyan A, Tumasyan A, Adam W, Andrejkovic JW, Bergauer T, Chatterjee S, Damanakis K, Dragicevic M, Hussain PS, Jeitler M, Krammer N, *et al* (CMS collaboration). Test of lepton flavor universality in semileptonic Bc+ meson decays in proton-proton collisions at $\sqrt{s}$ = 13 TeV. Physical Review D. 2025 Mar 1;111(5):L051102. **[Impact Factor: 4.6]**

2. CMS collaboration. Differential cross section measurements for the production of top quark pairs and of additional jets using dilepton events from pp collisions at $\sqrt{s}$ = 13 TeV. arXiv preprint arXiv:2402.08486. JHEP 2025 Feb 11;64. **[Impact Factor: 5]**

3. CMS Collaboration. Search for Higgs boson pair production in the bbW^+W^- decay mode in proton-proton collisions at $\sqrt{s}$ = 13 TeV. arXiv preprint arXiv:2403.09430. JHEP 2024 July 31; 293. **[Impact Factor: 5]**

4. Belforte S, Candelise V, Casarsa M, Da Rold A, Sorrentino G, *et al* (CMS Collaboration). Search for Higgs boson pairs decaying to WW* WW*, WW*$\tau\tau$, and $\tau\tau\tau\tau$ in proton-proton collisions at $\sqrt{s}$ = 13 TeV. JHEP. 2023;2023(07):1-64. **[Impact Factor: 5]**

5. Fernández Menéndez J, Epshteyn V, Kuznetsova E, *et al* (CMS Collaboration). A portrait of the Higgs boson by the CMS experiment ten years after the discovery. Nature 607, 60-68 (2022) https://doi.org/10.1038/s41586-022-04892-x. 2022. **[Impact Factor: 50.5]**

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Experimental High Energy Physics at the CMS experiment at LHC	Co-PI	Estonian Research Council	1646.0	5 years (2014-2019)
Study of Higgs boson production in the decay channel to tau leptons (PRG445)	Co-PI	Estonian Research Council	1205.0	5 years (2019-2023)
Creation of a multi-purpose FPGA based setup for trigger DAQ and Machine learning algorithm development for High Energy Physics applications	PI	BIT Mesra Seed Grant	5.00	2 years (2024-2026)

Industry/Academia Collaborations: Currently collaborating with national level institutes like TIFR, IIT Kanpur and Baylor University (Texas, USA) for academic research.

Achievements: Recipient of the Fundamental Physics Breakthrough Prize 2025 as member of CMS collaboration mixture. FRIN. 2012;49(2):641–7.

Brief Description of Project	
Problem Statement The Higgs boson is a milestone in the history of particle physics as it not only is the first fundamental scalar particle ever discovered but is also responsible for dynamic mass generation within Standard Model (SM). Consequently measuring its properties (e.g. mass, spin, coupling with other SM particles) is of top priority for the LHC experiments.	**Applications** ➤ Deeper understanding of the mechanism of mass generation in particle physics ➤ Precision measurements of SM Higgs couplings might point to new Physics beyond SM

Strategy/ Approach/ Technique/ Experiments used to solve
We currently analyse the proton collision data collected by the CMS experiment at LHC, CERN for both precision measurements of Higgs couplings as well as searches of particles beyond standard model of physics

Group Members

Research Group- Geometry In Physics

- **Name of Principal Investigator/ Group Leader: Dr. Suman Ghosh**
- **Research Theme**: Application of geometric tools in general relativity and condensed matter physics
- **Broad Area of Research and Scope:**
- ➢ Viability and signatures of wormholes.
- ➢ Understanding thermodynamic/statistical and quantum systems by analysing the Riemannian geometry of their parameter space.
- ➢ Exchange of ideas between GR and CMP.
- ➢ Search for materials with `super' properties.

Geometric concepts	Gravity as Spacetime Geometry	Classical / Quantum Theory Space
Geometric approach	Pseudo-Riemannian geometry	Riemannian geometry
Real part of the metric	Gravitational distance between two nearby spacetime points	Probability of transition betn two nearby states, correlation function
Imaginary part of the metric	Does not exist in general relativity!	Berry curvature
Affine connection	Defines covariant derivative	Defines covariant derivative, Berry connection
Riemann curvature tensor	Defines gravitational strength	Some gauge invariant aspect ??
Geodesics	Shortest distance	Lowest energy cost, ??
Geodesic deviation	Tidal force, gravity	???
Raychaudhuri equation	Singularity theorems	???
Topological invariants	Gauss-Bonnet invariants	Euler characteristic, Chern number
Matter-Geometry relation	Einstein equation	???

- **Total Number of Publications by the group:** 3 (Published) and 2 (Submitted)

- **Top 5 Article with impact factor:**

1. Mitra A, Ghosh S. Signature quasinormal modes of Ellis-Bronnikov wormhole embedded in warped braneworld background, Phys. Rev. D, (2024) 109, 064005. (IF: 4.6)

2. Sharma V, Ghosh S. Geodesic congruences in 5D warped Ellis‑Bronnikov spacetimes, Eur. Phys. J. Plus (2022) 137:881. (IF: 2.8).

3. Sharma V, Ghosh S. Geodesics in Generalised Ellis-Bronnikov Spacetime Embedded in Warped 5D Background, Eur. Phys. J. C (2022) 82:702. (IF: 4.2).

Research Projects:

Title	Role	Funding Agency	Amount (in Lacs)	Duration
Quantum spinor fields in cosmological backgrounds	PI	UGC-BSR Sanction order: No.F.30-420/2018(BSR	10	July 2018 – December 2020
Gravitational lensing, shadows, and quasi-normal modes of Ellis-Bronnikov wormholes embedded in five dimensional warped braneworld background	PI	BIT Mesra (Order no. RIE/SMS/DRIE-05/2023/2352)	4	September 2023 – August 2025

Targeted Application Area: Gravitation and Theoretical Condensed Matter Physics

Achievements: Dissertation work of MSc student Mr. Antariksha Mitra has been published in Physical Review D.

Brief Description of ongoing Projects : Analysis of geometric features of condensed matter systems

Problem Statement:

Both classical thermodynamic and quantum states can be represented in the parameter space that posses Riemannian geometry. The extent to which such geometry can be useful in condensed matter physics (as is the case in general relativity) is not yet fully explored. Can the geometric tools give us novel insights in critical phenomena or "super" properties and related features?

Applications
➤ Critical phenomena and renormalisation group
➤ Topological aspects of matter
➤ Room temperature superconductivity
➤ Cost effective quantum computation

Strategy/ Approach/ Technique/ Experiments used to solve

1. Set up the parallels with general relativity.
2. Analyse all aspects of geodesics and their physical interpretation.
3. Analyse critical phenomena and RG flow.
4. Construct an "Einstein equation" that can model matter required for superconductivity as such.
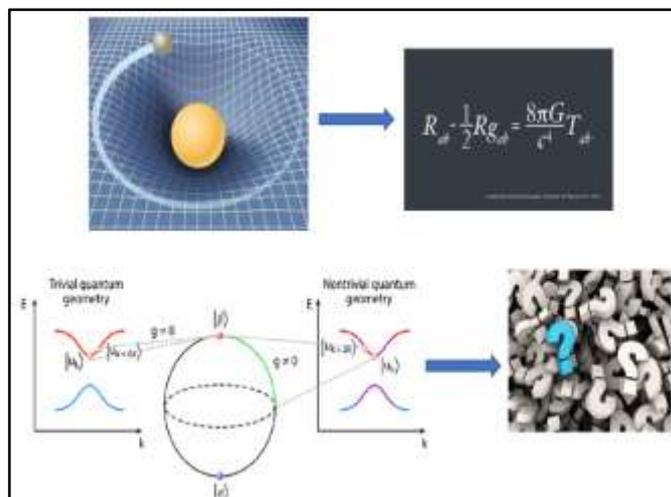
Group Members

Research Group- Materials Growth & Surface Physics Lab (Mgspl)

- **Name of Principal Investigator/ Group Leader**: Dr. Anupam Roy
- **Research Theme**: 2D Layered Materials: Growth, Material Properties and Electronic Device applications
- **Broad Area of Research and Scope:**
  - Large-area growth of 2D materials *via* Chemical Vapor Deposition (CVD)
  - Understanding parameters influencing different material properties
  - Application of 2D materials in devices
  - Modeling of CVD growth of 2D materials

Schematic Representation of Broad Area of Research
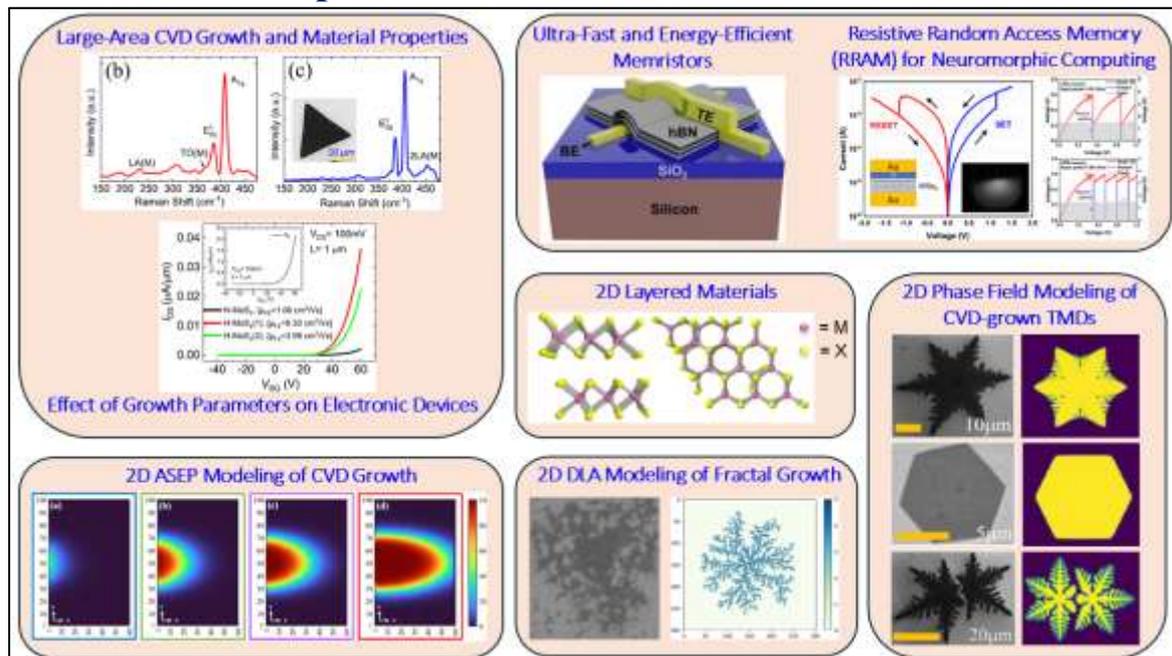
Total Number of Publications by the group: 08

Top 5 Article with impact factor:

1. Nibhanupudi SST*, **Roy A***, Veksler D, Coupin M, Matthews KC, Disiena M, Ansh, Singh JV, Warner J, Kulkarni JP, Bersuker G, Banerjee SK*. Ultra-fast switching memristors based on two-dimensional materials. Nat. Commun. 2024; 15:2334. (Journal Impact Factor: **14.7**)

2. Nibhanupudi SST*, **Roy A***, Chowdhury S, Schalip R, Coupin MJ, Matthews KC, Alam MH, Satpati B, Movva HCP, Luth CJ, Wu S, Warner JH, Banerjee SK, Low-temperature synthesis of WSe_2 by the selenization process under ultrahigh vacuum for BEOL compatible reconfigurable neurons. ACS Appl. Mater. Interfaces 2024; 16:22326-22333. (Journal Impact Factor: **8.5**)

3. Kumar G, Adhikari A, **Roy A**, Lahiri S, Two-dimensional ASEP model to study density profiles in CVD growth. Physica A 2024; 656:130206. (Journal Impact Factor: **2.8**)

4. **Roy A***, Pramanik T*, Chowdhury S, Banerjee SK. Phase-field modeling of chemical vapor-deposited 2D $MoSe_2$ domains with varying morphology for electronic devices and catalytic applications. ACS Appl. Nano Mater. 2022; 5:15488-15497. (Journal Impact Factor: **5.3**)

5. Chowdhury S*, **Roy A***, Alam MH, Pramanik T, Depoy J, Chorostowski R, Mangolini, Akinwande D, Banerjee SK*. Role of hydrogen in suppressing secondary nucleation in chemical vapor-deposited MoS_2. ACS Appl. Electron. Mater. 2022; 4:6133-6141. (Journal Impact Factor: **4.4**)

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Exploring Resistive Random Access Memory Devices based on Two-Dimensional Materials for Non-Volatile Memory Applications	PI	Science and Engineering Research Board (SERB), Department of Science & Technology, Govt. of India	32.12	2 Years (27.12.2022 to 26.12.2024)

- **Industry/Academia Collaborations:** *Prof. Sanjay K Banerjee* (The University of Texas at Austin USA); *Dr. Sai Subrahmanya Teja Nibhanupudi* (Intel Corp. USA); *Dr. Tanmoy Pramanik* (Indian Institute of Technology Roorkee India); *Dr. Rajib Batabyal* (UGC-DAE Consortium for Scientific Research Indore India).

- **Targeted Application Area:** Transition metal chalcogenide (TMD) based Field-Effect Transistors (FET), Resistive Random Access Memory (RRAM) Devices, Catalytic and Biomedical applications of 2D-TMDs.

- **Achievements:**

  1. Our article (Nat. Commun. 2024; 15:2334) is in the list of *Top 25* Physics papers published in Nature Communications in 2024 (https://www.nature.com/collections/ddjhhabece).
  2. Our article (J. Vac. Sci. Technol. A 2025; 43:022201) has been selected as the *Featured Article* and highlighted in *Beneath the AVS Surface* Newsletter April-2025 (https://avs.org/AVS/media/Files/Newsletters/Beneath%20the%20AVS%20Surface/2025/April.pdf).
  3. Rohit wins two best poster awards in the 2nd Indo-European Symposium on Surface Engineering (IESSE-2024) and International Conference on Advances in Materials and Chemical Sciences (AMCS-24).
  4. Paromita receives best poster award in AMCS-24.

Brief Description of Projects

Problem Statement:

The project aims to study growth *via* chemical vapor deposition (CVD) and in-depth characterization of 2D materials with well-controlled morphologies and defects, its use as alternative materials for forming-free RRAM devices with ultra-low operating voltages. In addition, understanding of underlying growth mechanism, for a better control over the grain/domain sizes and defects, and the switching mechanism of RRAM devices is achieved *via* simulation.

Applications:
- Resistive Random Access Memory
- Electronic Devices
- Optoelectronic Devices
- Catalytic Applications
- Thin Films and Nanotechnology

| **Strategy/ Approach/ Technique/ Experiments used to solve** |
| :--- |
| After the setup of CVD system, growth of 2D materials are optimized for different 2D layered materials, followed by device fabrication and measurement. Further optimization and improvement of growth process are carried out based on the feedback from different material properties and device characteristics. Different models are used to understand the growth dynamics and formation process of the conductive filament in these materials. |

Group Members

Research Group- Numerical Simulations and Quantum Materials Modeling (Nusquamm)

- **Name of Principal Investigator/ Group Leader**: **Dr. Rajyavardhan Ray**
- **Research Theme**: Theoretical Condensed Matter Physics and Materials Science
- **Broad Area of Research and Scope:**

> Strongly correlated systems and spin orbit coupled systems: Electronic structure, quantum magnetism and topological quantum materials

> Orbital magnetism and density functional theory: Methodological aspects of density functional theory

> Musings in quantum physics: Fundamental aspects of quantum entanglement and quantum computing using toy models.

Schematic Representation of Broad Area of Research
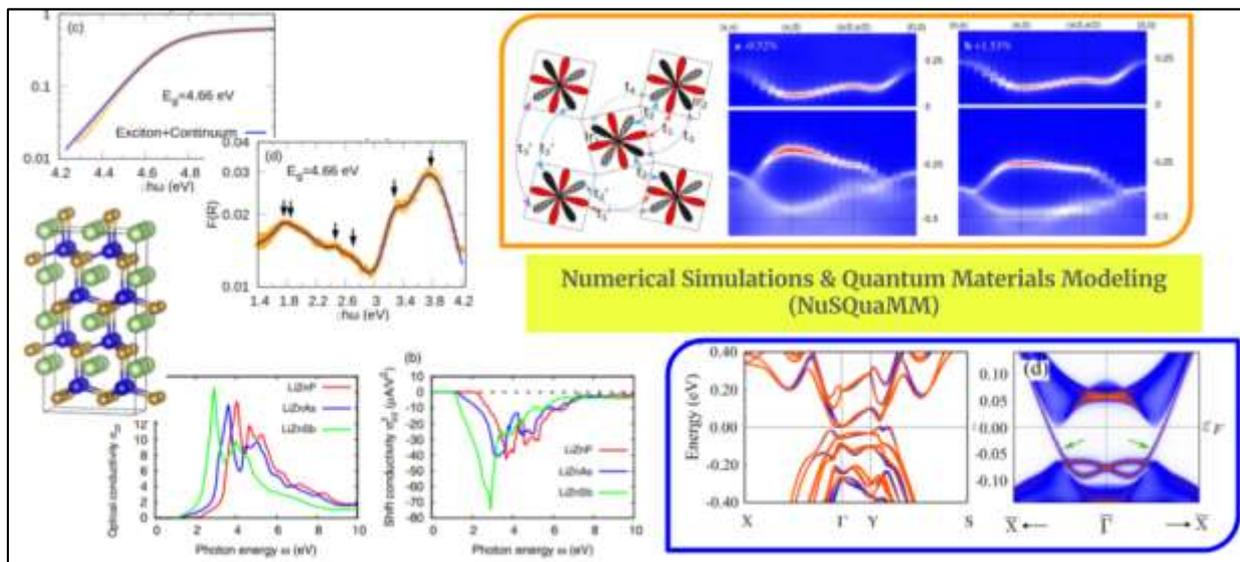
Top 5 Article with impact factor:

1. X Zhang, N Mao, O Janson, J van den Brink, R Ray. Layer dependent topological phases and transitions in $TaRhTe_4$: From monolayer and bilayer to bulk. Physical Review Materials 2024; 8 (9): 094201. (IF 3.1)

2. U Dey, J van den Brink, R Ray. Correlation between electronic polarization and shift current in cubic and hexagonal semiconductors. Physical Review Materials 2024; 8 (2): 025001. (IF 3.1)

3. S Mohapatra, DK Singh, R Ray, S Ghosh, A Singh. Spin–orbit coupling, orbitally entangled antiferromagnetic order, and collective spin–orbital excitations in Sr_2VO_4. Journal of Physics: Condensed Matter 2023; 35 (4): 045801. (IF 2.3)

4. EM Pärschke, WC Chen, R Ray, CC Chen. Evolution of electronic and magnetic properties of Sr_2IrO_4 under strain. npj Quantum Materials 2022; 7 (1): 90. (IF 5.6)

5. AK Himanshu, S Kumar, U Dey, R Ray. Multiple low-energy excitons and optical response of d0 double perovskite Ba_2ScTaO_6. Physica B: Condensed Matter 2022; 637: 413856 (IF 2.8)
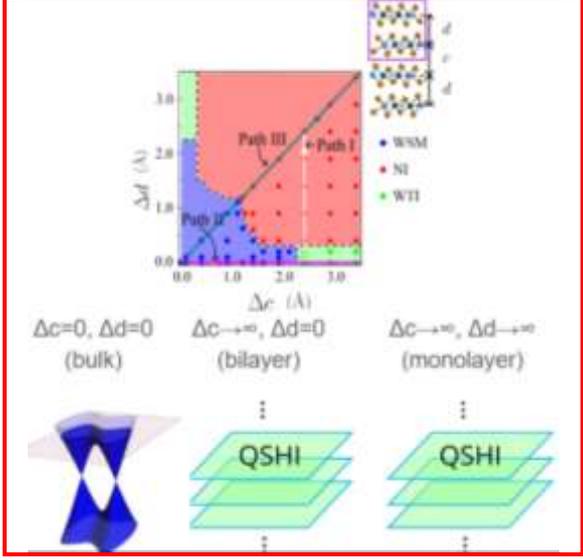
Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Magnetic excitations and crystal field effects in the honeycomb quantum antiferromagnets: Application to RCl_3 (R=Rare earths)	PI	SERB, DST	19.91	2023-25

Industry/Academia Collaborations:
- PD Manuel Richter, Leibniz IFW Dresden, Germany
- Prof. Dr. Jeroen van den Brink, Leibniz IFW Dresden, Germany
- Dr. Harish K. Singh, Paris Lodron Universität Salzburg, Austria
- Dr. Madhav P. Ghimire, Tribhuvan University, Nepal
- Dr. Ajay K Himanshu, Variable Energy Cyclotron Center (VECC), Kolkata

Targeted Application Area: Shift current conductivity and terahertz emission, quantum magnets, exciton physics, materials research

---

Layer dependent topological properties and phase transitions in $TaRhTe_4$
[Phys. Rev. Mater. **8**, 094201 (2024); Invited talk at FPLO Workshop 2025, MPI-CPfS Dresden, Germany (April 2025)]

Problem Statement

The recently synthesized ternary quasi-2D material TaRhTe4 is a bulk Weyl semimetal with an intrinsically layered structure, which poses the question of how the topology of its electronic structure depends on layer separations. Experimentally, these separations may be changed for instance by intercalation of the bulk, or by exfoliation, to reach monolayer or few-layer structures. A clear understanding of the evolution of topology with dimensions in layered materials is thus of fundamental importance not only from a fundamental viewpoint but also for the envisioned applications of such materials.

Methods

Here, employing density functional theory, we show that in the monolayer limit a quantum spin Hall insulator (QSHI) state emerges which is also well captured by the proposed minimal 4-orbital tight binding model. Even for weak spin-orbit couplings the QSHI is present, which has an interesting edge state that features Rashba-split bands with quadratic band minima. Further, we find that a weak topological insulator (WTI) manifests in the bilayer system due to sizable intralayer hopping, contrary to the common lore that only weak interlayer interactions between stacked QSHIs lead to WTIs. Stacked bilayers give rise to a phase diagram as a function of the interlayer separation that comprises a Weyl semimetal, WTI, and normal insulator (NI) phases.

Applications:
- These insights on the evolution of topology with dimensions can be transferred to the family of layered ternary transition metal tellurides.
- Spintronics, quantum computing.
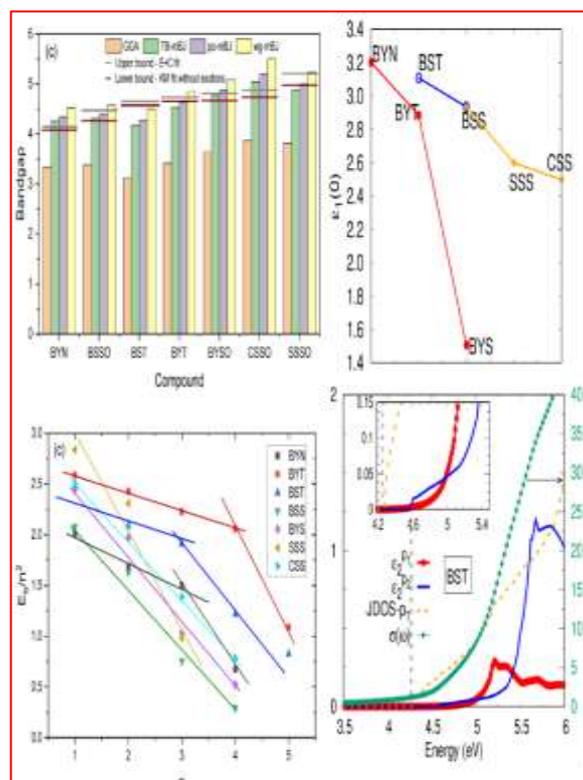
Problem Statement

Presence of excitons significantly influence the optoelectronic properties and potential applications of materials. Double perovskite oxides are a broad class of materials offering high degree of tunability and exhibit a wide rage of physical phenomena. Of particular relevance are the wide gap insulators considered promising for microwave-dielectric resonator applications and buffer materials. Despite their importance, a detailed knowledge of the optical properties are lacking which hinders their potential applications. Moreover, correlation between the elementary electronic properties and possible excitons in these materials remains elusive.

Methods

Using combined theoretical and experimental tools, we investigate the absorption spectra of d^0 double perovskite oxides Ba2YB′O6 (B′= Nb, Ta, Sb), Ba2ScB′O6 (B′= Ta, Sb) and A2ScSbO6 (A=Ca, Sr, Ba), allowing for a systematic variation of composition. We not only show that low-energy excitons are present in the visible range in all the considered so-called wide-gap insulators, but also that the nature and properties of these exciton modes differ from those in double perovskite halides as well as perovskite oxides. We provide insights on the origin of such differences by a detailed and comparative analysis of the electronic structure. Further, our findings elucidate possible correlations between the exciton properties and the composition, via the electronic structure, towards a comprehensive understanding of correlation effects and rational design principles.

Applications:

- Visible range excitons opens up further applications avenues for these materials.
- The established correlation between the excitons and elementary electronic correlations bolsters the quest for 'learning' the presence and nature of excitons in materials in general.
- Optoelectronics.

Group Members

204

Research Group- Soft Matter Physics

- **Name of Principal Investigator/ Group Leader**: **Dr. Madhu Priya**

- **Research Theme**: Mechanical and thermal properties of complex fluids

- **Broad Area of Research and Scope:**

➢ Glass Transitions
➢ Nonlinear rheology of complex fluids
➢ Kinetics of phase transitions
➢ Evolutionary Biology
➢ Hydrodynamics of microplastics

Schematic Representation of Broad Area of Research
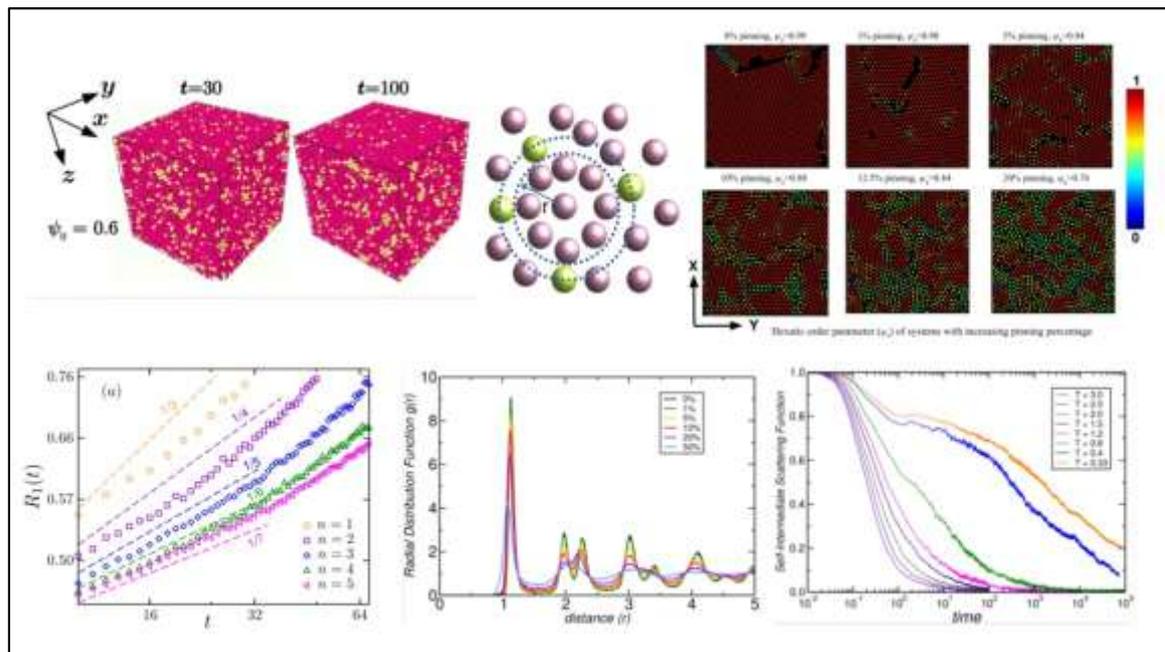
Total Number of Publications by the group: 17

Top 5 Article with impact factor:

1. Zaidi S S H, Suvarna S, Priya M , Puri S , Jaiswal P K. Early time wetting kinetics in surface-directed spinodal decomposition for off-critical quenches: A molecular dynamics study, J. Chem. Phys. 2025; 161 (15); 154703-10.

2. Chauhan S, Mandal S, Yadav V, Jaiswal P K, Priya M, Shrimali M D. Machine learning based prediction of phase ordering dynamics, Chaos 2023; 33 (6), 061103-6.

3. Suvarna S, Priya M. Role of range of interaction potential on structure and dynamics of a one-component system of particles interacting via Mie potential, AIP Advances 2024; 14 (4), 045030-10.

4. Das S, Priya M, Atypical Violation of the Stokes–Einstein Relation in a Dense Binary Lennard–Jones Mixture. JETP Letters 2025, 141, 205-213.

5. Zaidi S S H, Jaiswal P K, Priya M , Puri S. Universal fast mode regime in wetting kinetics, Phys. Rev. E 2022; 106 (5); L052801-6.

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Source Apportionment, Hydrodynamic Study and Environmental Fate Assessment of Micro-Plastics in Drinking Water Supplying Reservoirs of Ranchi, Jharkhand	Co-PI	CRG DST-SERB, India	38.10	May 2022-Aug 2025
Nonlinear Rheology of Dense Colloidal Suspensions	PI	ECR, DST-SERB, India	22.45	Sep 2018-sep 2021
Dynamics of dense colloidal suspensions under steady shear	PI	Seed Money Grant, BIT Mesra	1.00	Dec 2017-2018

Industry/Academia Collaborations:

1. Prabhat K Jaiswal, Associate Professor, Department of Physics, IIT Jodhpur
2. Manish Dev Shrimali, Professor, Department of Physics, Central Universty of Rajasthan
3. Sanjay Puri, Professor, School of Physics Sciences, Jawaharlal Nehru University

Targeted Application Area: Industrial Processing and Manufacturing, Advanced Materials

Achievements: Ms. Saumya Suvarna got 3rd best poster presentation in IESSE-2024 and 3nd best oral presentation in AMCS-24. Ms. Shuvalaxmi Das got best poster award in DAE-SSPS 2022.

Brief Description of Project

Problem Statement:

Understanding the relationship between interparticle interactions and collective behavior is essential for controlling the flow properties of dense liquids in industrial applications and for designing materials with tailored properties. In our group, we explore various interaction potentials between particles to assess their influence on the dynamical behavior of dense fluids. Additionally, we examine how these interactions affect the positional and orientational order of particles in the solid phase. Our group also explore the effect of polydispersity on structure and dynamics of complex fluids in different phases.

Strategy/ Approach/ Technique/ Experiments used to solve

We employ computer simulations and analytical models to investigate the properties of complex fluids across a range of temperatures. Our recent work focuses on leveraging molecular dynamics simulations to predict the behavior of molecular systems under varying conditions.

Applications:
- Paints and coatings
- Food and beverage industry
- Cosmetics
- Smart fluids
- Self-healing materials
- Liquid crystals and colloidal suspensions
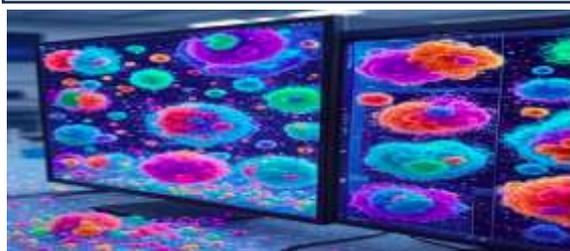
Group Members

Research Group-Theoretical Statistical Physics

- **Name of Principal Investigator/ Group Leader**: Dr. Sourabh Lahiri
- **Research Theme**: Stochastic Heat Engines
- **Broad Area of Research and Scope:**
  - ➢ Stochastic Thermodynamics: Study of thermodynamics at meso/nano scales.
  - ➢ Stochastic Heat Engines: Study of microscopic heat engines.
  - ➢ Quantum Heat Engines: Stochastic Heat Engines following the laws of Dissipative Quantum Mechanics.
  - ➢ Surface Growth: Study of growth of thin films on substrates using models from Statistical Physics.

Schematic Representation of Broad Area of Research
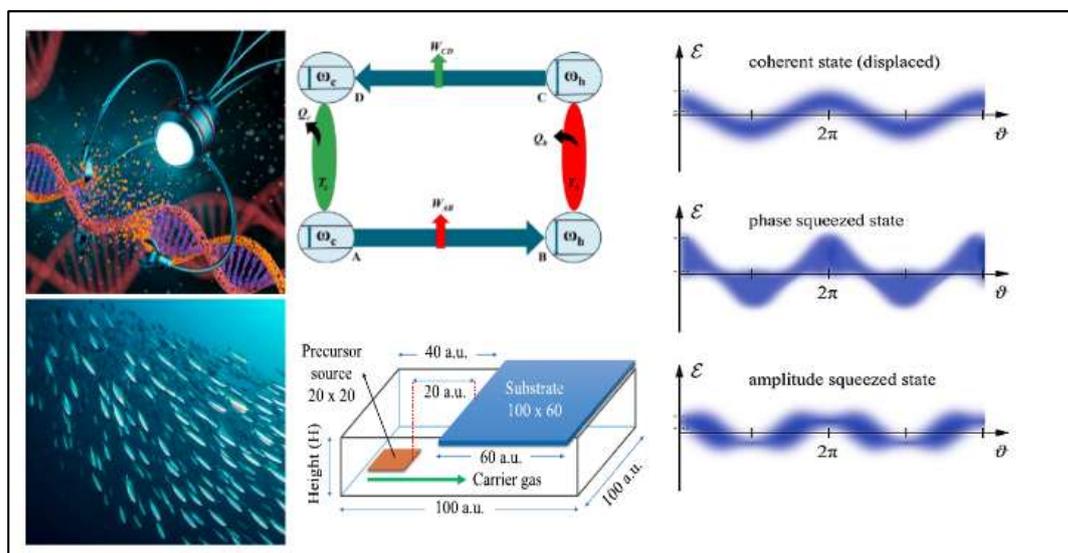
Top 5 Article with impact factor:

1. G. Kumar, A. Adhikari, A. Roy, and S. Lahiri, Two-dimensional ASEP model to study density profiles in CVD growth, Physica A 656, 130206 (07 Nov. 2024). Impact factor: 2.8
2. Efficiency of a microscopic heat engine subjected to stochastic resetting. S. Lahiri and S. Gupta, Phys. Rev. E 109, 014129 (22 Jan. 2024). Impact factor: 2.2
3. Thermodynamics of one and two-qubit nonequilibrium heat engines running between squeezed thermal reservoirs, A. Kumar, S. Lahiri, T. Bagarti and S. Banerjee, Physica A 623, 128832 (06 May 2023). Impact factor: 2.8
4. Stochastic heat engine using an active particle, A. Kumari, P. S. Pal, A. Saha and S. Lahiri, Phys. Rev. E 101, 032109 (09 Mar. 2020). Impact factor: 2.2
5. Return to origin problem for particle on a one-dimensional lattice with quasi-Zeno dynamics, S. Lahiri and A. Dhar, Phys. Rev. A 99, 012101 (04 Jan. 2019). Impact factor: 2.6

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Study of stochastic heat engines using active particles (completed)	PI	SERB	21.49	3 years + 2 months

Academia Collaborations:

1. Dr. Priyo Shankar Pal, Korea Institute for Advanced Study (KIAS), Republic of Korea
2. Dr. Shamik Gupta, Tata Institute of Fundamental Research (TIFR), India
3. Dr. Subhashish Banerjee, IIT Jodhpur, India
4. Dr. Arnab Saha, University of Calcutta, India
5. Dr. Trilochan Bagarti, Tata Steel Ltd., Jamshedpur

Targeted Application Area: Medicine, Pharmaceuticals, Quantum Information

Brief Description of Project

Problem Statement:
Microscopic engines can be used to drive tiny robots and can potentially revolutionize the medical industry. We develop a theoretical model for a microscopic heat engine using a classical active particle undergoing stochastic motion, and study its advantages over a similar engine that uses a passive particle.

Applications:
  Energy harvesting at small scales
  Actuation of nanoscale robots
  Treatments of cancer and genetic diseases by powering nanobots
  Understanding how thermodynamics works at nanoscales

Strategy/ Approach/ Technique/ Experiments used to solve
The analysis uses overdamped Langevin equations with exponentially correlated noise to model the motion of an active particle. The thermodynamic quantities are defined as per the prescriptions of Stochastic Thermodynamics.
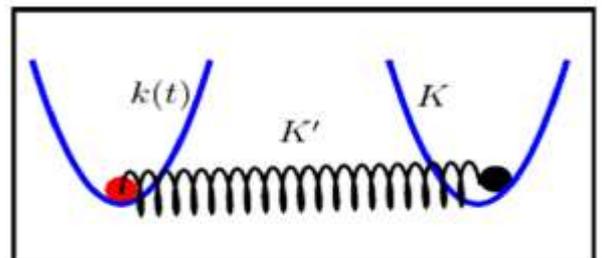
Group Members

PRODUCTION AND INDUSTRIAL ENGINEERING

Research Group- Advanced Materials And Manufacturing Technologies (Ammt)

- **Name of Group Leader**: **Prof. Indranil Manna**
- **Research Theme**: Laser Additive Manufacturing and Surface Engineering
- **Broad Area of Research and Scope:**
  - Laser Additive Manufacturing and Refurbishment
  - Laser Cladding
  - Laser-Based Manufacturing of Multi-Layer composite
  - Fabrication of Metal Matrix Composites/Aluminum Foam
  - Development of Nano-lubricant

Schematic Representation of Broad Area of Research
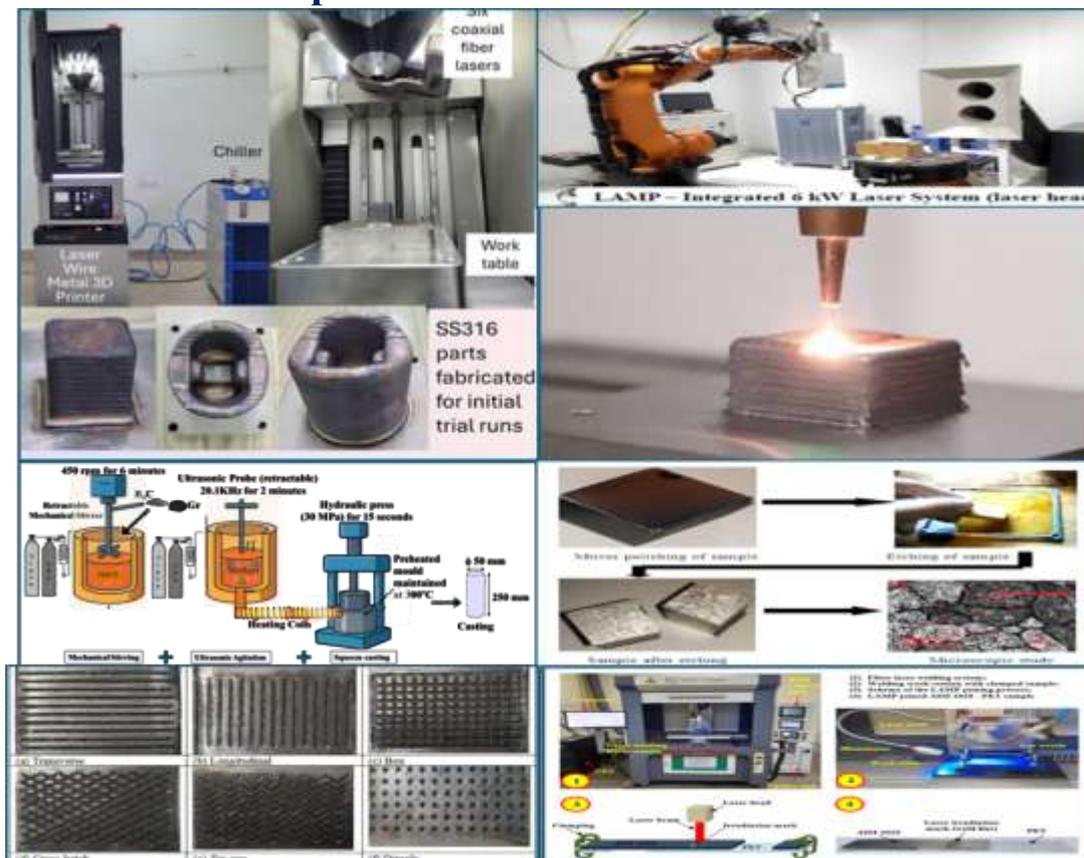
Total Number of Publications by the group: 25+

Top 5 Articles with impact factor:

1. M. Patil, **B. Acherjee, I. Manna**, Enhancing wear resistance of railway wheel by laser surface cladding of martensitic stainless steel on high carbon rail steel, Mater Today Commun., (2025), 42, 111353 (IF 3.7). https://doi.org/10.1016/j.mtcomm.2024.111353

2. Verma, P., **Ghose, J**., **Paul, G**., Pandey, V., & Pandey, U., Enhanced mechanical and tribological performance of AA2014-SiC metal matrix nanocomposites fabricated by a novel stir-ultrasonic-squeeze casting process. International Journal of Cast Metals Research, (2025), 38(1), 21–35. **SCI (IF 1.3)** https://doi.org/10.1080/13640461.2025.2469026.

3. K. Kanishka, **B. Acherjee,** R. Chokka, P. Anand, Remanufacturing of low-carbon steel components using WAAM: Microstructural, mechanical, and parametric analysis, Phys. Scr., (2024), 99, 105601 (IF 2.6). https://doi.org/10.1088/1402-4896/ad7105

4. **G. Paul**, P. Jha, A. Roy, **I. Manna**, Laser flash technique as an efficacious assessment approach for thermal conductivity of tungsten disulphide nanofluids, Journal of Molecular Liquids, (2024), 404, 124996, (IF: 6.0) https://doi.org/10.1016/j.molliq. 2024.124996

5. K. Kanishka, **B. Acherjee**, A systematic review of additive manufacturing-based remanufacturing techniques for component repair and restoration, J. Manuf. Process., (2023), 89, 220-283 (IF 6.2). https://doi.org/10.1016/j.jmapro.2023.01.034

Patents by the group:

Sl. No	Title and Inventor(s)	Application No. & Date	Status
1	**Aluminium Metal Foam and a process for Preparation thereof. Inventor: Dr. Joyjeet Ghose** Co-inventors: Dr. Vinay Sharma and Dr. Surender Kumar	Indian Patent (338236) 9.6.2020	Granted

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
I. Laser Additive Manufacturing and Refurbishment of High Temperature Resistant Structural Components	PI: Prof. I. Manna Co-PI(s): Dr. G. Paul, Dr. B. Acherjee, Dr. S. Datta	DST-TTI	435.496	2024-2027
II. Development of Hard and Wear-resistant Coating for Hydraulic Cylinders by Laser Surface Cladding as a substitute for Hard Chrome Plating	PI: Prof. I. Manna Co-PI(s): Dr. S. Datta, Dr. B. Acherjee	ANRF	44.67	2024-2027
III. Laser-based manufacturing of multi-layer polymer-metal sandwich composite and performance assessment for lightweight material applications	PI: Dr. B. Acherjee Co-PI: Dr. J. Ghose	ANRF	54.39	2023-2026
IV. Manufacturing and characterization of aluminium alloy hybrid nano-composite produced by stir-ultrasonic-squeeze casting method for automotive application	PI: Dr. J. Ghose Co-PI: Dr. B. Acherjee	ANRF	40	2022-2025
V. Assessment of Tribological Properties of Graphene based Nano-lubricants Developed by Ball Milling for Automotive Applications	PI: Dr. G. Paul	ANRF	32.92	2022-2024

Industry/Academia Collaborations: Tata Steel, IIT Kharagpur, IIT ISM Dhanbad, ARCI (Hyderabad), Hoganas (Pune)

Targeted Application Area: Automotive Sector, Steel Industry, Structural Components

Achievements:

- Developed M-P-M (metal-polymer-metal) sandwich composites with similar and dissimilar metal skins and a polymer core utilizing a laser-based fusion technique, for lightweight material applications

- Developed aluminium MMC via novel stir-ultrasonic-squeeze casting method

- Achieved enhanced wear resistance of high carbon rail steel via laser cladding of martensitic stainless steel for railway wheel applications
- Developed nano-lubricants dispersed with graphene and its derivatives and obtained superior tribological behaviour.

Brief Description of Projects :

Problem Statement:

Project I: The proposed technology development program offers to develop targeted components ether through direct manufacturing or refurbishment of existing components

Project II: An appropriate coating on alloy steel needs to be developed to replace hard chrome plating (HCP) by laser surface cladding (LCS) to offer improved wear and corrosion resistance for hydraulic cylinder applications

Applications:

- Wire-fed LAM of high temperature resistant structural components, guide plates, guide rolls in hot rolling applications.
- Laser-assisted martensitic and hybrid coatings could provide a sustainable alternative, enhancing wear resistance, surface finish, and corrosion properties, while also reducing the environmental risks associated with traditional hard chrome plating.

Group Members

PHARMACEUTICAL SCIENCES & TECHNOLOGY

Research Group- Phytopharmaceuticals Research Group

- **Name of Principal Investigator/ Group Leader**: Dr. Anima Pandey

- **Research Theme**: Bridging Traditional Insights and Modern Uses through Bioactive Phytochemicals

- **Broad Area of Research and Scope:**

➤ Exploration of Medicinal Plants from Jharkhand for Therapeutic Applications

➤ Standardization and modernization of traditional Ayurvedic formulations

➤ Investigation of Plant-Based Materials as Pharmaceutical Excipients

Schematic Representation of Broad Area of Research

Starch Isolation and Preparation of Film as an active food packaging material

GREEN SYNTHESIS OF NANOPARTICLES USING PLANT EXTRACT AND THEIR BIOLOGICAL APPLICATIONS
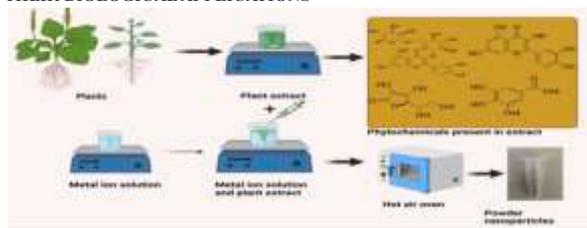
STARCH ISOLATION AND PREPARATION OF FILM AS AN ACTIVE FOOD PACKAGING MATERIAL

ETHANOBOTANICAL RESERACH

SCIENTIFIC VALIDATION OF WOUND HEALING POTENTIAL OF MEDICINAL PLANTS
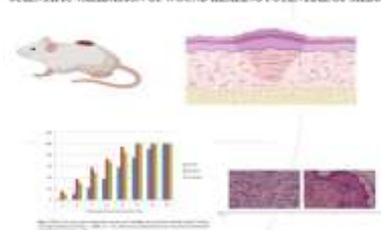
INVESTIGATING ANTIMALARIAL ACTIVITY OF PLANT EXTRACT AND PHYTOCHEMICALS USING IN VITRO TECHNIQUES AND MOLECULAR DOCKING
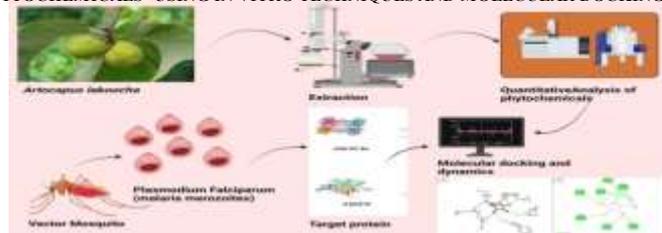
Total Number of Publications by the group: 17

Top 5 Article with impact factor:

1. Mal T, Pandey A. Isolation and effect of physical modification on the release characteristics of *Euryale ferox* Salisb polysaccharide. *IJBM*. 2025; 19:141243. **IF: 7.7**

2. Chaurasia S, Pandey A. *Artocarpus lakoocha* seed starch and thymol-based films for extending fresh fruit shelf life: Antioxidant and physicochemical properties. *IJBM*.2025:294:139556. **IF: 7.7**

3. Pandey A, Yadav SK, Mali SN. Biogenic nanoparticles as safer alternatives for gastric ulcers: An update on green synthesis methods, toxicity, and their efficacy in controlling inflammation. *BTER*. 2025. Accepted for publication. **IF:3.37**

4. Mali SN, Pandey A. Development of curcumin integrated smart pH indicator, antibacterial, and antioxidant waste-derived *Artocarpus lakoocha* starch-based packaging film. *IJBM*. 2024; 275:133827. **IF: 7.7**

5. Mittal A, Sardana S, Pandey A. Scientific validation of wound healing potential of *Jasminum sambac* Ait. *SAJBo*. 2019.121:584–589. **IF: 3.31**

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Screening and Validation of Phytoconstituents as Antimalarials from Plants of Jharkhand	PI	MRHRU Angara – a scheme of Dept. of Health Research, Govt of India. 2024.		

Industry/Academia Collaborations:

- National Institute of Malarial Research Field Unit Ranchi, Jharkhand, India.
- Model Rural Health Research Unit, Angara, ICMR.
- Department Of Pharmacology RIMS, Bariatu, Ranchi, Jharkhand.

Targeted Application Area:

- Therapeutical application in communicable and non-communicable diseases.
- Phytopharmaceutical and Phytocosmetics applications
- Isolation and value addition of natural excipients

Brief Description of Projects

Problem Statement:

The increasing problem of antimalarial drug resistance necessitates exploring alternative treatments, especially considering the rich biodiversity of Jharkhand. However, the potential therapeutic benefits of indigenous plants remain largely untapped due to the absence of a systematic scientific approach and adequate support. This underutilization of natural resources hampers efforts to combat malaria effectively. To address this challenge, there is an urgent need to identify novel antimalarial agents. Traditional knowledge provides valuable insights into indigenous plants with potential antimalarial properties, yet systematic exploration is lacking. Targeting the hemozoin pathway offers a promising strategy, yet many potential β-hematin inhibitors from indigenous plants remain unidentified. A high-throughput screening approach, guided by medicinal plants insights, is needed to efficiently discover cost-effective natural antimalarial agents.

Applications:

- **Speeding up the identification** of promising antimalarial phytochemicals.
- **Screening multiple samples efficiently**, saving both time and resources.
- **Enabling systematic analysis** of underutilized medicinal plants from Jharkhand.
- **Focusing efforts on the hemozoin formation pathway**, a validated antimalarial target.
- **Supporting the development of plant-based therapeutics**, backed by scientific evidence and traditional knowledge.
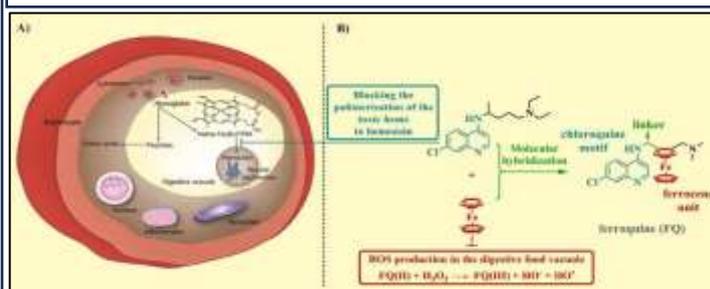
Strategy/ Approach/ Technique/ Experiments used to solve

To address the growing challenge of antimalarial drug resistance, this study focuses on exploring medicinal plants from Jharkhand, selected based on traditional Ayurvedic knowledge. The research targets the hemozoin formation pathway, a critical mechanism in the survival of the malaria parasite. A high-throughput screening approach is employed to efficiently test a wide range of plant extracts for their ability to inhibit β-hematin formation. The process includes systematic collection and extraction of plant materials, followed by in vitro assays to evaluate antimalarial activity. Active extracts are further analyzed through phytochemical profiling and preliminary toxicity screening to ensure safety and effectiveness. That provides a more natural walking experience and reduces these issues.
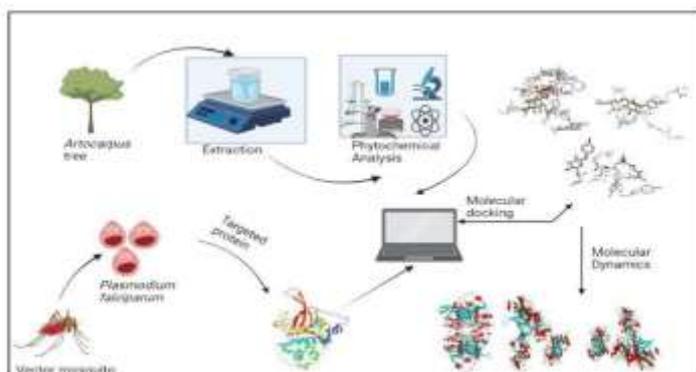
Pathway for hemozoin formation & inhibition

Group Members

Research Group- Solid State Pharmaceutics Research Labopratory (Ssprl)

- **Name of Principal Investigator/ Group Leader**: Dr. Animesh Ghosh
- **Research Theme**: Solid state modification of pharmaceuticals such as cocrystals, co-amorphous, eutectics, etc., for addressing the challenges associated with their poor physicochemical properties.
- **Broad Area of Research and Scope:**

The Solid-State Pharmaceutics Research Laboratory (SSPRL) is dedicated to addressing challenges associated with poor physicochemical properties of active pharmaceutical ingredients (APIs), which often hinder effective drug delivery and development. The lab primarily focuses on the design and development of novel solid forms such as pharmaceutical cocrystals, co-amorphous systems, and eutectic mixtures through crystal engineering and solid-state pharmaceutics. By enhancing the key properties like solubility, stability, and bioavailability, SSPRL aims to improve the therapeutic performance of poorly soluble or poorly absorbed drugs. The lab also provides deep insights into the structural and thermal behaviours of pharmaceutical compounds. The research carried out at SSPRL contributes significantly to the development of efficient drug formulations, paving the way for more effective and patient-friendly therapies.

Schematic Representation of Broad Area of Research
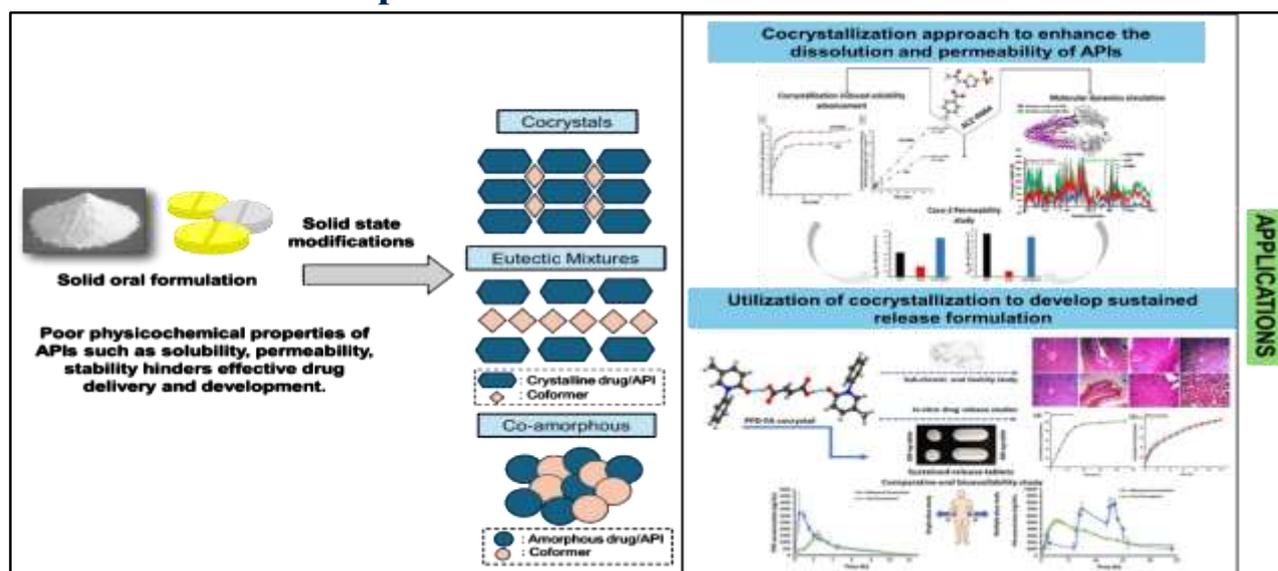
Total Number of Publications by the group: 90

Top 5 Articles with impact factor:

1. Pandey N, Tiwari A, **Kundu S**, Mondal SK, Michalchuk AA, **Kumari N**, Roy P, Higashi K, Jain A, **Ghosh A**. Elucidating the Mechanistic Shortcomings of Acetazolamide Cocrystals in Harnessing the Anticipated Solubility and Permeability Advantages. Crystal Growth & Design. 2025 May 9; 25(10): 3425-3440. (IF:3.2)

2. **Kumari N**, Roy P, Roy S, Wang C, Das S, Pandey N, Mondal SK, Bose A, Sun CC, **Ghosh A**. Development of direct compression Acetazolamide tablet with improved bioavailability in healthy

human volunteers enabled by cocrystallization with p-Aminobenzoic acid. International journal of pharmaceutics. 2024 Mar 5;652:123793. (IF:5.3)

3. **Kumari N**, Roy P, Roy S, Parmar PK, Chakraborty S, Das S, Pandey N, Bose A, Bansal AK, **Ghosh A**. Investigating the role of the reduced solubility of the pirfenidone–fumaric acid cocrystal in sustaining the release rate from its tablet dosage form by conducting comparative bioavailability study in healthy human volunteers. Molecular Pharmaceutics. 2022 Mar 15;19(5):1557-72. (IF:4.5)

4. Pandey N, **Kumari N**, Roy P, Mondal SK, Thakur A, Sun CC, **Ghosh A**. Tuning Caco-2 permeability by cocrystallization: insights from molecular dynamics simulation. International journal of pharmaceutics. 2024 Jan 25;650:123666. (IF:5.3)

5. Roy P, Chakraborty S, Pandey N, **Kumari N**, Chougule S, Chatterjee A, Chatterjee K, Mandal P, Gorain B, Dhotre AV, Bansal AK, **Ghosh A.** Study on Sulfamethoxazole–Piperazine Salt: A Mechanistic Insight into Simultaneous Improvement of Physicochemical Properties. Molecular Pharmaceutics. 2023 Sep 7;20(10):5226-39. (IF:4.5)

Patents by the group:

S. No	Title and Inventors	Application No. & Date	Status
1.	Novel Pharmaceutical Acetazolamide based compounds and method of preparation thereof. (**Nimmy Kumari**, Parag Roy, Noopur Pandey, **Animesh Ghosh**)	548706 (27.08.2024)	Granted
2.	Pharmaceutical co-crystal composition of piperazine and sulfamethoxazole and method thereof. (Parag Roy, **Animesh Ghosh**)	539514 (13.12.2022)	Granted
3.	Matrix type transdermal patch formulations. (Subham Banerjee, Pronobesh Chattopadhyay, **Animesh Ghosh**, Vijay Veer)	319521 (30.08.2019)	Granted

Research Projects:

Title	Role	Funding Agency		Amount (in Lacs)	Duration
To develop a low dose acetazolamide tablet containing acetazolamide-p-amino benzoic acid cocrystal and to finalize the dosing range bioequivalent to 250 mg marketed tablet through pharmacometrics study	PI	BIRAC-PACE-AIR		41.35	2024-2026
Mitigation of poor physical and chemical properties of SGLT2 inhibitor by drug-drug cocrystallization with DPP4 inhibitor and comparative pharmacokinetic study with their respective co-administered drug products	PI	SERB-CRG		28.43	2023-2026
To modulate the aqueous solubility of poorly water soluble pharmaceuticals by crystal engineering technique and understand the mechanistic approach of solubilization	PI	AICTE-RPS		24.12	2019-2022
Prophylactic Transdermal Patch Against Neurotoxin Poisoning Biological Warfare Situations	PI	BIRAC-SRISTI (PMU) (Society for Research)		15	2017-2021
To develop chemically modified non-toxic bio polymers for therapeutically effective controlled drug delivery system	PI	EMR, SERB-DST		36.76	2015-2018

Industry/Academia Collaborations:

Academic collaborations:

1. Graduate School of Pharmaceutical Sciences, Chiba University, Japan
2. School of Chemistry, University of Birmingham, U.K.
3. Pharmaceutical Materials Science and Engineering Laboratory, Department of Pharmaceutics, College of Pharmacy, University of Minnesota, United States
4. Solid State Pharmaceutics Lab, Department of Pharmaceutics, National Institute of Pharmaceutical Education and Research (NIPER), Sector-67, S.A.S Nagar, Mohali 160062, Punjab, India
5. BAM Federal Institute for Materials Research and Testing, Richard-Willstatter-Strasse 11, 12489 Berlin, Germany

Industry Collaboration:

1. Globela Pharma Pvt. Ltd., Plot No. 357 & 358, Road Number 3, Near Ginza Industries, GIDC, Sachin, Surat, Gujarat 394230, India

Targeted Application Area: Pharmaceutical Technology

Achievements:

1. Fellow of the Indian Chemical Society
2. Member of the National Academy of Sciences (NASI)
3. Received an International Travel Grant from SERB to participate in the 12th Crystal Forms Convention
4. Received IPA-ACG-SciTech Award 2024 in the category of Best Innovative Development of a Solid Dosage Formulation.

Project 1: Mitigation of poor physical and chemical properties of SGLT2 inhibitor by drug-drug cocrystallization with DPP4 inhibitor and comparative pharmacokinetic study with their respective co-

Problem Statement

SGLT2 inhibitors, commonly used for the management of type 2 diabetes, possess poor physicochemical properties such as low solubility, poor permeability, hygroscopicity, and polymorphism, which affect their bioavailability, manufacturability, and stability. Similarly, certain DPP4 inhibitors also possess challenges in pharmaceutical processing and therapeutic efficacy. Conventional fixed-dose combinations (FDCs) of these drug classes do not adequately address these limitations. Therefore, there is a critical need for innovative strategies to overcome these challenges.

Applications
➢ Pharmaceutical Technology
➢ Healthcare

Strategy

Drug-drug crystallization offers a promising approach to enhance the biopharmaceutical performance of these APIs through improved solubility, permeability, stability, and manufacturability, potentially leading to enhanced pharmacokinetics, therapeutic efficacy, and better patient compliance compared to traditional FDCs or co-administered formulations.

Improving SGLT2 and DPP4 Inhibitor Performance via Drug-Drug Cocrystallization
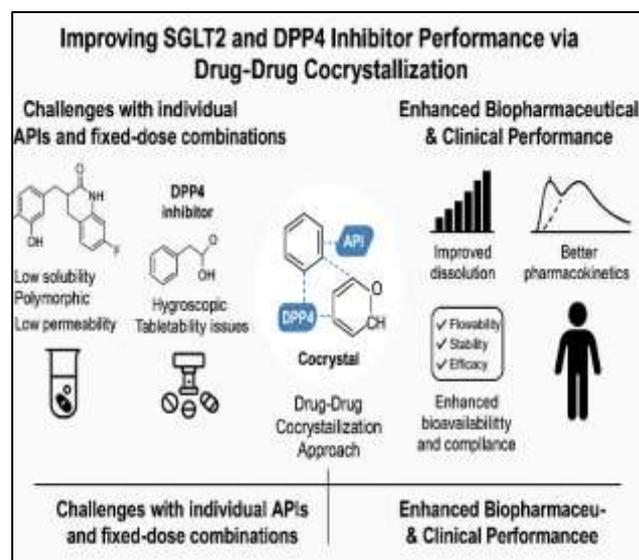
Project 2: To develop a low dose acetazolamide tablet containing acetazolamide-p-amino benzoic acid cocrystal and to finalize the dosing range bioequivalent to 250 mg marketed tablet through pharmacometrics study

Problem Statement:
Acetazolamide (ACZ), a diuretic and carbonic anhydrase inhibitor, suffers from poor biopharmaceutical performance due to limited dissolution rate, low permeability, and poor flow properties. These limitations result in suboptimal bioavailability and manufacturing challenges, ultimately affecting therapeutic efficacy, and cost-effectiveness.

Applications:
- Pharmaceutical Technology
- Healthcare

Strategy/ Approach/ Technique used to solve:
The strategy involves formulating an ACZ cocrystal with para-aminobenzoic acid (PABA), which has improved the physicochemical properties of ACZ, such as enhanced dissolution, permeability, and tabletability. The improved physicochemical properties of ACZ through cocrystallization allow for dose reduction and support a cost-effective direct compression manufacturing process.

Group Members

Alumni

Dr. Santanu Kaity
Assistant Professor
NIPER Kolkata

Dr. Subham Banerjee
Associate Professor
NIPER Guwahati

Dr. Jinu Issac
Principal
Lisie College of Pharmacy

Dr. Mahesh Kumar Posa
Associate Professor
Jaipur National University

Dr. Saundray Raj Soni
Research Manager
SUN PHARMA

Dr. Nimmy Kumari
Assistant Professor
BIT MESRA

Dr. Parag Roy
Postdoctoral fellow
Newcastle University, UK

Dr. Noopur Pandey
Associate Scientist
Aragen Life Sciences

Current Members

Sri Vidya   Amit Raj   Puja Lal   Arvind Jha   Aritra Saha   Pranav Vivek   Saiswari Dwibedi

220

Research Group- Polyphenol-BIT

- **Name of Principal Investigator/ Group Leader**: Dr. Biswatrish Sarkar

- **Research Theme:**

- **Broad Area of Research:**

  - ➢ Oxidative stress and Antioxidants
  - ➢ Pharmacological activity of polyphenols
  - ➢ Clinical applications of herbs and natural products in medicine

Schematic Representation of Broad Area of Research
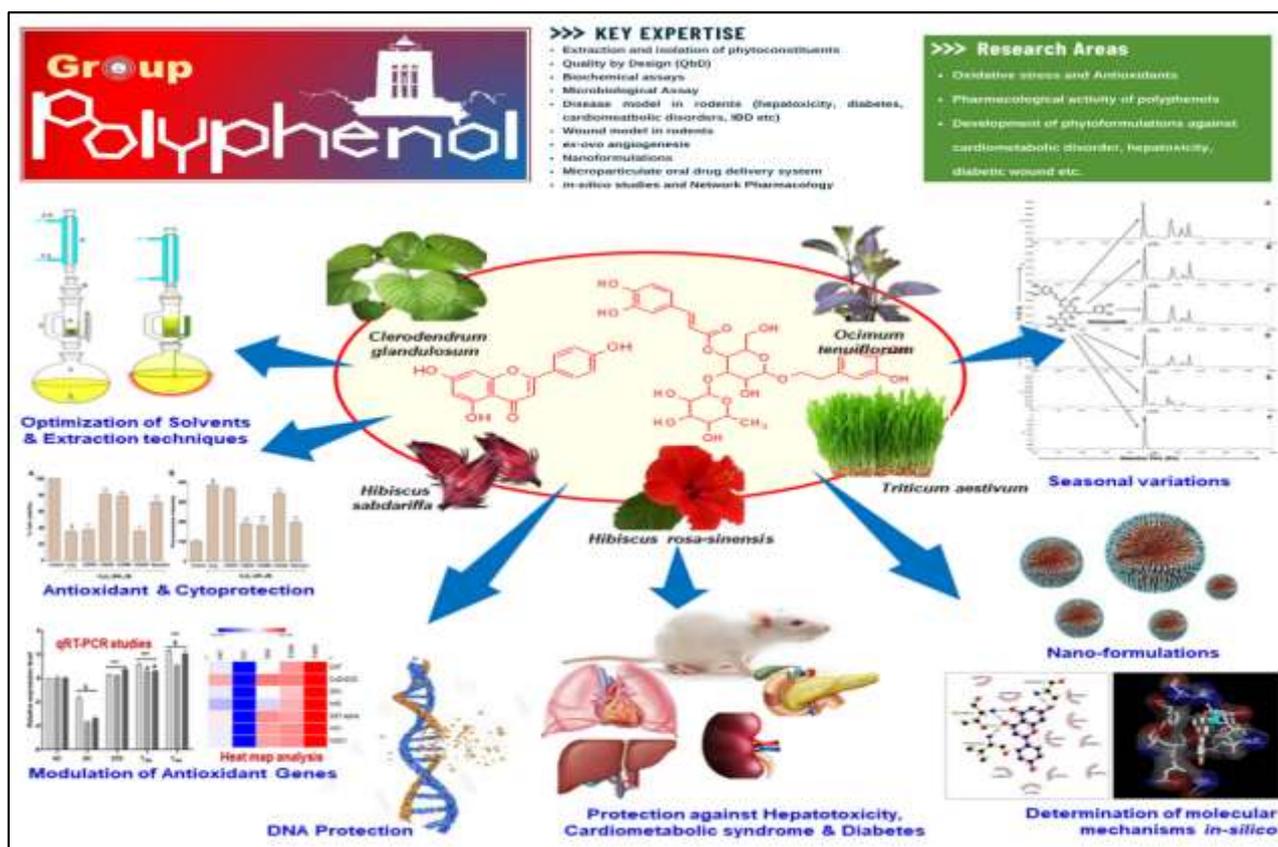
Total Number of Publications by the group: 42

Top 5 Article:

1. Kumar, S., Jain, A., **Sarkar, B.** (2025). Exploring the Molecular Mechanisms of *Ocimum tenuiflorum* Linn. Against Crohn's Disease: A Network Pharmacology and Molecular Modelling Approach. Chemistry & Biodiversity. 0:e03091. https://doi.org/10.1002/cbdv.202403091 (Impact factor 2.5).

2. Saha R, **Sarkar B**. Application of response surface methodology towards the development of a phenylethanoid-based silver nanoparticle with multifaceted biological properties. New Journal of Chemistry. 2025;49(3):1030-42. (Impact factor 2.5).

3. Chatterjee, A., **Sarkar, B.** (2025). Polyphenols and terpenoids derived from *Ocimum* species as prospective hepatoprotective drug leads: a comprehensive mechanistic review. *Phytochemistry Reviews*, 24, 2087–2129 https://doi.org/10.1007/s11101-024-09992-2 (Impact factor 7.6)

4. Majie, A., Saha, R., Sarkar, A., Bhowmik, R., Karmakar, S., Sharma, V., Deokar, D., Haque, A. U., Tripathy, S. S., **Sarkar, B.** (2024). A novel chitosan-PEG hydrogel embedded with in situ silver nanoparticles of *Clerodendrum glandulosum* Lindl. extract: Evaluation of its in vivo diabetic wound healing property using an image-guided machine learning model. *RSC Biomaterials Science,* 12, 4242-4261 https://doi.org/10.1039/D4BM00349G (Impact factor 5.8)

5. Adhikary, M., Mukhopadhyay, K., **Sarkar, B**. (2021) Flavonoid-rich wheatgrass (*Triticum aestivum* L.) diet attenuates diabetes by modulating antioxidant genes in streptozotocin- induced diabetic rats. *Journal of Food Biochemistry*. 45 (4): e13643. https://doi.org/10.1111/jfbc.13643 (Impact factor 3.5)

Patents by the group:

Sl. No	Title	Application No. & Date	Status
1	Rodent behavioral assessment apparatus	424485-00; 17.02.2025	Granted
2	Floating dialysis plate for drug release	412110-001; 30.01.2025	Granted
3	Rota rod apparatus for rat	418681-001; 05.08.2024	Granted
4	A method for formulating phytochemical-based cardioprotective composition	202431045123; 06.9.24	Published
5	Microsphere-based gel for wound care with controlled drug release applications and method of synthesis thereof	202331089113; 26.1.24	Published
6	A nanofibre mat for managing wound healing, formulation and method of preparation thereof	202331078733; 01.12.23	Published
7	Polyphenolic phytochemical-reduced nanoparticles and method of synthesis thereof, for improving bioactivity	202331071055; 27.10.23	Published
8	Bioactive extract reduced *in-situ* nanoparticle-based hydrogel formulation and preparation method thereof, for wound care	202331066305; 20.10.23	Published
9	A method for fortification of whole grain puffed rice	202331036336; 06.10.23	Published

Research Projects:

Title	Role	Funding Agency	Amount (in Lacs)	Duration
QbD based approaches and mechanistic studies towards development of verbascoside loaded topical formulations to treat diabetic wound	PI	SERB-EMEQ	40.537	2022-2025
Development of non-destructive process technology for simultaneous micronutrient fortification and bioavailability enhancement in Dal through selective binding of phytic acid	Co-PI	Dept. of Biotechnology	57.90	2021-2024
Phyto-chemical characterization of polyphenols in *Ocimum tenuiflorum* and investigation on its protective potentials against oxidative stress and DNA damage	PI	SERB-EMR	34.23	2018-2021
Design and Synthesis of Substrate Based Peptide Inhibitors of DENV Protease for the Treatment of Dengue Viral Infections	Co-PI	SERB-EMR	45.604	2017-2020
Study on hepatoprotective properties and expression of antioxidant enzymes by anthocyanins from *Ocimum tenuiflorum*	PI	Seed Money Scheme (BIT, Mesra)	0.8	2015-2017
Study of Antioxidant and DNA Protective Properties of Anthocyanins	Co-PI	UGC, Major	10.8	2009-2012

Project 1: Development of polyphenol enriched microparticulate formulation against inflammatory bowel disease

Problem Statement:

Inflammatory bowel disease (IBD) is increasing worldwide, with current treatments often limited by side effects and reduced efficacy. Polyphenols offer therapeutic potential as a safer alternative, but their clinical use is hindered by low bioavailability due to poor

Strategy

To develop and optimize a colon-targeted oral formulation of polyphenol-rich *Ocimum tenuiflorum*, Ch-Alg microspheres were prepared via complex coacervation using biocompatible materials (Ch, Alg, and Eudragit RS100) for effective microencapsulation.

Publication

Kumar, S., Jain, A., Sarkar, B. *Chemistry & Biodiversity* (2025), 0:e03091.

Applications

- *Targeted Drug Delivery:* Microsphere formulations can provide sustained release, ensuring prolonged exposure of colonic tissue to therapeutic agents.
- *Protection of Polyphenols from Degradation:* Polyphenols are often unstable in acidic environments and susceptible to enzymatic degradation.
- *Modulation of Gut Microbiota:* Colon-targeted
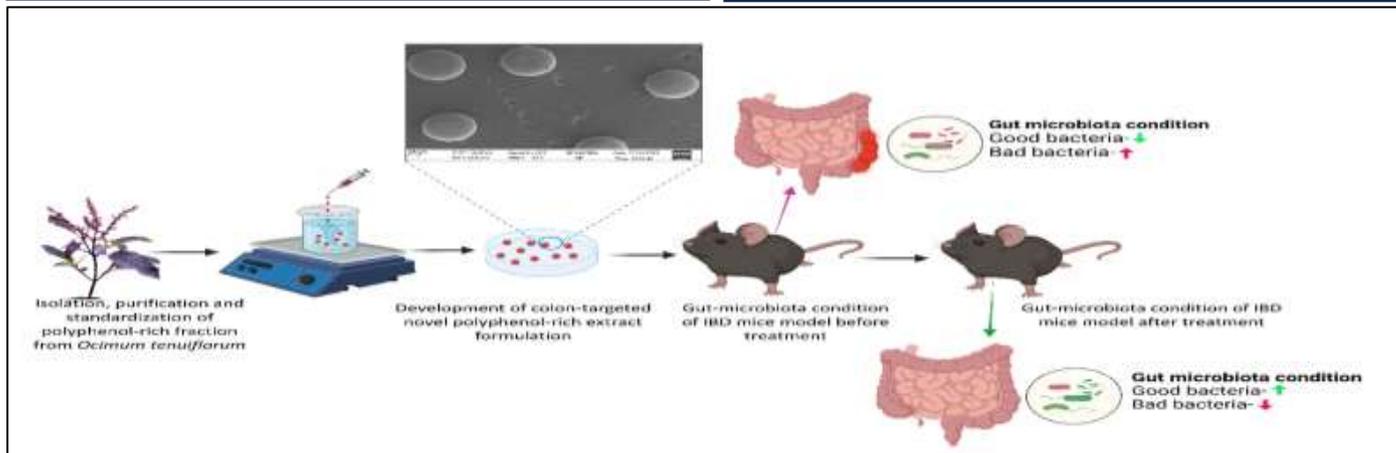
Problem Statement:
- Diabetes impedes the wound healing process.
- This leads to chronic ulcers/ wounds, mostly in the lower extremities
- Major cause of amputation across the world.
- Only a few effective therapeutic remedies are available.

Applications
➤ Formulation of novel topical formulation for wound

➤ Identification of the molecular mechanism of wound healing by PhGs

Strategy
- Isolation, purification and characterization of PhGs from *Clerodendrum* species
- Quality by Design (QbD) approach for development of topical formulations using purified PhGs
- *in-vitro* and *In-vivo* studies to elucidate the molecular mechanisms and efficacy of PhGs loaded topical formulations to treat diabetic wound.

Publication & Patents
- Saha, R., **Sarkar, B.** *New Journal Chemistry* (2025), 49, 1030-1042
- *Patent 1:* Microsphere-based gel for wound care with controlled drug release applications and method of synthesis thereof (Appl. No.: 202331089113A & Date: 26.01.24).
- *Patent 2:* A nanofibre mat for managing wound healing, formulation and method of preparation thereof (Appl. No.:202331078733A & Date: 01.12.23).
- *Patent 3*: Polyphenolic phytochemical-reduced nanoparticles and method of synthesis thereof, for improving bioactivity (Appl. No.: 202331071055 & Date 27.10.23)
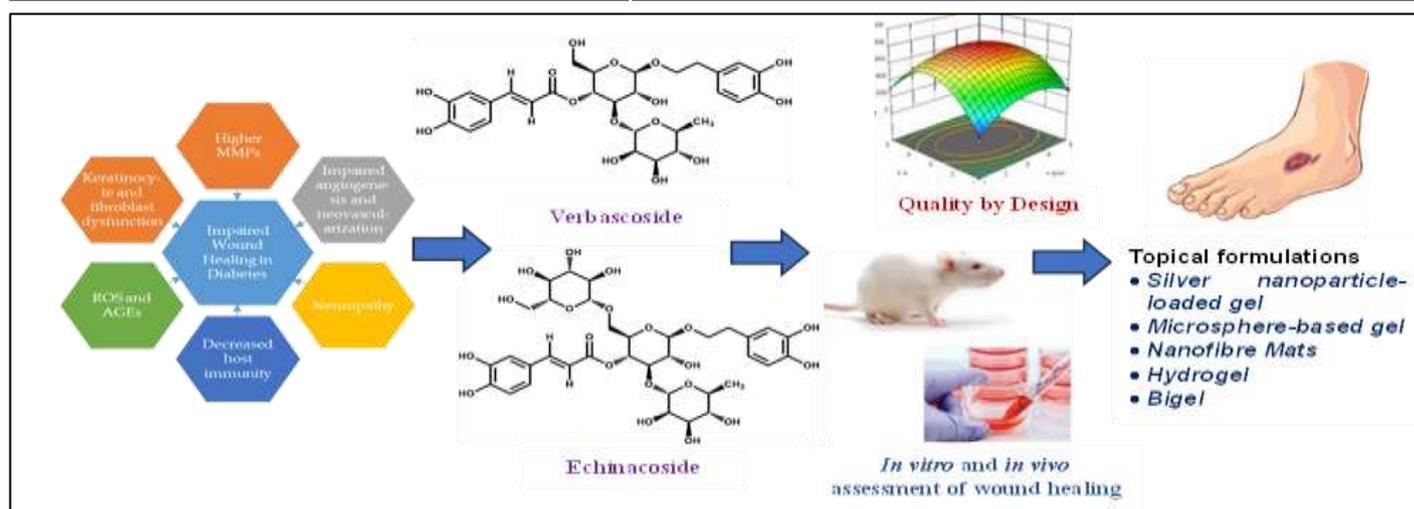
Group Members

Ritika Baidya
Junior Research Fellow (DST-SERB)

Satish Kumar
Institute Research Scholar (IRS)

Alumni

Amrita Chatterjee
Research Associate
Leiutis Pharmaceuticals,
Hyderabad, India

Rajdeep Saha
Research Associate
Leiutis Pharmaceuticals,
Hyderabad, India

Dr. Prashanta Kr. Deb
Postdoctoral Fellow
University of Texas Medical
Branch, Galveston, USA

Dr. Maria Adhikary
Research Associate
ILS, Bhubaneswar
India

224

Research Group- Medicinal Chemistry Group

- **Name of Principal Investigator/ Group Leader**: Dr. Swastika Ganguly
- **Research Theme**: Design, synthesis and evaluation of novel heterocyclic analogs for various biological activities

- **Broad Area of Research and Scope:**
- Medicinal Chemistry
- Computer Aided Drug Design
- **Scope:**

  Medicinal chemistry is a dynamic and interdisciplinary field that lies at the intersection of chemistry, biology, pharmacology, and computational sciences. It focuses on the design, synthesis, and development of pharmaceutical agents to improve human health. The scope of medicinal chemistry is vast, encompassing various stages of drug discovery and development, as well as integrating emerging technologies and methodologies.
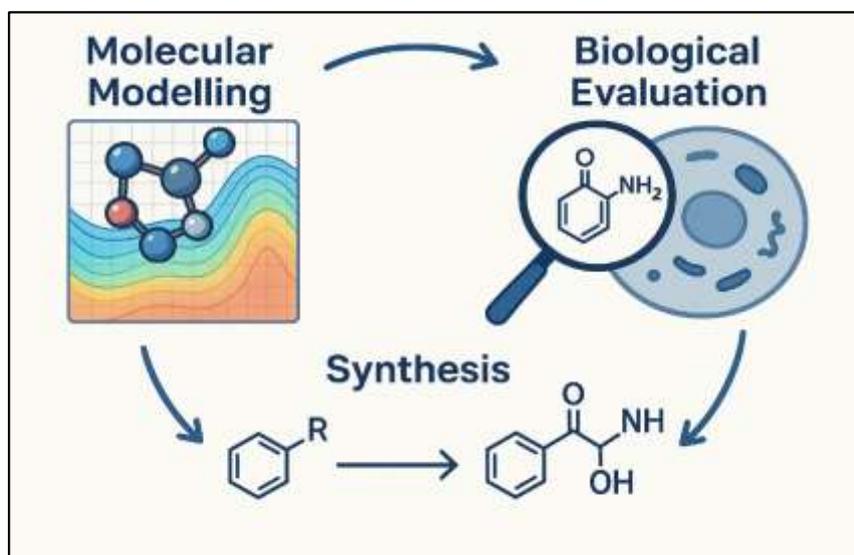
Total Number of Publications by the group: 50

Top 5 Article with impact factor: (Vancouver Style)

1. Sony J. K, Swastika G., Pravin K., Raju P., and Anoop K., Homology modeling, molecular dynamics simulation, and novel pyrazole analog design of Candida albicans lanosterol 14α-demethylase, a target enzyme for antifungal therapy, J. Biomol. Str. Dyn. 2017; 35(7):1446–1463. Impact factor: 5.3

2. Geeta Y. and Swastika G**.**, Structure activity relationship (SAR) study of benzimidazole scaffold for different biological activities: a mini-revie . Eur. J. Med. Chem, 2015; 97: 419- 443.Impact factor:11.7

3. Nigam J. M. , Swastika G**.** , Kiattawee C. , Supaphorn S., Siriwan S.and Thitinan A.,Synthesis, *in vitro* Anti-HIV-1RT evaluation, molecular modeling, DFT and acute oral toxicity studies of some benzotriazole derivatives. Journal of Structural Biology.
   DOI: https://doi.org/10.1016/j.jsb.2024.108094. Impact factor 3.0

4. Rahul G. and Swastika G**.**, An Integrative Computational Approach for Design and Evaluation of Novel [1,2,4]triazolo[3,4-b][1,3,4]thiadiazole Analogues as Dual-Action Anti-Retroviral and Anti-Bacterial Agents: Insights into Rational Drug Design Strategies. J. Comput. Biophy. Chem.,

https://doi.org/10.1142/S2737416524500418 Impact factor: 2.44

5. Krishnan S. K**., Swastika G.**, Ravichandran V. and Erik D. C.**,** Synthesis, Antiviral activity and Cytotoxicity Evaluation of Schiff bases of some 2-PhenylQuinazoline-4(3)H-ones, Eur. J. Med. Chem. 2010; 45 :,5474-5479. Impact factor:11.7

<h1 style="text-align:center; color:red;">Patents by the group:</h1>

Sl. No	Title and Inventors	Application No. & Date	Status
1	Thiazolidine-2,4-Dione Derivatives,Their Synthesis And Uses, Radhe Shyam Bahare and Swastika Ganguly	Patent No:434035 Application dated 27/01/2012	Granted
2	Novel benzotriazole compounds and their methods of synthesis thereof, Nigam Jyoti Maity and Swastika Ganguly	Application No: 202431017120 A dated 9th March 2024	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
In Silico Design, Synthesis and Evaluation of newer azoles as HIV-1-RT inhibitors	PI: Swastika Ganguly CoPI: Abhimanyu Dev	UGC MRP	13.838	3 years (2013-2016)
Design, Synthesis and evaluation of some DAMNI analogs as Novel NNRTIs with broad-spectrum chemotherapeutics	PI: Swastika Ganguly CoPI: Papiya Mitra mazumdar	AICTE-RPS	9.37	2 years (2008-2010)
Synthesis, Evaluation and Molecular Modeling studies of Some Imidazole analogs as potential Non Nucleoside Reverse Transcriptase Inhibitors	PI: Swastika Ganguly CoPI: Papiya Mitra mazumdar	UGC MRP	1.40	2 years (2009-2011)

- **Industry/Academia Collaborations:**
  1. Collaboration with Dr. Mark Ashton and his team, Newcastle University, United Kingdom
  2. Collaboration with Dr. Kiattawee Choowongkomon, Kasetsart University, Bnagkok, Thailand.
  3. Collaboration with Dr. Petrina Kapewangolo,Biochemistry, Microbiology and Biotechnology, University of Namibia, Africa
  4. Collaboration with Dr. Nicholas Cremer,and his team, University of Pittsburgh.

- **Targeted Application Area:** Medicinal Chemistry

- **Achievements:**
  - Development of novel heterocyclic analogs as antimicrobial and antiHIV agents.
  - Patents and publications achieved accordingly.
  - 16 research scholars awarded their Ph.D. degree and more than 30 students awarded their PG degree.

Problem Statement

HIV is the pathogenic retrovirus of the lentivirus family and causative agent of AIDS or AIDS Related Complex (ARC). In general, the inhibitors of HIV-1-RT are classified into two main categories: Nucleoside inhibitors (NRTIs) such as AZT, ddI, ddC and 3TC, and Non Nucleoside inhibitors (NNRTIS), like Nevirapine, delaviridine and efavirenz. However, the emergence of resistant viral strains severely impairs the long term efficacy of NNRTIs.

Strategy

Newer azoles were designed based on the pharmacophoric requirements of NNRTIs, and synthesized. Biological evaluation of the novel heterocycles were carried out in the assay systems of HIV .

Applications

- Development of 3 D QSAR model for prediction of unknown compounds for significant activities.
- Development of novel heterocyclic analogs for antimicrobial and antiHIV activities.

Publication
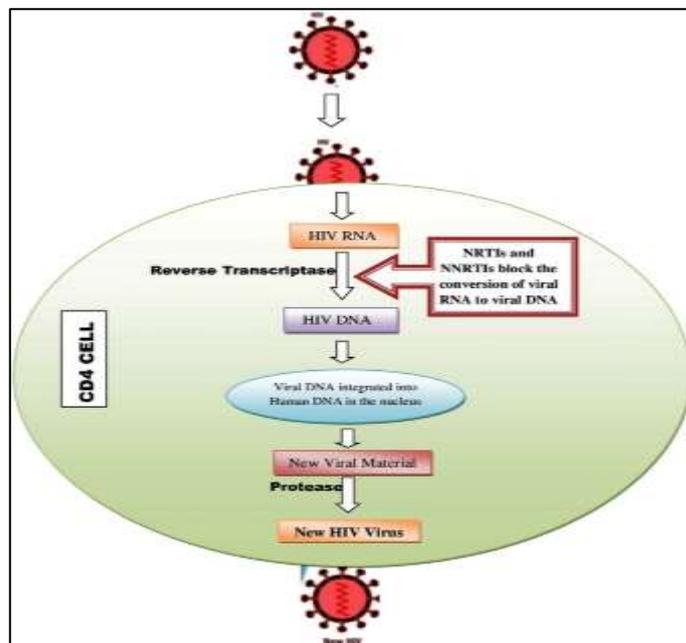
Problem Statement:

HIV has been identified as the probable causative agent for AIDS. It targets the monocytes expressing surface CD4 receptors producing profound defects in cell-mediated immunity. Overtime infection leads to severe depletion of CD4 T-lymphocytes (T-cells) resulting in opportunistic infection (OIs) like tuberculosis (TB), fungal, viral, protozoal and neoplastic diseases and ultimately death.

No such drug exists for HIV/AIDS patients which could suppress HIV replication thereby acting as anti-HIV drug and also could treat OIs like TB, hepatitis and other bacterial infections parallely.

Publication & Patents

- S.K. Krishnan, **S. Ganguly**, R. Veerasamy, B. Jan, , European Review for Medical and Pharmacological Sciences, 15, 2011, 673-682.. No.: 202331071055 & Date 27.10.23)
- **Swastika Ganguly**, Vatsal Vijay Vithlani, Anup Kr. Kesharwani, Ritu Kuhu, Baskar L, Papiya Mitramazumder, Ashok Sharon and Abhimanyu Dev, Acta Pharm, 2011, 61,187-201.
- S.Murugesan, **S. Ganguly** and G. Maga, , Journal of Chemical Sciences, March 2010, 122(2), 169-176

Strategy
- Newer Dimethoxy nitroimidazoles(DAMNI) were designed based on the pharmacophoric requirements of NNRTIs.
- The designed analogs were synthesized and evaluated for their HIV-1-RT inhibitory activities and antimicrobial activities.

Applications

1.Development of 3 D QSAR model for prediction of unknown imidazoles for significant activities.

2.Development of novel nitroimidazoles for antiHIV activities with broad spectrum chemotherapeutic properties.
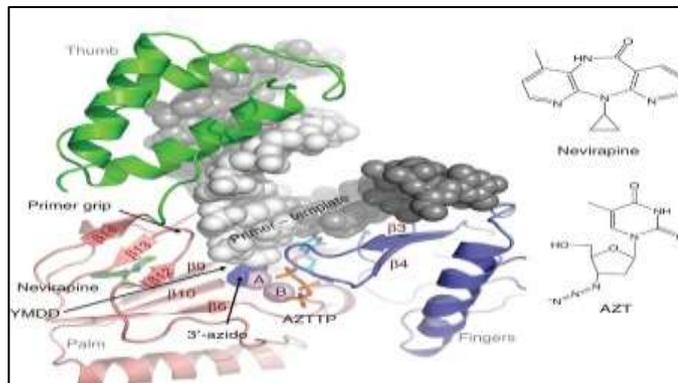
Group Members

Research Group- Sustainable Biomaterials Lab

- **Name of Principal Investigator/ Group Leader**: Dr. Santanu Ghosh

- **Research Theme**: Biomaterials development for biomedical applications

- **Broad Area of Research and Scope:**
  - Functional polymer materials
  - Nanomaterials

Schematic Representation of Broad Area of Research
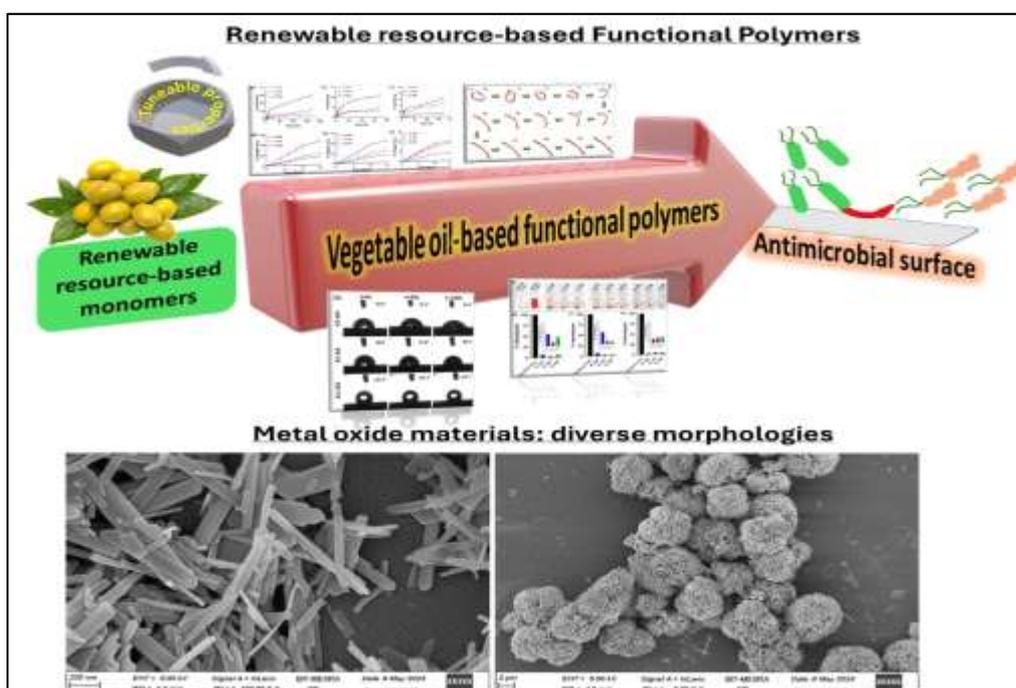
Total Number of Publications by the group: 04

Top 5 Article with impact factor:

1. Ghosh S, Saha R, Sarkar B, Ganguly S, **Ghosh S**. Olive Oil-Based Shape Memory Poly (ether ester)s with Intrinsic Antimicrobial Properties. ACS Applied Polymer Materials. 2025. https://doi.org/10.1021/acsapm.5c00563 (I.F.= 4.5)

2. Ghosh S, **Ghosh S**. Vegetable oil-derived functional polymers in biomedical applications: hurdles and possibilities. Journal of Materials Chemistry B. 2025; 13:4994-5022. https://doi.org/10.1039/D4TB02648A (I.F.= 6.1)

3. Sawan S, Kumari A, Majie A, Ghosh A, Karmakar V, Kumari N, **Ghosh S**, Gorain B. siRNA-based nanotherapeutic approaches for targeted delivery in rheumatoid arthritis. Biomaterials Advances. 2024; 214120. https://doi.org/10.1016/j.bioadv.2024.214120 (I.F.= 5.5)

4. Ghosal K, **Ghosh S**. Biodegradable polymers from lignocellulosic biomass and synthetic plastic waste: an emerging alternative for biomedical applications. Materials Science and Engineering: R: Reports. 2023;156:100761. https://doi.org/10.1016/j.mser.2023.100761 (I.F.= 31.6)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status
1.	A system and formulation for developing chitosan and polyvinyl alcohol airgel loaded with ketoconazole. Barik A, Chakraborty S, Das D R, Das S, **Ghosh S**, Halder A, Khan T A, Kundu S, Roy P, Uddin A B M H.	German Patent: DE202023107713U1; 30/12/2023	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Tailoring bioactive nano-constituent embedded fish waste-derived collagen/polycaprolactone nanofiber to promote rapid hemostasis in the management of traumatic conditions.	Co-PI	ICMR	51.00	3 years (2025-2028)
Copper oxide nanomaterials impregnated edible oil-derived poly(ether ester)s as implants: evaluation of nanomaterial's shape on mechanical & antimicrobial properties.	PI	BIT-Mesra	5.00	2 years (2023-2025)

Industry/Academia Collaborations: Indian Institute of Science, Bangalore; Fibroheal Woundcare Pvt Ltd.

Targeted Application Area: Antimicrobial and tissue regeneration applications.

Achievements:

- Dr. Santanu is one of the inventors of the recently commercialized hemostatic product, **'Fibroplug'**. This innovative product is currently being utilized by the Indian defence forces, demonstrating its practical applicability and impact in critical field conditions.
- Paromita Chowdhury got 2nd best poster award at AMCS-24: International Conference on Advances in Materials and Chemical Sciences' organized by Department of Chemistry, BIT, Mesra on Dec 18-20'2024.
- Shrinjay Ghosh got 1st prize in the poster presentation category in an International Conference 'Emerging Trends in Chemical Engineering and Advanced Materials (ETCEAM-2024)' organized by Department of Chemical Engineering, BIT, Mesra on Dec 13-15'2024.
- Sania Hasan got 3rd prize in the poster presentation category in an International Conference 'Emerging Trends in Chemical Engineering and Advanced Materials (ETCEAM-2024)' organized by Department of Chemical Engineering, BIT, Mesra on Dec 13-15'2024.

Problem Statement:

Polymers used in advanced medical applications are primarily derived from petrochemicals. However, the depletion of fossil fuel resources, stringent regulations, and environmental concerns are driving the development of renewable resource-based alternatives.

Applications:

- Tissue engineering
- Medical devices
- Prosthetics manufacturing
- Minimally invasive implantation

Strategy/ Approach/ Technique/ Experiments used to solve

Vegetable oil-based renewable resources offer a sustainable alternative. Polymers derived from these sources that possess tunable physicochemical properties, shape memory behavior, degradability, biocompatibility, and inherent antimicrobial activity are particularly advantageous for use in medical device applications.
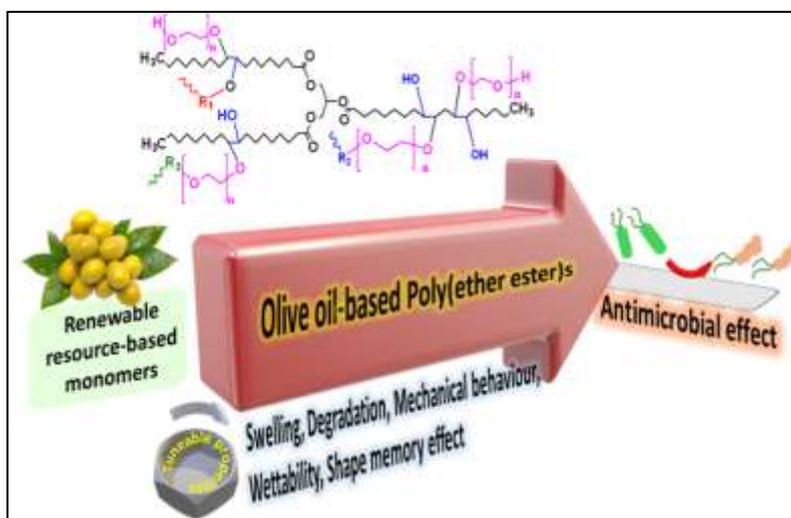
Group Members

Research Group- Biomaterial & Biomedical Research Lab-Bit

- **Name of Principal Investigator/ Group Leader**: Dr. Trishna Bal

- **Research Theme**: Biomaterial & Biomedical Devices

- **Broad Area of Research and Scope:**

➤ Polymeric scaffold for wound healing & tissue regeneration for both soft and hard tissues
➤ Pharmaceutical excipients for enhancement of solubility & permeability of poorly soluble drugs
➤ Andrology research and contraceptives
➤ Diabetes management

Schematic Representation of Broad Area of Research
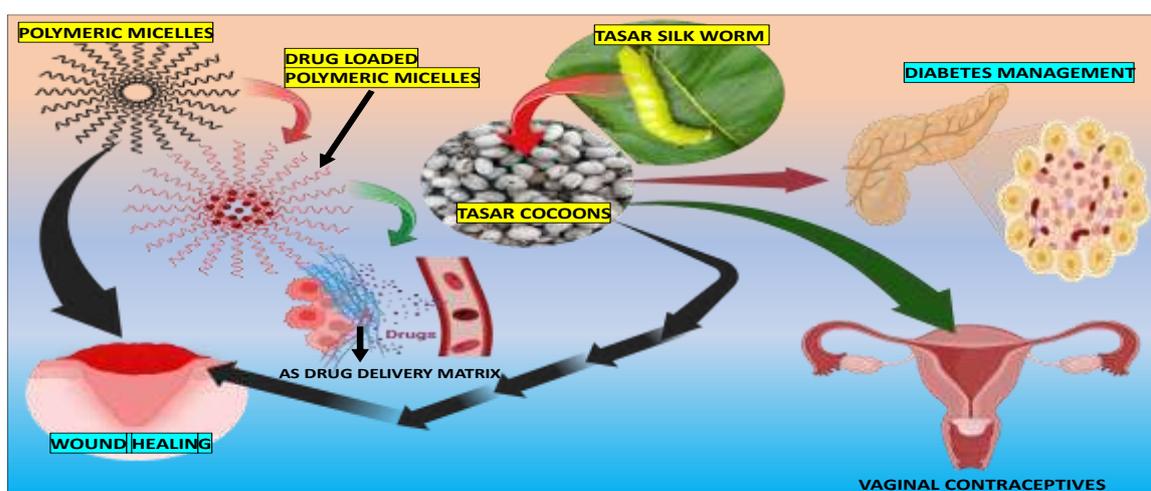
Total Number of Publications by the group: 50

Top 5 Article with impact factor:

1. Shreya Sharma [a], Uma R. Lal [b], Trishna Bal. pH-sensitive polymeric micelles of polyvinyl acetate grafted neem gum amphiphilic graft copolymer for curcumin delivery. International Journal of Biological Macromolecules. Volume 303, April 2025, 140574

2. Fahaduddin, Trishna Bal. Fabrication and evaluation of *Dillenia indica*-carrageenan blend hybrid superporous hydrogel reinforced with green synthesized MgO nanoparticles as an effective wound dressing material. International Journal of Biological Macromolecules. Volume 265, Part 2, April 2024, 130835

3. Aditya Dev Rajora, Trishna Bal. Evaluating neem gum-polyvinyl alcohol (NGP-PVA) blend nanofiber mat as a novel platform for wound healing in murine model. International Journal of Biological Macromolecules.Volume 226, 31 January 2023, Pages 760-771

4. Itishree Jogamaya Das, Trishna Bal. Evaluation of Opuntia-carrageenan superporous hydrogel (OPM-CRG SPH) as an effective biomaterial for drug release and tissue scaffold.**International Journal of Biological Macromolecules. Volume 256, Part 2,** January 2024, 128503.

5. Aditya Dev Rajora, Trishna Bal .**Evaluation of cashew gum-polyvinyl alcohol (CG-PVA) electrospun nanofiber mat for scarless wound healing in a murine model.** International Journal of Biological Macromolecules. Volume 240, 15 June 2023, 124417

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status
1.	A biopolymers hydrogel-based dosage formulation and method of preparation thereof Inventors: 1. SINGH, Snigdha 2. BAL, Trishna 3. RAJORA, Aditya Dev 4. SWAIN, Mahendra Pratap 5. SHARMA, Shreya 6. DAS, Itishree Jogamaya 7. UDDIN, Fahad 8. DAFADAR, Samsur Ali	202331071051& October 18, 2023	Product Patent Published
2.	AIR PERMEABILITY TESTER FOR THIN FILM Inventors: Dr. Trishna Bal, Dr. Manik Ghosh, Dr. Balaji Ayyanar Chinnappan, Dr. Chanchal Mishra and Dr. Mugilan Thanigachalam	420716-001& June 20, 2024	Design Patent Granted
3.	ADJUSTABLE BLOW SPINNING MACHINE Inventors: Dr. Trishna Bal, Dr. Manik Ghosh, Dr. Balaji Ayyanar Chinnappan, Dr. Chanchal Mishra	415842-001 &May 03, 2024	Design Patent Granted
4.	GREEN SYNTHESIZED PHARMACEUTICAL EXCIPIENT AND METHOD FOR SYNTHESIS THEREOF Inventors: BASAK, Biswasarathi 2. KUMARI, Laxmi 3. BAL, Dr. Trishna 4. PRABHA, Prachi 5. DAS, Itishree Jogmaya 6. DAFADAR, Samsur Ali 7. SHARMA, Shreya	202431103557 & December 26, 2024	Product Patent Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Inflatable mucoadhesive vaginal tablet coin (VTC) for instant spermicidal action as local vaginal contraceptive and microbicide" (2024-2027)	PI	DBT	76Lakhs	3years
Management of TypeII Diabetic (T2D) condition through tasar sericin (2024-2026)	PI	CTRTI, CSB	54.31Lakhs	2years 6months

Targeted Application Area: Biomedical Industry, Andrology Products

Brief Description of Project	
Problem Statement: 1. Contraceptive medications lead to numerous problems in females and most of the contraceptives available are steroids, which lead to tremendous health related issues.To alleviate such problems, biomaterials in the form of localized contraception within the vaginal area can not only bring a solution but also will reduce any localized infections and highly contagious sexually transmitted diseases 2. Diabetes related complications lead to many unwanted problems like progressive wound which never heal and later they can lead to amputation of organs. 3. Thus Tasar silk proteins are a promising biomaterial in the field of diabetes management as well as for loaclized contraceptive devices which will act as spermicides.	**Applications:** ➢ The product can be used by females both from urban and rural areas who have problems in taking steroidal drugs. ➢ The Silk based scaffold can easily heal wounds and also if taken orally can reduce diabetic conditions

Group Members

Research Group- Advanced Pharmacology Laboratory

- **Name of Principal Investigator/ Group Leader**: **Dr. Bapi Gorain**
- **Research Theme**: Advanced Pharmacology Laboratory
- **Broad Area of Research:**
  - Diabetic wounds, traumatic hemorrhages, and neurodegenerative diseases
  - Formulation development
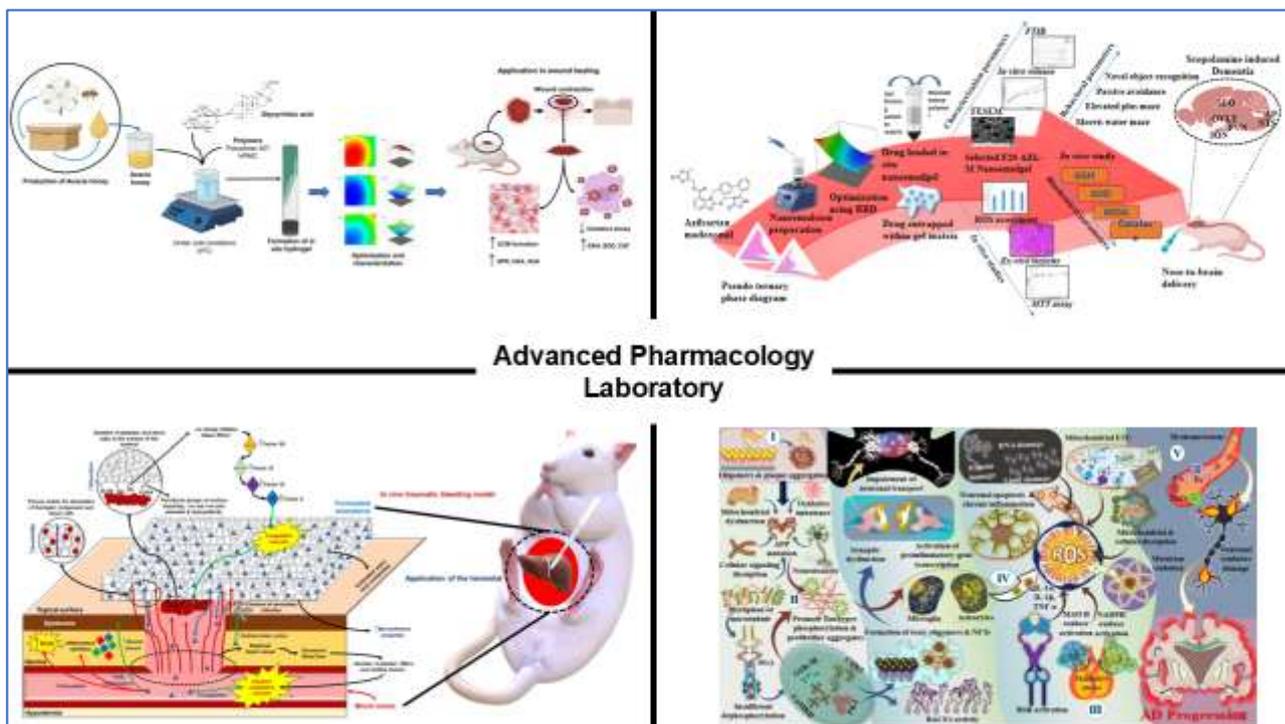
- **Total Number of Publications by the group:** 164
- **Top 5 Article:**

1. Jha, B., Majie, A., Roy, K. and Gorain, B., 2025. Functional and molecular insights in topical wound healing by ascorbic acid. *Naunyn-Schmiedeberg's Archives of Pharmacology*, pp.1-26.

2. Roy, K., Majie, A., Jha, B., Chatterjee, A., Lim, W.M. and Gorain, B., 2025. Comparative physicochemical, microbiological, pharmacological, and toxicological evaluations of different varieties of honey targeting wound repairment. *Biocatalysis and Agricultural Biotechnology*, p.103544.

3. Chakraborty, S., Karmakar, V., Chatterjee, K., Chatterjee, A., Dwivedi, M. and **Gorain, B.**, 2025. Chitosan nanoparticle-mediated nose-to-brain delivery of naringenin: Attenuating memory decline in experimental animals via behavioural assessment and modulation of biochemical parameters. *International Journal of Biological Macromolecules*, *286*, p.138336.

4. Jha, B., Majie, A., Roy, K., Lim, W.M. and Gorain, B., 2024. Glycyrrhizic acid-loaded poloxamer and HPMC-Based in situ forming gel of Acacia Honey for Improved Wound Dressing: Formulation optimization and characterization for Wound Treatment. *ACS Applied Bio Materials*, *8*(1), pp.310-328.

5. Karmakar, V., Gorain, B**.**, 2023. Potential molecular pathways of angiotensin receptor blockers in the brain toward cognitive improvement in dementia. *Drug Discovery Today,* 29(1):103850.

- **Patents by the group:**

Sl. No	Title and Inventors	Application No. & Date	Status
1	Selective COX-2 inhibition of 2-(substituted benzyl)-3,5,6,7-tetrahydro-4H-cyclopenta[4,5]thieno[2,3-d]pyrimidin-4-ones and 4-fluoro-n-(4-oxo-3,5,6,7-tetrahydro-4H-cyclopenta[4,5]thieno[2,3-d]pyrimidin-2-yl)benzamide as anti-inflammatory agents. Inventors: Katharigatta N. Venugopala, Pran Kishore Deb, Raghu Prasad Mailavaram, Nizar A. Al-Shar'i, Swastika Ganguly, **Bapi Gorain**, Annie Lee Pei Wen, Goh Hui Shan.	US12227516B1; 18.02.2025	Granted
2	Thieno [2, 3-d] pyrimidines as COX-2 inhibitors. Inventors: Katharigatta N Venugopala, Pran Kishore Deb, Raghu Prasad Mailavaram, Nizar A Al-Shar'i, Swastika Ganguly, **Bapi Gorain**, Lim Tse Mun, Jamie Kow Kean Hing.	11932656; 19.03.2024	Granted

- **Research Projects:**

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Tailoring bioactive nano-constituent embedded fish waste-derived collagen/polycaprolactone nanofiber to promote rapid hemostasis in the management of traumatic conditions	PI	Indian Council of Medical Research, Govt. of India, New Delhi, India	51	3 years
Protein nanoparticles integrated biodegradable microneedle patch: Preclinical investigation on extended therapeutic effect of apremilast through localized intradermal delivery for Psoriasis	Co-PI	Indian Council of Medical Research, Govt. of India, New Delhi, India	27	3 years
Mechanistic insight of healing diabetic wound by different varieties of honey via regulating the expression of adenosine monophosphate-activated protein kinase (AMPK), hypoxia inducible factor-1α (HIF-1α), and inflammatory cytokines, with special emphasis on identification of active component in honey	PI	Department of Science and Technology-Science and Engineering Research Board (DST-SERB)	29.4	3 years
Wound healing potential of naringin via regulating the expression of adenosine monophosphate-activated protein kinase (AMPK) and hypoxia inducible factor-1α (HIF-1α) in experimentally induced diabetic animals	PI	Seed money project, Birla Institute of Technology, Mesra, Ranchi	5	3 years
Biomaterial based nanofiber loaded with deferoxamine for as potential wound healing dressing for diabetic foot ulcer	PI	Taylor's University, Malaysia	RM 50,000	-

236

Project 1 : Mechanistic insight of healing diabetic wound by different varieties of honey via regulating the expression of adenosine monophosphate-activated protein kinase (AMPK), hypoxia inducible factor-1α (HIF-1α), and inflammatory cytokines, with special emphasis on identification of active component in honey

Diabetic wounds are a severe complication of diabetes mellitus, often leading to infections and non-traumatic limb amputations. Current treatments are limited, and the rising prevalence of diabetes increases the urgency for effective wound management strategies. Honey, known for its antimicrobial, anti-inflammatory, and wound-healing properties, has shown promise in various commercial products. However, the precise molecular mechanisms-particularly their influence on key regulators like AMPK, HIF-1α, and inflammatory cytokines-remain inadequately explored. Understanding these pathways is crucial for optimizing therapeutic efficacy. Therefore, there is a need to systematically evaluate different honey varieties to identify potent candidates and their active components for diabetic wound healing.

➢ This project bridges ethnopharmacology and modern science, promoting evidence-based integration of traditional remedies into mainstream diabetic wound management.
➢ Identification of potent honey varieties and their bioactive components can lead to the formulation of effective natural-based therapeutics for diabetic wound healing.
➢ Insights into AMPK, HIF-1α, and inflammatory modulation can aid in designing mechanism-driven wound care products with improved efficacy.
➢ Effective honey-based thermosensitive hydrogels may accelerate healing, reducing chronic wound complications.

Strategy/ Approach/ Technique/ Experiments used to solve

• LC-MS to determine the phytochemical constituents of different honey varieties and perform in silico studies (network pharmacology, molecular docking, and dynamics).
• Optimization and development of thermosensitive hydrogel with P407 and HPMC by loading different varieties of honey based on gelation time, gelation temperature, and viscosity.
• *In vitro* studies of the optimized formulation – antimicrobial, antioxidant, and anti-inflammatory studies.
• *In vivo* studies of the optimized formulation in diabetic wound-induced SD rats.
• *Ex vivo* antioxidant and anti-inflammatory studies, and histopathological studies.

Publication/patent:
1. Jha, B., Majie, A., Roy, K. and Gorain, B., 2025. Functional and molecular insights in topical wound healing by ascorbic acid. Naunyn-Schmiedeberg's Archives of Pharmacology, pp.1-26.
2. Roy, K., Majie, A., Jha, B., Chatterjee, A., Lim, W.M. and Gorain, B., 2025. Comparative physicochemical, microbiological, pharmacological, and toxicological evaluations of different varieties of honey targeting wound repairment. Biocatalysis and Agricultural Biotechnology, p.103544.
3. Jha, B., Majie, A., Roy, K., Lim, W.M. and Gorain, B., 2024. Glycyrrhizic acid-loaded poloxamer and HPMC-Based in situ forming gel of Acacia Honey for Improved Wound Dressing: Formulation optimization and characterization for Wound Treatment. ACS Applied Bio Materials, 8(1), pp.310-328.

237
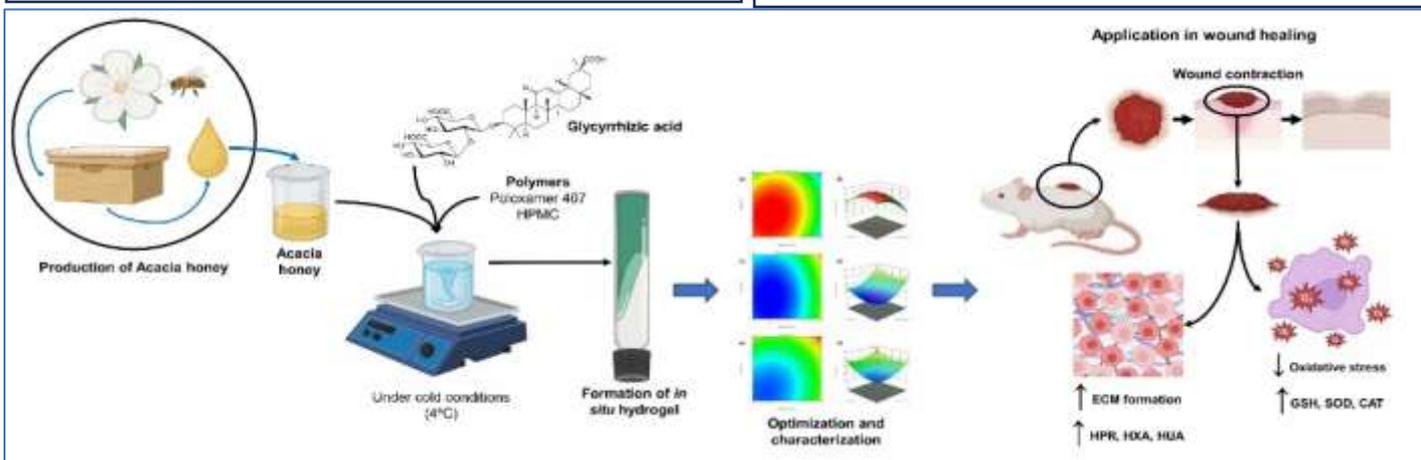
Problem Statement:

Traumatic hemorrhage leads to early deaths from hypovolemic shock and late deaths from coagulopathy, immunosuppression, and sepsis, often resulting in multi-organ failure. Excessive inflammation (SIRS), disrupted coagulation (TIC), and oxidative stress worsen outcomes. Conventional treatments may aggravate late-stage complications like immunosuppression and secondary infections. Therefore, regulating coagulation, immune response, and infection control is essential. This study aims to develop an effective hemostatic and immunomodulatory strategy to reduce mortality in hemorrhagic trauma. Simultaneously, utilizing fish waste—rich in collagen—offers an eco-friendly approach for developing therapeutic biomaterials, addressing both clinical needs and environmental sustainability in India's 4 mMT annual fish waste challenge.

Strategy/ Approach/ Technique/ Experiments used to solve

I. Identification of molecular targets of thymoquinone for hemostasis based on network pharmacology, molecular docking, and molecular dynamics approach

II. Development, optimization, and characterization of thymoquinone-loaded cubosomes (TQC) and TQC-loaded collagen/polycaprolactone nanofiber mat (TQC-CoPCL NFM)

III. *In-vitro* assessment of the fabricated TQC-CoPCL NFM to establish coagulability, compatibility, and antimicrobial potential

IV. *In-vivo* evaluation of TQ-CoPCL NFM in the animal models for management of hemostasis and to estimate the

Applications:

➢ Development of Bioactive Hemostatic Agents: Utilization of collagen from fish waste can lead to novel, sustainable, and cost-effective hemostatic materials for rapid blood clotting in traumatic injuries.

➢ Integrated Immunomodulatory Therapy: Formulation of therapeutics that balance pro- and anti-inflammatory responses, potentially preventing complications like sepsis and multi-organ failure.

➢ Management of Trauma-Induced Coagulopathy (TIC): The project offers a targeted approach to control early hypocoagulability and late hypercoagulability phases, reducing trauma-related mortality.

➢ Sustainable Waste Valorization: Converts over 4 million metric tons of fish waste in India into high-value biomedical products, promoting environmental sustainability and circular bioeconomy.

➢ Improved Clinical Outcomes in Emergency Medicine: Provides a multifunctional therapeutic solution that enhances trauma care efficiency, especially in resource-limited or battlefield settings.
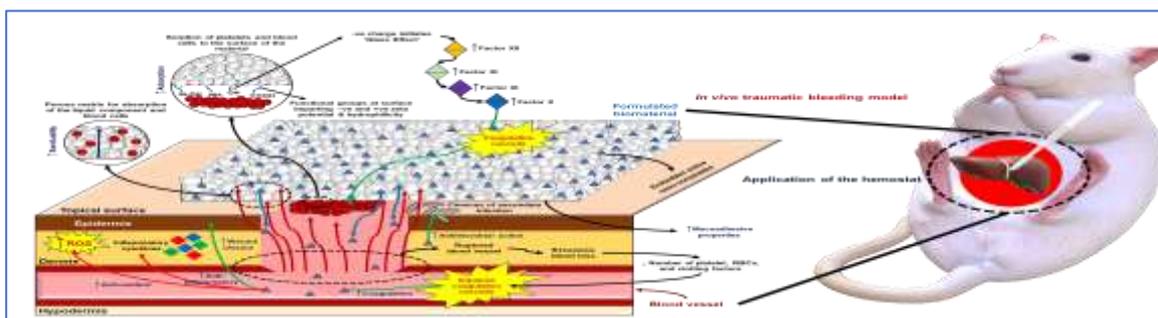
Group Members

Ms. Varnita Karmakar
CSIR-SRF (Direct)

Mr. Kankan Roy
JRF, DST-SERB

Mr. Arya Ghosh
IRS, BIT Mesra

Mr. Ankit Majie
ICMR Project Scientist-I

Mr. Abhinav Gupta
PhD Scholar

Research Group - Anti-Cancer Drug Discovery

- **Name of Principal Investigator/ Group Leader**: **Dr. Pran Kishore Deb**

- **Research Theme**: Discovery and Development of Novel Chemical Entities for the Treatment of Inflammation, Cancer, Tuberculosis & Malaria

- **Broad Area of Research:**
  - *In silico,* computer-aided drug design of Novel Chemical Entities (NCEs)
  - Synthesis and characterization of NCEs belonging to the Thienopyrimidine Scaffold
  - *In vitro* and *in vivo* anticancer, anti-TB, larvicidal, and anti-inflammatory screening of NCEs

Schematic Representation of the Broad Area of Research
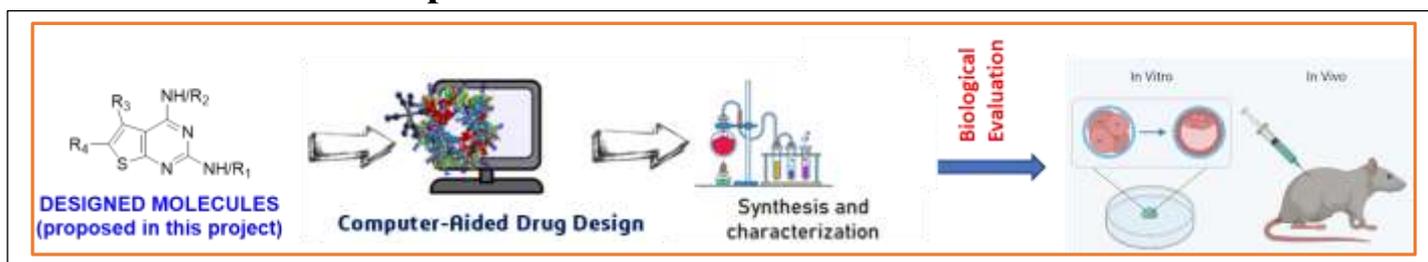
Total Number of Publications by the group: 160

Google Scholar Link: https://scholar.google.com/citations?hl=en&user=isTTsukAAAAJ&view_op=list_works&sortby=pubdate

Top 5 Article: (Vancouver Style)

1. Deb PK, Menon AM, PSR FN, Shruti I, Nidal S, Venugopala KN, et al. Exploring intermolecular interactions and energetics in crystalline substituted thieno[2,3-*d*]pyrimidines. *RSC CrystEngComm*. **2025**;27:2070-2085.

2. Deb PK, Maity P, Sarkar B, Venugopala KN, Tekade RK, Batra S. Insights from Clinical Trials on A2A Adenosine Receptor Antagonists for Cancer Treatment. *ACS Pharmacology & Translational Science*. **2025**;8(6):1498-512.

3. Salou RA, Deb PK, Hourani W, Al-Shar'i N, Al Aboudi A, Venugopala KN, et al. Synthesis, X-ray Crystallography, and Computational Analysis of 2, 4-disubstituted-6, 7-dihydro-5H-cyclopenta[4,5]thieno[2,3-*d*]pyrimidines as COX-2 Inhibitors and Anticancer Agents. *Journal of Molecular Structure*. **2025**:142907.

4. Venugopala KN, Chandrashekharappa S, Deb PK, Al-Shar'i NA, Pillay M, Tiwari P, et al. Identification of potent indolizine derivatives against Mycobacterial tuberculosis: In vitro anti-TB properties, in silico target validation, molecular docking and dynamics studies. *International Journal of Biological Macromolecules*. **2024**;274:133285.

5. Deb PK, Al-Shar'i NA, Venugopala KN, Pillay M, Borah P. In vitro anti-TB properties, in silico target validation, molecular docking and dynamics studies of substituted 1,2,4-oxadiazole analogues against Mycobacterium tuberculosis. *Journal of enzyme inhibition and medicinal chemistry*. **2021**;36(1):869-84.

Patents by the group (38):

Sl. No	Title and Inventors	Application No. & Date	Status
1.	5-(substitutedphenyl)-7-thioxo-7, 8-dihydropyrimido [4, 5-d] pyrimidine-2, 4 (1H, 3H)-dione analogues as antibacterial agents.	**U.S. Patent 12,297,204,** issued **13/5/2025**	Granted
2.	Selective COX-2 inhibition of 2-(substituted benzyl)-3,5, 6,7-tetrahydro-4*H*-cyclopenta[4,5]thieno[2,3-*d*]pyrimidin-4-ones and 4-fluoro-n-(4-oxo-3,5,6,7-tetrahydro-4*H*-cyclopenta[4,5]thieno[2,3-*d*]pyrimidin-2-yl)benzamide as anti-inflammatory agents.	**U.S. Patent 12,227,516B1,** issued **18/2/2025**	Granted
3.	1-(2-(substituted phenyl)-2-oxoethyl)-4-methylpyridin-1-ium bromide as anti-tubercular agents.	**U.S. Patent 12,227,480,** issued **18/2/2025**.	Granted
4.	5-(Substitutedphenyl)-7-thioxo-7,8-dihydropyrimido[4,5-d]pyrimidine-2,4(1H,3H)-dione analogues as antibacterial agents.	**U.S. Patent 18/736710, A1,** issued **13/2/2025**.	Granted
5.	5-(substitutedphenyl)-7-thioxo-7,8-dihydropyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-dione analogues as antibacterial agents.	**U.S. Patent 12221450,** issued **11/2/2025**.	Granted
6.	(E)-1-(2-(4-substitutedphenyl)-2-oxoethyl)-4-((hydroxyimino) methyl) pyridinium bromides as antitubercular agents.	**U.S. Patent 12215082,** issued **4/02/2025**.	Granted
7.	5-(Substitutedphenyl)-7-Imino-7,8-Dihydropyrimido[4,5-*d*]pyrimidine-2,4(1*H*,3*H*)-dione analogues as anti-inflammatory agents.	**U.S. Patent 12187733,** issued **07/01/2025**.	Granted
8.	(E)-2-(3-Cyano-4-isobutoxyphenyl)-N′-(substituted benzylidene)-4-methylthiazole-5-carbohydrazides as anti-tubercular agents.	**U.S. Patent 12172973,** issued **24/12/2024**.	Granted
9.	(E)-2-(3-cyano-4-isobutoxyphenyl)-n′-(substituted benzylidene)-4-methylthiazole-5-carbohydrazides as anti-tubercular agents.	**U.S. Patent 12,145,915,** issued **19/11/2024**.	Granted
10.	Substituted 1,3,4-oxadiazole derivatives as anti-tubercular agents.	**U.S. Patent 11998532B1,** issued **04/06/2024**.	Granted
11.	3-Cyano 4,5-diphenyl furan-2-carboxamides as potential antitubercular agents.	**U.S. Patent 11987563B1,** issued **21/05/2024**.	Granted
12.	(6-Methyl-4-substitutedphenyl-2-oxo/thioxo-1,2,3,4-tetrahydropyrimidin-5-yl)(piperidin-1-yl)methanones as anti-tubercular agents.	**U.S. Patent 11986476B1,** issued **21/05/2024**.	Granted
13.	7-isopropyl 1, 2-dimethyl 3-(substituted benzoyl) indolizine-1, 2, 7 tricarboxylates as adenosine receptor active compounds.	**U.S. Patent 11981673B1,** issued **14/05/2024**.	Granted
14.	Oxoimidazolidine derivatives as anti-tubercular agents.	**U.S. Patent 11981643B1,** issued **14/05/2024**.	Granted
15.	7-isopropyl 1-ethyl/methyl 3-(substituted benzoyl)-2-substituted indolizine-1, 7-dicarboxylates as larvicidal agents.	**U.S. Patent 11981674B1,** issued **14/05/2024**.	Granted
16.	Substituted 7-amino-3-(substituted benzoyl) indolizine-1-carboxylates as anti-tubercular agents.	**U.S. Patent 11976066B1,** issued **07/05/2024**.	Granted
17.	Adenosine receptor activity of methyl/ethyl 3-(substituted benzoyl)-6, 8-dimethylindolizine-2-substituted-1-carboxylates.	**U.S. Patent 11974991B1,** issued **07/05/2024**.	Granted
18.	{5-chloro-2-(2-(3-(substitutedphenyl)-1,2,4-oxadiazol-5-yl)ethyl)phenyl}(phenyl) methanones as larvicidal agents.	**U.S. Patent 11970470B1,** issued **30/04/2024**.	Granted
19.	4-[(substituted-1*H*-benzimidazol-2-ylsulfanyl)methyl]-6-substituted-2*H*-chromen-2-ones as larvicidal agents.	**U.S. Patent 11970489B1,** issued **30/04/2024**.	Granted
20.	5-(3-substitutedphenyl)-pyrimido[4,5-*d*]pyrimidine-2,4,7(1*H*,3*H*,8*H*)-trione derivatives as anticancer agents.	**U.S. Patent 11964982B1,** issued **23/04/2024**.	Granted
21.	Dimethyl 7-bromo-1-(4-substituted benzoyl)pyrrolo[1,2-*a*]quinoline-2,3-dicarboxylates as anti-inflammatory agents.	**U.S. Patent 11945819B1,** issued **02/04/2024**.	Granted
22.	Ethyl 2-substituted-1-(substitutedbenzoyl)-7-methylpyrrolo[1,2-a]quinoline-3-carboxylate derivatives as anti-tubercular agents.	**U.S. Patent 11938120B1,** issued **26/03/2024**.	Granted
23.	Substituted 1,4-dihydropyrimidines as antitubercular agents.	**U.S. Patent 11932609B1,** issued **19/03/2024**.	Granted
24.	Thieno [2,3-*d*]pyrimidines as COX-2 inhibitors.	**U.S. Patent 11932656B1,** issued **19/03/2024**.	Granted
25.	5-(3-substitutedphenyl)-pyrimido[4,5-*d*]pyrimidine-2,4,7(1H,3H,8H)-trione derivatives as anticancer agents.	**U.S. Patent 11932649B1,** issued **19/03/2024**.	Granted
26.	Substituted 7-methyl quinoline derivatives as antitubercular agents.	**U.S. Patent 11926627B1,** issued **12/03/2024**.	Granted

Research Projects:

Title	Role (PI/Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Anticancer Drug Discovery Targeting A$_{2A}$ Adenosine Receptor by Optimizing 2/4-Amino-5,6-substituted-thieno[2,3-*d*]pyrimidine Scaffold	PI	Birla Institute of Technology (BIT), Mesra, Ranchi, Seed Money Scheme (Grant Number BIT/DRIE/SMS/2024-25/1877).	5	2 Years (2024-2025)
Design, Synthesis and Evaluation of Novel Hetero-fused Bicyclic and Tricyclic Thienopyrimidines as Possible Adenosine Receptor Antagonists	PI	Scientific Research Fund, Ministry of Jordan. (MPH/1/33/2018)	70	3 Years (2019-2022)
Lead optimization of 2-(4-methoxyphenyl)-3,5,6,7-tetrahydro-4*H*-cyclopenta[4,5]thieno[2,3-*d*]pyrimidine-4-one: Synthesis, & Evaluation of New Derivatives as Possible Inhibitors of Cyclooxygenase Isoenzyme 2 (COX-2)	PI	Philadelphia University Research Grant, Jordan, Project ID: 46/34/100PU	15	2 Years (2017-2019)
Hit to Lead Optimisation: Synthesis and Biological Evaluation of New Thienopyrimidine Derivatives as Potential Antagonists of Adenosine A$_3$ Receptor, A Promising Target for the Treatment of Asthma.	PI	Ministry of Science, Technology and Innovation Malaysia, Project ID: 06-02-09-SF0048 (IMU R 164/2015)	35	3 Years (2015-2017)
Design, synthesis, and Evaluation of some Novel Thienopyrimidine Derivatives as Possible A3 Adenosine Receptor Antagonists.	PI	International Medical University, Malaysia (IMU 293/2013)	10	2 Years (2013-2015)

## Project 1: Anticancer Drug Discovery Targetting Adenosine Receptors and COX-2 Enzyme

Problem Statement:
- Tumor microenvironment (TME) overexpresses A2AAR on cytotoxic immune cells, where adenosine binding to A2A AR & inhibits T-cell activation, suppresses cytotoxic T lymphocytes (CTLs) and natural killer (NK) cells, promotes regulatory T cells (Tregs), and impairs antigen-presenting cells (APCs). A2AAR antagonists work synergistically with immune checkpoint inhibitors (ICIs), radiotherapy, and chemotherapy, counteracting adenosine-induced immunosuppression.
- The COX-2 enzyme plays a key role in cancer development by promoting angiogenesis, proliferation, metastasis, evasion of

Applications:
- Adenosine A$_2$A receptor antagonists can be used either as a standalone therapy or as an adjuvant to enhance anti-tumor responses and improve the efficacy of cancer immunotherapy by restoring immune function, activating CD8$^+$ T cells, increasing NK cell cytotoxicity, reducing Treg-mediated immune suppression, and improving antigen presentation.
- COX-2 selective inhibitors hold potential not only for the safe treatment of chronic pain and inflammation but also for providing therapeutic benefits in various cancers, including

Strategy/ Approach/ Technique/ Experiments used to solve
- *In silico* computer-aided drug design (CADD) of Novel Chemical Entities (NCEs).
- Synthesis, purification and characterization of designed Novel Chemical Entities (NCEs).
- *In vitro* adenosine receptors & COX-2 binding studies of NCEs.
- *In vitro* anticancer studies.
- *In vivo* toxicity profiling of the potent

Publication/patent:
1. *RSC advances*. **2025**;15(26):20418-20445.
2. *ACS Pharmacology & Translational Science*. **2025**;8(6):1498.
3. *J. Molecular Structure* **2025**:142907.
4. RSC *CrystEngComm*. **2025**, 27,2070.
5. *Pharmaceuticals*, **2024;** 17, 1645.
6. **U.S.Patent**11932656B1,Granted 18/2/**2025**
7. **U.S.Patent**11932656B1,Granted 07/1/**2025**

Project 2: Discovery of Anti-TB Agents Targeting InhA Enzyme

Problem Statement:
- Tuberculosis (TB) has been known to affect human beings for millennia with a high mortality rate, and the control of TB remains one of the largest endeavors of public health authorities.
- Although predominantly a pulmonary pathogen, TB can spread throughout the body and remains a major global public health burden, responsible for 1.4 million deaths & 10 million infections worldwide in 2019. Our research efforts are focused towards the development of novel compounds with different

Applications:
- Isoniazid (INH), the primary drug for treating tuberculosis, functions by inhibiting Enoyl-ACP reductase (InhA). However, mutations in either InhA itself or, more commonly, in KatG catalase-peroxidase, which activates the INH prodrug, can reduce the effectiveness of isoniazid.
- Therefore, the discovery of inhibitors that directly target InhA, bypassing the need for activation by KatG (known as direct InhA inhibitors), could offer a promising approach to overcome isoniazid resistance.

<table>
<tr>
<td>

Strategy/ Approach/ Technique/ Experiments used to solve

- *In silico* design (CADD) of Novel Chemical Entities (NCEs) and to identify the putative drug target(s) and, consequently, uderstand their mechanism of action.
- Synthesis, purification and characterization of designed Novel Chemical Entities (NCEs).
- *In vitro* anti-TB assay of designed NCEs against drug Susceptible (H37Rv), multi-drug resistant (MDR) and extremely-drug resistant (XDR-TB) strains of M. tuberculosis.
- *In vitro* & *In vivo* InhA enzyme inhibition study.

</td>
<td>

</td>
</tr>
</table>
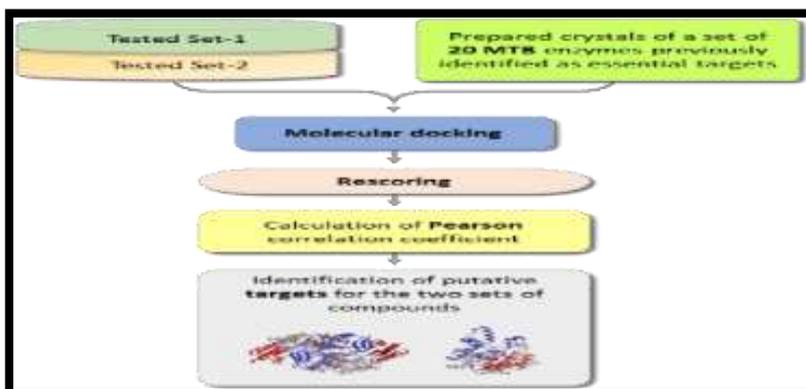
Publication/patent:

1. RSC CrystEngComm. **2025**, 27:1707-1721.
2. *International Journal of Biological Macromolecules* **2024**, 133285.
3. *Journal of Enzyme Inhibition and Medicinal Chemistry.* **2021**, 36 (1), 869-884.
4. *Journal of Enzyme Inhibition and Medicinal Chemistry.* **2021,** 36(1), 1472-87.
5. **U.S. Patent 12,297,204**, Granted 13/5/**2025**
6. **U.S. Patent** 12,227,480, Granted 18/2/**2025**
7. **U.S. Patent** 12215082, Granted 04/02/**2025**
8. **U.S. Patent** 12172973, Granted 24/12/**2024**

DR. PRAN KISHORE DEB'S RESEARCH GROUP
BIRLA INSTITUTE OF TECHNOLOGY

| Dr. Pran Kishore Deb (Supervisor) | Mr. Prasenjit Maity (PhD scholar) | Mr. Chandan K Singh (PhD scholar) | Ms. Champa Tudu (PhD scholar) | Dr. Reetuparna Acharya (PhD scholar) | Mr. Biprajit Sarkar (M.Pharm scholar) | Ms. Diya Roy (M.Pharm scholar) | Ms. Gracy Nag (M.Pharm scholar) |

DEPARTMENT OF REMOTE SENSING

Research Group- Aerosol and Climate Research Lab[ACRL]

- **Name of Principal Investigator/ Group Leader**: **Dr. Swagata Payra**
- **Research Theme**: Atmospheric processes, aerosols, radiative forcing, and extreme weather modelling using satellite and ground-based observations.
- **Broad Area of Research and Scope:**
  - **Atmospheric Sciences and Aerosol Studies**:
    - Radiative forcing estimation
    - Lightning vulnerability mapping
    - Heatwave and air quality modelling
  - **Remote Sensing Applications:**
    - Satellite validation (MODIS, VIIRS, MERRA-2, AERONET)
    - Statistical and numerical modelling of extreme weather events
  - **Instrumentation and Climate Infrastructure:**
    - Use of hyperspectral spectroradiometers, Aethalometers, AWS
    - FIST-supported lab for long-term monitoring of aerosol-climate interactions

Total Number of Publications by the group: More than 50

Top 5 Article with impact factor:

1. **Payra S**, Sharma A, Mishra MK, Verma S. Performance evaluation of MODIS and VIIRS satellite AOD products over Indian subcontinent. *Front Environ Sci*. 2023; 11:596. https://doi.org/10.3389/fenvs.2023.1158641 *(Related to AERONET and satellite validation work; SCIe, IF ~5.4)*

2. Ghosh S, Sarkar A, Bhatla R, Mall RK, **Payra S**, Gupta P. Changes in the mechanism of South Asian summer monsoon onset propagation induced by pre-monsoon aerosol dust storm. *Atmos Res*. 2023;

294:106980. https://doi.org/10.1016/j.atmosres.2023.106980 *(Aerosol-climate interaction study – related to broader FIST project objectives; SCI, IF ~5.5)*

3. Soni M, **Payra S**, Chandel AS, Verma S, Prakash D, Holben B. Aerosols properties over desert influenced locations situated in four different continents. *Atmos Environ*. 2021; 248:118232. https://doi.org/10.1016/j.atmosenv.2021.118232 *(Global desert aerosol study – supports AERONET-SPARTAN case; SCIe, IF ~5.0)*

4. Soni M, Verma S, Mishra MK, Mall RK, **Payra S**. Estimation of particulate matter pollution using WRF-Chem during dust storm event over India. *Urban Clim*. 2022; 42:101202. https://doi.org/10.1016/j.uclim.2022.101202
(WRF-Chem modeling — relevant to RESPOND lightning and FIST instrumentation usage; SCIe, IF ~6.4)

5. Verma S, Prakash D, Srivastava AK, **Payra S**. Radiative forcing estimation of aerosols at an urban site near the Thar Desert using ground-based remote sensing measurements. *Aerosol Air Qual Res*. 2017;17(5):1294-1304.https://doi.org/10.4209/aaqr.2016.09.0424

Research Projects:

Title of the Project	Role (PI/ Co-PI)	Funding Agency / Collaborator	Amount (₹ in Lakhs)	Duration	Status
AERONET Station at Jaipur	PI	NASA – GSFC	Instrumental Mode (>₹10 L)	2009–Present	Continuous
Physical and Optical Properties of Aerosols over Jaipur, India	Co-PI	DST, India	₹ 38.95	2010–2014	Completed
Air Pollution and Precipitation Chemistry at Jaipur	—	MoES – IITM	Not specified	2016–2017	Completed
Lightning Impact on Ozone Precursors and Tropospheric Ozone over India	PI	MoES, New Delhi	₹ 24.43	2017–2023	Completed
Prediction of Ground-Level PM from Multi-Satellite AOD over Indian Subcontinent	Co-PI	ISRO – SAC	₹ 22.08	2019–Continue	Ongoing
FIST Earth and Atmospheric Sciences Infrastructure (Level-C)	PI	DST – FIST	₹ 215.00	2023–2028	Ongoing
Generation of High-Resolution Cloud-to-Ground Lightning Vulnerability Maps Using Ground and Space-borne Data	PI	ISRO – RESPOND	₹ 26.33	2024–2026	Ongoing
Expansion of Aerosol Monitoring Network through SPARTAN at Jaipur	PI	SPARTAN – Dalhousie University	US$45k equivalent	2025	Ongoing

- **Achievements:**

❖ Established AERONET station in Jaipur since 2009
❖ Lead PI for DST FIST grant worth ₹2.15 Cr
❖ Multiple international collaborations (NASA, WMO, UCLA)
❖ Published in high-impact journals like *Scientific Reports*, *Environmental Pollution*, *Atmospheric Research*

Targeted Application Area:
Air Quality & Health, Lightning Risk & Disaster Prep, Climate Impact & Mitigation, Environmental Policy Support.

Industry/Academia Collaborations:
NASA (AERONET), MoES (IITM, SAC), IMD (MoU), Poornima Univ., IIHMR, BHU, Dalhousie Univ. (SPARTAN)

Description of Projects: 1) AERONET Station at BIT Jaipur

Problem Statement

Northwestern India, especially the Jaipur region, experiences intense dust loading and aerosol variability due to its proximity to the Thar Desert. Lack of consistent ground-based aerosol data hampers validation of satellite products and limits understanding of regional air quality dynamics.

Applications

- Validation of satellite AOD products (MODIS, VIIRS)
- Monitori   ng of aerosol climatology and long-term trends in Northwestern India
- Supports public health, desert dust studies, and urban air quality assessments
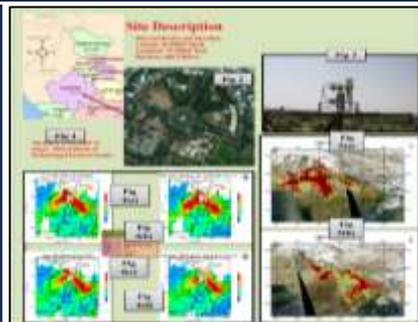
Strategy / Approach / Technique Used:

Established AERONET site (2009) with NASA GSFC; used Cimel Radiometer for AOD, water vapor; integrated satellite & model data (WRF-Chem, SBDART); data shared via AERONET portal.

Description of Projects: 2) Lightning Vulnerability Mapping using Ground and Satellite Data

Problem Statement

Lightning fatalities are increasing across India, particularly in underserved and high-exposure zones. Existing lightning monitoring systems offer limited spatial detail, leading to inadequate risk mapping and public preparedness.

Applications:

Lightning risk zoning, disaster planning & early warning, infrastructure safety mapping.

Strategy / Approach / Technique Used

ISRO-RESPOND project integrating ground & satellite lightning data (LIS, INSAT-3D, MODIS); geospatial/statistical modelling for lightning risk maps; GIS layers (land cover, elevation, indices); collaboration with NRSC, ISRO.

Description of Projects: 3) DST-FIST Earth and Atmospheric Sciences Infrastructure

Problem Statement

Environmental research in Earth and atmospheric sciences at BIT Mesra was limited by lack of high-end instruments. This constrained the department's ability to carry out advanced research in aerosol dynamics, trace gas monitoring, and model validation needed for air quality and climate assessment.

Applications:

• High-res monitoring of trace gases, aerosols & climate validation

• Support for education, research & long-term environmental tracking

Strategy / Approach / Technique Used

- Funded by the Department of Science and Technology (DST), Govt. of India, under the FIST Level-C scheme
- Procurement and installation of advanced atmospheric instruments: Aethalometer (AE33), Aerosol Spectrometer ,Hyperspectral Spectroradiometer ,Gas Analyzer (NOx, O₃, CO) Automatic Weather Station (AWS) ,High-End Server for Modelling
- Creation of a fully equipped Aerosol Research Laboratory
- Supports ongoing research projects, Ph.D. supervision, and model-simulation exercises such as WRF-Chem and SBDART

Group Members

Dr. Mili Ghosh nee Lala
Birla Institute of Technology (BIT) Mesra

Dr. Rajeev Bhatla
Banaras Hindu University

Dr. Divya Prakash
Poornima University Jaipur

Dr. Sunita Verma
Banaras Hindu University

Dr. Atul K Srivastava
IITM, Pune

Dr. Satyaki Sarkar
Birla Institute of Technology (BIT) Mesra

Dr. Amrita Sarkar
Birla Institute of Technology (BIT) Mesra

Dr. Nishi Srivastava
Birla Institute of Technology (BIT) Mesra

Dr. Varsha Tanu
JIIMB University Jaipur

Dr. Manish Soni
University of North Carolina

Ms. Ashmita Jessie Sen
Birla Institute of Technology (BIT) Mesra

Mrs. Ananya Aditi Saha
Birla Institute of Technology (BIT) Mesra

Ms. Sibalika Kundu
Birla Institute of Technology (BIT) Mesra

Mrs. Sumedha S Singh
Birla Institute of Technology (BIT) Mesra

Ms. Mala Sinha
Birla Institute of Technology (BIT) Mesra
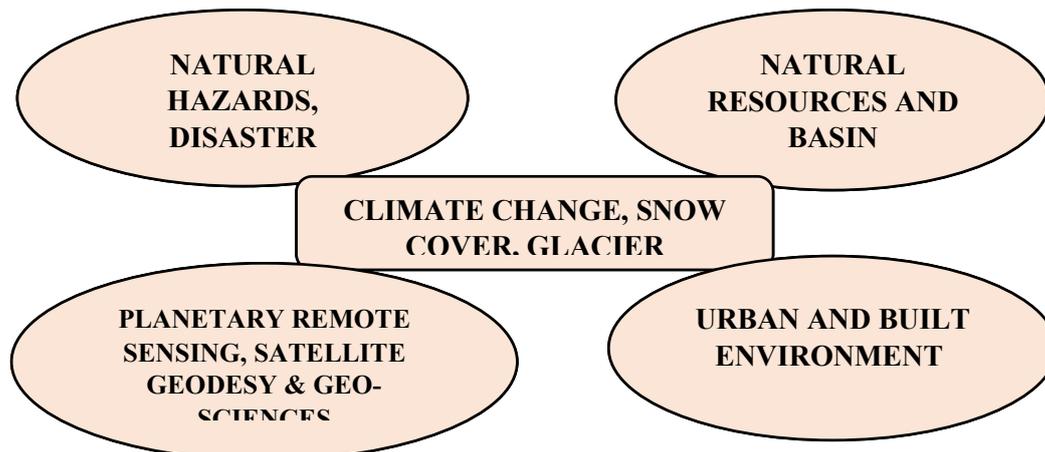
Ms. Kankana Ghosh
Birla Institute of Technology (BIT) Mesra

247

Research Group- Geospatial Applications and Analytics Group

- **Name of Principal Investigator/ Group Leader**: Dr. A P Krishna

- **Research Theme**: Geospatial applications and analytics

- **Broad Area of Research and Scope:**

➢ Geospatial Technology, Remote Sensing, Geoinformatics

NATURAL HAZARDS, DISASTER

NATURAL RESOURCES AND BASIN

CLIMATE CHANGE, SNOW COVER. GLACIER

PLANETARY REMOTE SENSING, SATELLITE GEODESY & GEO-SCIENCES

URBAN AND BUILT ENVIRONMENT

Total Number of Publications by the group: 45

Top 5 Article with impact factor:

1. Tabassum, F, Krishna, A P. Spatio-temporal drought assessment of the Subarnarekha River basin, India, using CHIRPS-derived hydrometeorological indices. *Environ Monit Assess* 194, 902 (2022). https://doi.org/10.1007/s10661-022-10547-1

2. Ojha, A K, Biswas, R, **Krishna, A P.** Stacked encoding and AutoML-based identification of lead–zinc small open pit active mines around Rampura Agucha in Rajasthan state, India. *Nature Sci Rep* 15, 5766 (2025). https://doi.org/10.1038/s41598-025-89672-z

3. Biswas, R, Rathore, V S, Krishna, A P, Das, A K, Bhattacharya, A, Porwal, A. 2025. Reconstruction of the lost Saraswati river course and its associated palaeochannels using multi-resolution SAR and MSS images in the northwestern desertic plains of Rajasthan, India, *Remote Sensing Applications: Society and Environment*, Volume 38, (2025). https://doi.org/10.1016/j.rsase.2025.101559

4. Jeganathan, C, Singh, B, Singh, C P, Behera, M D, Srivastava, S, Singh, K, Ranjan, R, Prakash, M, Kumar, A, Pandya, M R, Bhattacharya, B K, Krishna, A P, Ghosh, M, Rathore, V S, Sinha, N K, Choudhary, K, Bhuyan, M, Singh, S S, Sardar, P, 2024. Integrated use of Field Sensors, PhenoCam and Satellite data for pheno-phase monitoring in a Tropical Deciduous Forest of Dalma Wildlife Sanctuary, Jharkhand, India: Initial Results from Indian Phenology Network Initiative, *Biodiversity and Conservation*, Springer Nature (2024). https://doi.org/10.1007/s10531-024-02889-8

5. Shaheen, Farzana, Scariah, Nayama Valsa, Nee Lala, Mili Ghosh, Krishna, Akhouri Pramod, Jeganathan, C, Hoekzema, N. Shadow method retrievals of the atmospheric optical depth above Gale crater on Mars using HRSC images, *ICARUS*, Elsevier (2022). Volume 388 https://doi.org/10.1016/j.icarus.2022.115229

Research Projects:

Sl No	Title	Role	Funding Agency	Amount	Duration
1	DST-PURSE Promotion of Universities in Research and Scientific Excellence for "Center for Advanced Research on Machine LEarning for Geospatial Analytics and Solutions for Jharkhand State (ARMLEGS)	Co-PI	DST-GoI	Rs. 8.4 Crores	2023-2027
2	DST FIST Level B Fund for Improvement of S&T Infrastructure in Universities and Higher Educational Institutions	Co-PI	DST-GoI	Rs. 2.15 Crores	2023-2028
3	Mapping and morphological characterization of craters in the south polar region of the lunar surface using Chandrayaan-2 Dual Frequency SAR (DFSAR), High resolution OHRC and TMC-2 data, under Chandrayaan-2 data utilization Announcement of Opportunity (Ch-2-AO)	Co-PI	ISRO, Bengaluru	Rs. 19.98 Lacs	2022-2025
4	Remote Sensing based Hydrologic budget of the Subarnarekha River Basin	PI	DST-SERB	27.39 Lacs	2020-2023
5	National Wetland Inventory and Assessment (NWIA) Phase-II	Co-PI	ISRO/SAC Ahmedabad	Rs 20.50 Lacs	2019-2021

Industry/Academia Collaborations: Leads Connect Ltd., NOIDA

Targeted Application Area:

1. Natural hazards and disaster management research
2. Hydrology and Cryosphere research
3. Planetary remote sensing research
4. Urban and built-environment research

Brief Description of Projects : Remote Sensing based Hydrologic Budget of the Subarnarekha River Basin

Problem Statement:

➢ Subarnarekha river originating near Piska/ Nagri village near Ranchi city, capital of Jharkhand state traverses through Ranchi, Saraikela Kharsawan and East Singhbhum districts in the state and further to the states of West Bengal and Odisha (basin area 21471 km2)

➢ Ranchi city, the capital of Jharkhand state (created in the year 2000) has immense pressure of perceived rapid development activities around the river origin and the upper catchment

➢ Spatial science and technology using remote sensing and GIS offer better power of combining analytical and computational component of modelling of watershed/basin hydrology parameters

Applications:

➢ Integrated Water Resource Management (IWRM)
➢ Climate Change Impact Assessment
➢ Urban and Regional Land Use Planning
➢ Groundwater Exploration and Management
➢ Watershed Hydrology and Modelling
➢ Geological and Hydrogeological Risk Assessment
➢ Agricultural Water Management
➢ Decision Support for Policy Makers

Group Members

Research Group- Planetary Science and Lightning (Psl) Research Group

- **Name of Principal Investigator/ Group Leader**: Dr. Mili Ghosh Nee Lala
- **Research Theme**: Atmospheric lightning, Planetary remote sensing
- **Broad Area of Research and Scope:**

LIGHTNING
  - ➢ Lightning induced vulnerability assessment using satellite and ground-based obse...
  - ➢ Identification of main causative factors for CC and CG lightning and diagnostic analysis

PLANETARY SCIENCE
  - ➢ Photometric correction of lunar images, mapping iron and titanium rich zones
  - ➢ Algorithm development for automatic crater detection
  - ➢ Thermal properties of Martian surfaces
  - ➢ Detection and analysis of sand dune migration over Mars

Schematic Representation of Broad Area of Research:

Lightning induced vulnerability assessment   Algorithm development for automatic crater detection
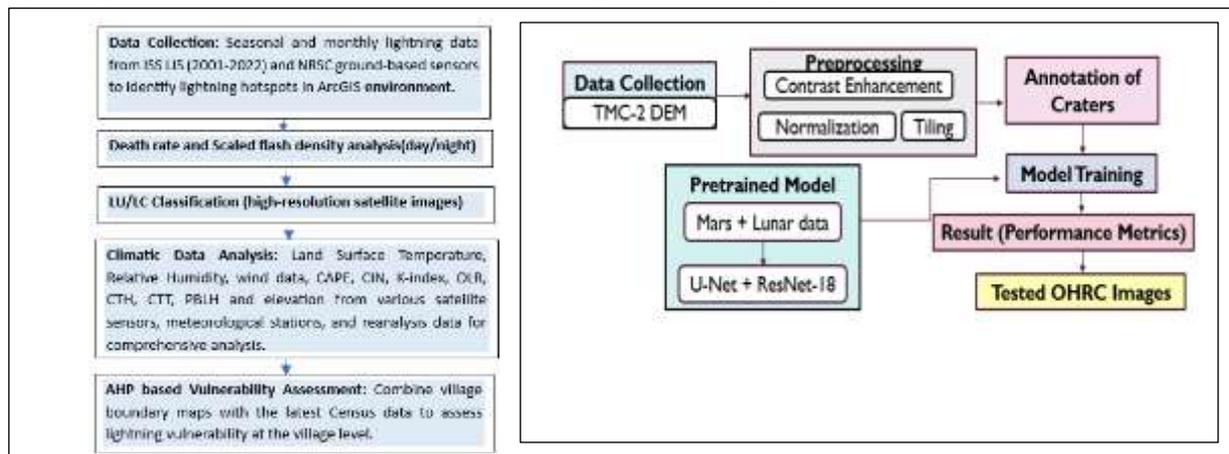
Total Number of Publications by the group: 9 SCIE,6 Scopus

Top 5 Article with impact factor: (Vancouver Style)

1. Shaheen F, Lala MG, Krishna AP, Payra S. Seasonal variation in atmospheric optical depth (AOD) and thermal inertia (TI) inter-relationship over Martian Gale crater. Planetary and Space Science. 2024 Mar 1;242:105865.

2. Sinha M, Paul S, Ghosh M, Mohanty SN, Pattanayak RM. Automated Lunar Crater Identification with Chandrayaan-2 TMC-2 Images using Deep Convolutional Neural Networks. Scientific Reports. 2024 Apr 8;14(1):8231.

3. Rangarajan VG, Ghosh M. Seasonal thermal inertia variations at Gale crater: Role of active surface deposition phenomena. Icarus. 2020 Feb 1;337:113499.

4. Ahmad A, Ghosh M. Variability of lightning activity over India on ENSO time scales. Advances in Space Research. 2017 Dec 1;60(11):2379-88.

5. Mushtaq F, Lala MG, Anand A. Spatio-temporal variability of lightning activity over J&K region and its relationship with topography, vegetation cover, and absorbing aerosol index (AAI). Journal of Atmospheric and Solar-Terrestrial Physics. 2018 Nov 1;179:281-92.

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration (in years)
Machine Learning and Deep Learning based Automatic Lunar Crater Detecting using Terrain Mapping Camera-2 DEM Images	Co-PI	Ch-2 AO, ISRO	21.98	3
Source Apportionment, Hydrodynamic Study and Environmental Fate Assessment of Micro-Plastics in Drinking Water Supplying Reservoirs of Ranchi, Jharkhand u	Co-PI	DST, SERB	38.102	3
Aerosol Characterization and its Radiative Effects on Changing Climate	Co-PI	DST, FIST	215	5
Centre for Advanced Research on Machine Learning for Geospatial Analytics and solutions for the state of Jharkhand	Co-PI	DST-PURSE	844.71	4
Generation of high-resolution cloud to ground lightning vulnerability maps using the ground and space borne data	Co-PI	RESPOND, ISRO	26.33568	2

Industry/Academia Collaborations: -- BHU, Varanasi and IIST, Trivandrum

Targeted Application Area:

❖ Use of automatic crater detection algorithm in identification of region with new impact crater
❖ Diagnostic approach-based classification/delineation of lightning and non-lightning cases

Achievements: Aprajita Mahila Samman-2024 by Prabhat Khabar Publishing house

Brief Description of Projects Ch-2 AO Project (Sponsored by ISRO) as Co-PI	
Problem Statement: Machine Learning and Deep Learning based Automatic Lunar Crater Detection using Terrain Mapping Camera-2 DEM Images	Applications: ➢ Lunar surface age determination ➢ Identification of new crater
Strategy/ Approach/ Technique/ Experiments used to solve **Deep learning approach**	
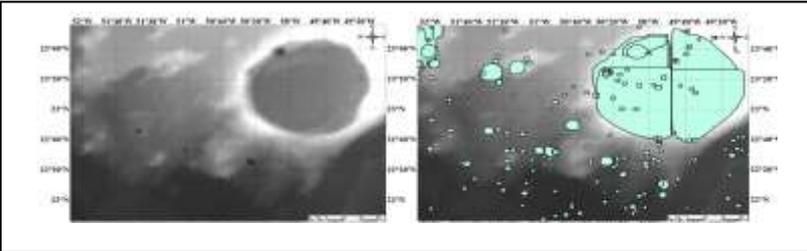
Brief Description of Projects RESPOND (Sponsored by ISRO) as Co-PI	
Problem Statement: Generation of high resolution cloud to ground lightning vulnerability maps using the ground and space borne data"	**Applications**: Useful in adopting mitigation measures
Strategy/ Approach/ Technique/ Experiments used to solve	
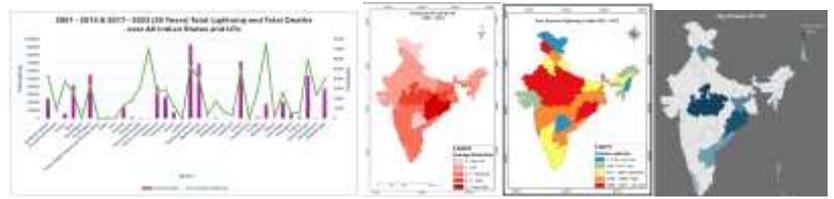
Group Members

Research Group-Terrestrial and Planetary Hydro Geo

- **Name of Principal Investigator**: Dr. V. S. Rathore
- **Research Theme**: Terrestrial and Extra-terrestrial Geomorphology, Surface and Subsurface water resources and Natural Hazards and Disaster Management
- **Broad Area of Research and Scope:**
  - Morphological characterisation of lunar craters
  - Hyperspectral and SAR data analysis for determining lunar surface composition including study of presence of volatiles in the South Pole Region of the moon.
  - River course dynamics, climate and LULC change impact assessment on surface and subsurface water resources.
  - Floods, droughts and landslides hazards and associated disaster risk assessment

Schematic Representation of Broad Area of Research:

Total Number of Publications by the group: 19
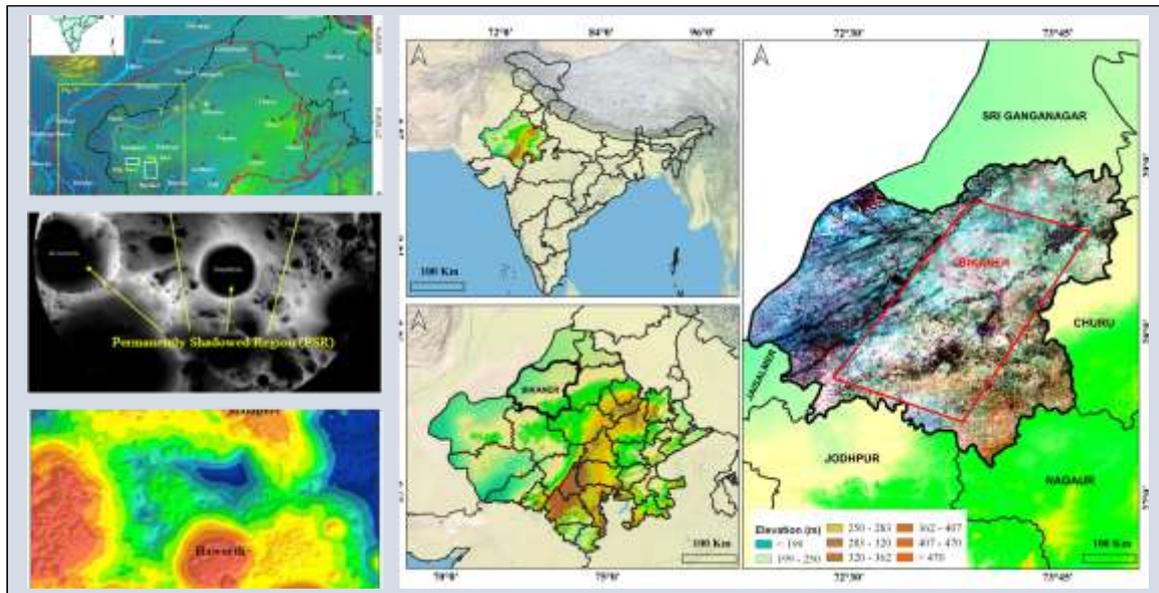   **Top 5 Article with impact factor: (Vancouver Style)**

1. Singh G, Malik R, Mohanty S, **Rathore VS**, Yamada K, Umemura M, Yamaguchi Y. Seven-component scattering power decomposition of POLSAR coherency matrix. IEEE Trans Geosci Remote Sens. 2019 Nov;57(11):8371–82. doi:10.1109/TGRS.2019.2920762. (Impact factor-7.5)

2. Kar S, **Rathore VS**, Champati Ray PK, Sharma R, Swain SK. Classification of river water pollution using Hyperion data. J Hydrol. 2016 Jun;537:221–33. doi:10.1016/j.jhydrol.2016.03.047. (Impact Factor-5.9)

3. **Rathore VS**, Nathawat MS, Champatiray PK. Palaeochannel detection and aquifer performance assessment in Mendha River catchment, Western India. J Hydrol. 2010 Dec 15;395(3–4):216–25. doi:10.1016/j.jhydrol.2010.10.026. (Impact Factor-5.9)

4. Biswas R, **Rathore VS**, Krishna AP, Das AK, Bhattacharya A, Porwal A. Reconstruction of the lost Saraswati river course and its associated palaeochannels using multi-resolution SAR and MSS

images in the northwestern desertic plains of Rajasthan, India. Remote Sens Appl Soc Environ. 2025 Apr;38:101559. doi:10.1016/j.rsase.2025.101559. (Impact Factor-3.8)

5. **Rathore VS**, Nathawat MS, Champati Ray PK. Influence of neotectonic activity on groundwater salinity and playa development in the Mendha river catchment, western India. Int J Remote Sens. 2008;29(13):3975–86. doi:10.1080/01431160801891861. (Impact Factor-3)

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
DST FIST Level B Fund for Improvement of S&T Infrastructure in Universities and Higher Educational Institutions	Co-PI	DST-GoI	215	5 Years
Mapping and morphological characterization of craters in the south polar region of the lunar surface using Chandrayaan-2 Dual Frequency SAR (DFSAR), High resolution OHRC and TMC-2 data	PI	ISRO	19.98	3 years
Remote Sensing based Hydrologic budget of the Subarnarekha River Basin	Co-PI	DST-SERB	27.39	3 Years
National Wasteland Change Analysis-cycle 2015-16	PI	NRSC, ISRO, Hyderabad	13.25	3 Years
Ground Water Quality Mapping under RGNDWM-PH-IV in parts of M.P.	PI	NRSC, ISRO, Hyderabad	45.25	8 Years

Industry/Academia Collaborations: ISRO, SAC Ahmedabad, NRSC Bangalore, IIT Bombay, Desert Research Institute, Reno, Nevada, IIRS, Dehradun

Targeted Application Area: Planetary science, Climate and LULC change effect on surface and subsurface water resources, Natural hazards monitoring and disaster risk assessment

Achievements:

- **Publication Chair:** InGARSS 2024, Goa (December 02-05, 2024)
- **Session Chair:** InGARSS 2024, Goa (December 02-05, 2024)
- **Organising Secretary:** National Symposium on Advances in Remote Sensing: Trends, Challenges and Opportunities for Development (NS-ARS21) (December 9-11, 2021)
- **Session Chair:** "Natural Resources & Environmental Management" at National Symposium on Advances in Remote Sensing: Trends, Challenges and Opportunities for Development (NS-ARS21) (December 9 - 11, 2021)
- **Coordinator:** Conducted AICTE ATAL FDP during 16-20 August 2021

Chandrayaan-2 AO Project

1.

Problem Statement:

The permanently shadowed regions (PSRs) of the lunar south pole are key sites for potential water ice, yet remain poorly understood due to limited exploration. This study addresses the need for detailed mapping and morphological characterization of impact craters in these PSRs, alongside analysis of backscatter coefficients, circular polarization ratio (CPR), and dielectric constant. Using Chandrayaan-2's DFSAR, TMC-2, and OHRC data, the study aims to assess surface properties and detect volatiles, supporting future lunar exploration and resource identification.

Applications:

➢ Identification of potential water ice deposits for future lunar resource utilization.
➢ Improved understanding of lunar surface properties through radar and optical data integration.
➢ Mapping and characterization of impact craters in permanently shadowed regions for geological analysis.
➢ Support for future lunar landing site selection by identifying stable and resource-rich regions.

Strategy/ Approach/ Technique/ Experiments

The study utilizes Chandrayaan-2's DFSAR (L & S-band) and LOLA-DEM data to map and analyse impact craters in the Permanently Shadowed Region (PSR) of the lunar south pole. Craters are identified using backscatter analysis and Yamaguchi decomposition. Morphometric parameters such as Depth/Diameter (d/D) ratio, slope, Circularity Index (CI), and Topographic Roughness Index (TRI) are computed to assess crater shape and degradation. Based on these analyses, craters are classified into preserved, partially degraded, and degraded categories for better understanding of lunar surface evolution.
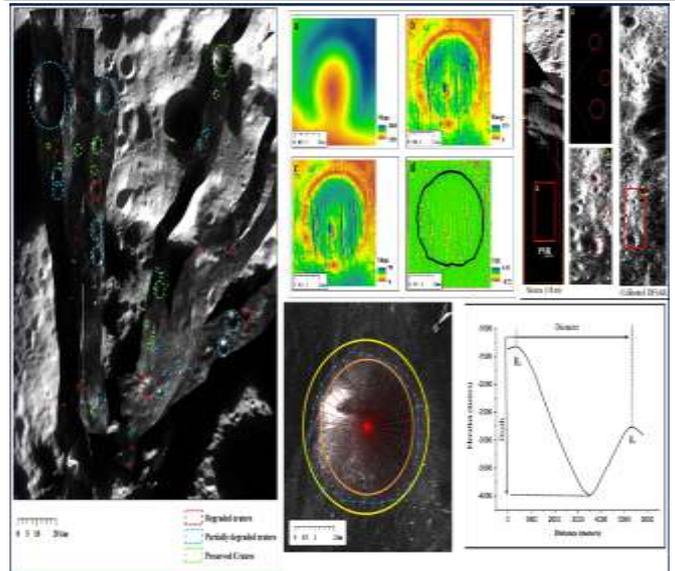
2. **NISAR Project**

Problem Statement:

The Saraswati River, once a major river supporting the Harappan civilization, has long vanished due to tectonic and climatic changes. Its lost course and associated palaeochannels remain buried under the arid terrain of northwestern Rajasthan, making detection challenging. Accurately reconstructing the river's path is crucial for understanding ancient civilizations and hydrological evolution in the region.

Applications:

➢ Helps locate ancient Harappan sites along the reconstructed river course.
➢ Identifies paleochannels that may serve as groundwater aquifers.
➢ Supports efforts to document and protect historically significant landscapes.
➢ Demonstrates the effectiveness of SAR-optical fusion methods for subsurface feature detection.

Strategy/ Approach/ Technique

The study uses multi-sensor and multi-resolution satellite data, including SAR and high-resolution optical imagery, fused using techniques like IHS, GS, and PCA. It analyzes surface features such as soil moisture and vegetation alignment to trace buried channels. The findings are validated using historical maps, archaeological data, groundwater records, and lithologs to ensure accuracy.

Group Members

Dr. V. S. Rathore   Dr. C. Jeganathan   Dr. A. P. Krishna
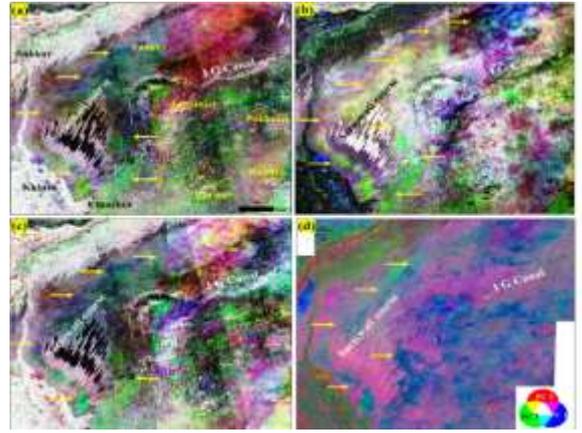
Department of Centre for Quantitative Economics and Data Science

Research Group- Digital Innovation Lab

- **Name of Principal Investigator/ Group Leader**: Dr. Manish Kumar Pandey
- **Research Theme**: Artificial Intelligence and Digital Transformation
- **Broad Area of Research and Scope:**
  - AI/ML-Based Solutions in BFSI
  - Data Science and Engineering
  - Quantum Computing
  - Big Data Analytics
  - Climate Change Analytics
  - Intelligent Automation

Schematic Representation of Broad Area of Research:
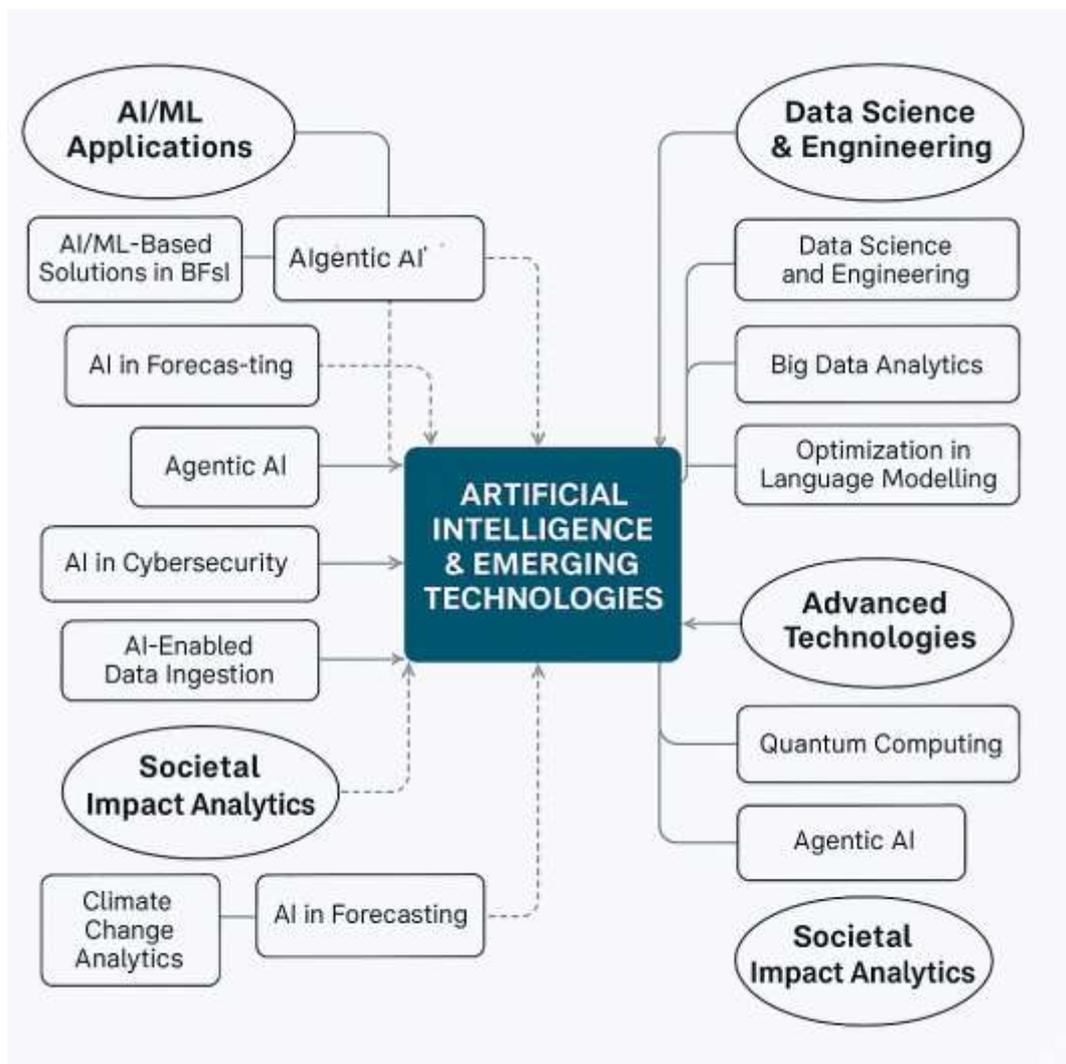
Total Number of Publications by the group:

Top 5 Article with impact factor: (Vancouver Style)

1. Surydhwaj P, Kumar Pandey M. AI-Insurance Unleashed: Redefining Insurance using Language Models. Whitepaper.

2. Sharma N, Kumar Pandey M. Integrative approaches for skin cancer detection and classification: a dual modal analysis. Accepted for presentation at: International Conference on Artificial Intelligence and Computer Vision in Medical Domain (AICVMD-2025); 2025 Feb 17–19; Banaras Hindu University.
3. Sharma N, Kumar Pandey M. Classification and identification of malware families using deep learning techniques. Accepted for presentation at: 2nd Annual QEDS Conference (AACM-2025); 2025 Feb 13–15; Birla Institute of Technology.
4. **Surydhwaj P, Kumar Pandey M. Explainability of encoder-based LLMs in medical text classification. Accepted for presentation at: International Conference on Communication and Smart Device (ICCoSD 2025); 2025 Jul 25–27; Birla Institute of Technology.**

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Digital Innovation Lab	PI (Head)	Adrosonic IT Consultancy Pvt Ltd.	INR 92,63,523.92	1st March 2023 to 28th February 2028

Industry/Academia Collaborations:

No. of Active International Collaborations (in terms of Research, Publication etc.):
- NASA Jet Propulsion Laboratory
- Umeå University, Umea, Sweden
- Systems Engineering and Automatic Control, University of the Basque Country
- Higher School of Saharan Agriculture Adrar (Algeria)
- USTHB (Algeria) & Aber. Univ. (UK)
- Aarhus University; Department of Geography, Harokopio University, Athens, Greece
- Informatics Centre, School of Science and Technologies, University of Camerino, 62032 Camerino, Italy
- Clinical Research Centre, School of Medicinal and Health Products Science, University of Camerino, Camerino, Italy
- KTH Engineering Mechanics, Stockholm (Sweden); Louisina State University
- International Rice Research Institute, India

No. of National Level Collaborations (in terms of Research, Publication etc.):
- Defense Terrain Research Laboratory (DTRL) DRDO
- IESD BHU
- Delhi University
- University of Allahabad
- National Institute of Advanced Studies, Bangalore
- Indian Institute of Science, Bangalore
- IARI, New Delhi
- Space Applications Centre, ISRO Ahmedabad
- CSRE-IIT,
- SNU New Delhi
- Rani Lakhsmi Bai Agricultural University, Jhansi

No. of Industrial Collaboration (Research Publication/Consultancy etc.)
- Adrosonic IT Consultancy Pvt Ltd., State Bank of India, Fractal Analytics, TCS and Adani Group

Targeted Application Area:

- AI in forecasting
- AI enabled Data Ingestion
- Agentic AI
- AI in Cybersecurity
- Intelligent Object Identification
- Optimization in Language Modelling

Achievements:

- **Travel Support from Adrosonic London, UK to showcase the Digital Innovation Lab prototypes at Elevate Connect.**
- **Participation in the Panel Discussion on AI's Impact on Art & Literature in Metaphor- Lucknow Literature Festival on 14th December 2024 at CII, Vibhuti Khand, Gomtinagar, Lucknow.**

Brief Description of Projects : *To explore the Multimodality and Explainability in Large Language Models (LLMs) for the insurance industry.*

Problem Statement:

The fusion of multimodality in Large Language Models (LLMs) is an exciting and rapidly evolving area of research. It involves integrating multiple types of data (e.g., text, images, audio, video) within LLMs to create models that can understand and generate more comprehensive and contextually rich information. Explainable AI (XAI) in Large Language Models (LLMs) is an emerging area of research focused on making the decisions and behaviors of these complex models understandable to humans. LLMs, such as GPT-4, are powerful tools for generating text and performing various natural language processing tasks, but their inner workings and decision-making processes are often opaque, leading to a "black box" problem. Explainable AI aims to address this by providing insights into how these models make predictions, which is crucial for building trust, ensuring fairness, and enabling safe deployment in critical applications.

Applications:

- AI enabled BFSI Domain
- Customer support
- Multi-modal claim processing
- Fraud detection
- Responsible AI in Insurance

Strategy/ Approach/ Technique/ Experiments used to solve

- Methods like LIME (Local Interpretable Model-agnostic Explanations) and SHAP (SHapley Additive exPlanations) can be adapted to LLMs to highlight influential words or phrases that led to the model's response.
- Methods like LIME (Local Interpretable Model-agnostic Explanations) and SHAP (SHapley Additive exPlanations) can be adapted to LLMs to highlight influential words or phrases that led to the model's response.

Group Members:

Research Group- Applied Data Science Lab

- **Name of Principal Investigator/ Group Leader**: Dr. Manish K Pandey
- **Research Theme**: Quantum Computing, Hyperspectral Analytics, Climate Change Analytics, Data Assimilation, Sustainability Solutions.

- **Broad Area of Research and Scope:**
  - **Quantum Computing**
    Quantum computing harnesses the principles of quantum mechanics to solve complex problems beyond the capability of classical computers. It holds transformative potential for cryptography, optimisation, and scientific simulations.
  - **Hyperspectral Analytics**
    Hyperspectral analytics involves analysing data across hundreds of spectral bands to detect subtle differences in materials. It is widely used in agriculture, mineralogy, and environmental monitoring.
  - **Climate Change Analytics**
    Climate change analytics uses historical and real-time data to model, monitor, and predict climate trends. It supports evidence-based policy making and risk mitigation strategies.
  - **Data Assimilation**
    Data assimilation integrates observational data with model forecasts to improve accuracy in environmental and climate systems. It enhances predictive power in weather forecasting, oceanography, and hydrology.
  - **Sustainability Solutions**
    Sustainability solutions focus on developing technologies and strategies that meet present needs without compromising future generations. These include renewable energy, resource efficiency, and resilient ecosystems.

Schematic Representation of Broad Area of Research
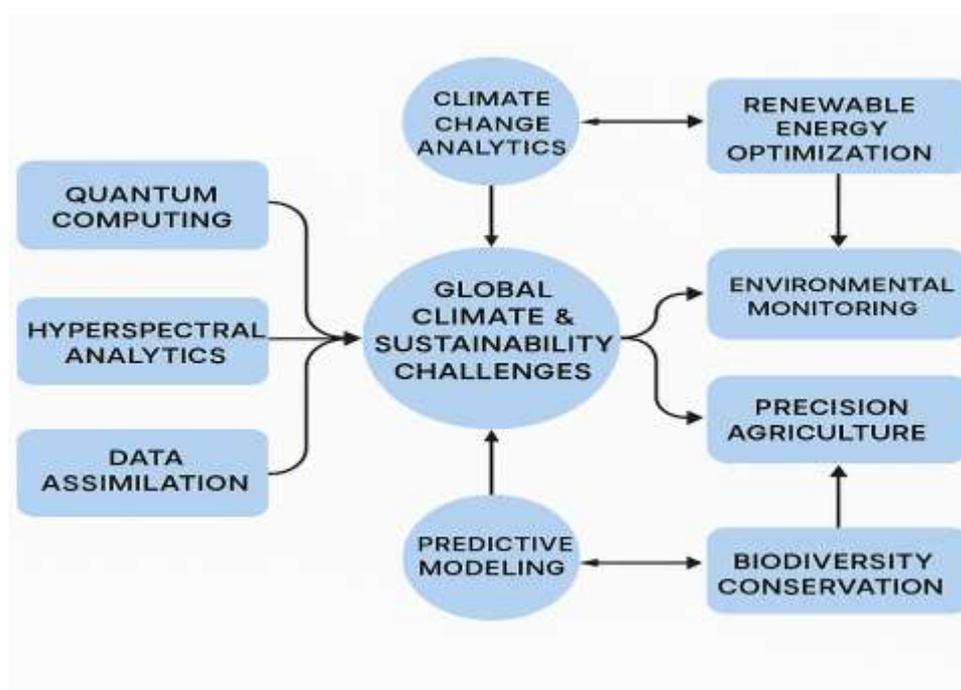
Top 5 Article with impact factor: (Vancouver Style)

1. Jaiswal R, Shekhar H, Gupta S, Payra S, Kumar Pandey M, Verma S. Assessing the impact of land use changes on PM2.5 concentrations: A geographically weighted regression approach. In: EGU General Assembly 2024; 2024 Apr 14–19; Vienna, Austria. EGU24-16601. Available from: https://doi.org/10.5194/egusphere-egu24-16601

2. Jaiswal R, Shekhar H, Kumar Pandey M, Verma S. Urban growth and air quality: Tracking PM2.5 changes over two decades. In: IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2025; 2025 Aug 3–8; Brisbane, Australia.

3. Maurya NK, Kumar Pandey M. Application of machine learning in forest monitoring: Recent progress and future challenges. In: Advanced Geospatial and Ground-Based Techniques in Forest Monitoring. 2025. Forthcoming.

Research Projects:

	Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
1.	Development of a Robust Machine Learning Tool to Support Quick Malaria Detection and Parasite Stage Identification for Reducing Malaria Burden	Co-PI	ICMR	151.50	Feb 2025 to January 2028
2.	One-day national workshop on "data analytics for efficient decision-making" in collaboration with the Administrative Staff College of India, Hyderabad	Convener	ASCI		7 January 2024
3.	Quantum Machine Learning for Hyperspectral Medical Image Processing	Supervisor	I-Hub Quantum Technology Foundation, Iiser	0.5	1February 2024 to 30th June 2024
4.	4 weeks Training and Skill Internship (VRITIKA) on "Hyperspectral Data Analytics"	Event Organizer	Science and Engineering Research Board (SERB)	1.5	
5.	Microwave satellite data assimilation in Weather Research & Forecasting model through deep learning for improved forecasting of surface and sub-surface soil moisture conditions	Co-PI	SERB	25.41	March 2023 to February 2026
6.	Development and Validation of Graph Optimisation-Based Multi-Sensor Fusion Algorithm to Establish Real-Time Connections between Climatic Variables in Himalayan Ecohydrological Process Networks for Future Climate Projections.	PI	BIT Mesra (SEED Money Scheme)	5	September 2022 to December 2025
7.	High-End workshop (KARYASHALA) on "Techniques and Applications of Hyperspectral Data Analytics"	Event Organizer	Science and Engineering Research Board (SERB)	5	25th July to 7th August 2022

Industry/Academia Collaborations:

No. of Active International Collaborations (in terms of Research, Publication etc.):
- NASA Jet Propulsion Laboratory
- Umeå University, Umea, Sweden
- Systems Engineering and Automatic Control, University of the Basque Country
- Higher School of Saharan Agriculture Adrar (Algeria)
- USTHB (Algeria) & Aber. Univ. (UK)
- Aarhus University; Department of Geography, Harokopio University, Athens, Greece
- Informatics Centre, School of Science and Technologies, University of Camerino, 62032 Camerino, Italy
- Clinical Research Centre, School of Medicinal and Health Products Science, University of Camerino, Camerino, Italy
- KTH Engineering Mechanics, Stockholm (Sweden); Louisina State University
- International Rice Research Institute, India

No. of National Level Collaborations (in terms of Research, Publication etc.):
- Defense Terrain Research Laboratory (DTRL) DRDO
- IESD BHU
- Delhi University
- University of Allahabad
- National Institute of Advanced Studies, Bangalore
- Indian Institute of Science, Bangalore
- IARI, New Delhi
- Space Applications Centre, ISRO Ahmedabad
- CSRE-IIT,
- SNU New Delhi
- Rani Lakhsmi Bai Agricultural University, Jhansi

No. of Industrial Collaboration (Research Publication/Consultancy etc.)
- Adrosonic IT Consultancy Pvt Ltd., State Bank of India, Fractal Analytics, TCS and Adani Group

Group Members:
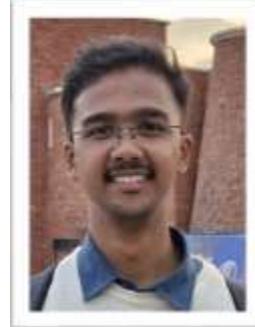
Research Group- Advanced Data Science Lab

- **Name of Principal Investigator/ Group Leader**: Dr. Manish Kumar Pandey
- **Research Theme**: This Lab is sponsored by **State Bank of India** for Solving Challenges in Responsible Banking, Risk Governance through Data Driven Approach.
- **Broad Area of Research and Scope:**
  - **Responsible Banking**
    - Environmental, Social, and Governance (ESG) aspects Forecasting
    - Empowering Service, Transparency, Ethics, Politeness & Sustainability (STEPS).
  - **Risk Governance**
    - Credit Risk, Market Risk, Operational Risk and Liquidity Risk
    - Credit Risk Management, Market Risk Management, Compliance Risk
  - **Management & ESG Risk Management**
    - Analyzing regional and global financial activities, behaviors, events and their impact and risk

Schematic Representation of Broad Area of Research:
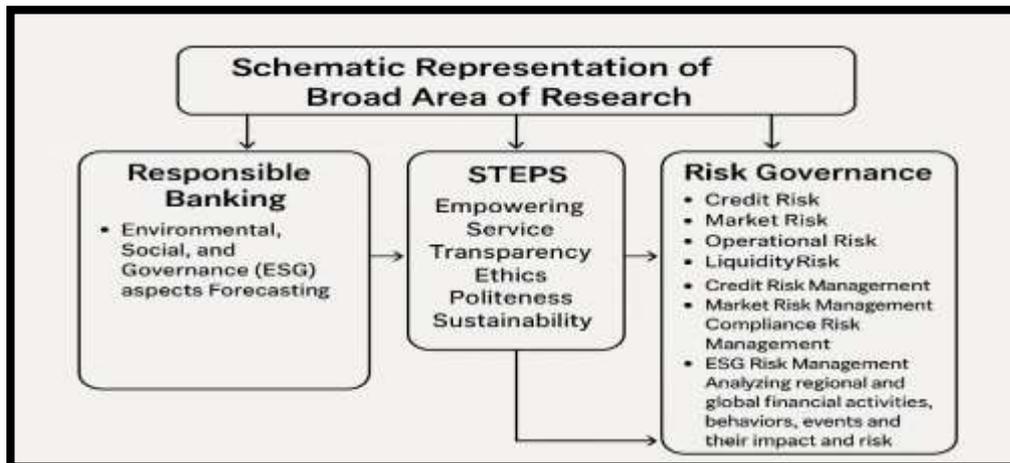
Total Number of Publications by the group:

Top 5 Article with impact factor:

1. Kumar Pandey M*, Karthikeyan S. Enhancing financial services sustainability through improved predictive and preventive analytic techniques on defaults made by customers using an optimally balanced dataset. In: 2nd Annual QEDS Conference; 2025 Feb 13–15; Accepted at AACM-2025.
2. Mahto B, Kumar Pandey M*. Vision Transformer-driven brain tumor identification with local interpretable model explanations. In: International Conference on Communication and Smart Device (ICCoSD 2025); 2025 Jul 25–27; Accepted.

Research Projects:

Title	Role (PI/Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of Machine Learning Tool for Reducing Exposure to ESG (Environmental, Social, and Governance) Risks	PI	Asha & Sajjan Agarwal Foundation	INR 17,91,000.00	July 2025 to June 2027

Industry/Academia Collaborations:

No. of Active International Collaborations (in terms of Research, Publication etc.):
- NASA Jet Propulsion Laboratory
- Umeå University, Umea, Sweden
- Systems Engineering and Automatic Control, University of the Basque Country
- Higher School of Saharan Agriculture Adrar (Algeria)
- USTHB (Algeria) & Aber. Univ. (UK)
- Aarhus University; Department of Geography, Harokopio University, Athens, Greece
- Informatics Centre, School of Science and Technologies, University of Camerino, 62032 Camerino, Italy
- Clinical Research Centre, School of Medicinal and Health Products Science, University of Camerino, Camerino, Italy
- KTH Engineering Mechanics, Stockholm (Sweden); Louisina State University
- International Rice Research Institute, India

No. of National Level Collaborations (in terms of Research, Publication etc.):
- Defense Terrain Research Laboratory (DTRL) DRDO
- IESD BHU
- Delhi University
- University of Allahabad
- National Institute of Advanced Studies, Bangalore
- Indian Institute of Science, Bangalore
- IARI, New Delhi
- Space Applications Centre, ISRO Ahmedabad
- CSRE-IIT,
- SNU New Delhi
- Rani Lakhsmi Bai Agricultural University, Jhansi
-

No. of Industrial Collaboration (Research Publication/Consultancy etc.)
- Adrosonic IT Consultancy Pvt Ltd., State Bank of India, Fractal Analytics, TCS and Adani Group

Project:

Group Members:

Birla Institute of Technology, Deoghar

Research Group- Macromolecular, Electrochemical, and Micro-Engineering Study (ME2S)

- **Name of Principal Investigator/ Group Leader: Dr. Shyam Sundar Majhi**
  In-Charge, Chemistry Department, BIT, Deoghar Campus -814142
- **Research Theme:** (i) Frontal polymerization approaches for the manufacturing of polymer composites
  (ii) Electrochemical machining approaches for manufacturing of extremely hard or tough metals or alloys.
- **Broad Area of Research and Scope:**
  - Rapid and energy-efficient manufacturing of polymers and composites using frontal polymerization techniques.
  - Utilizing frontal polymerization to develop environmentally friendly polymer-based composite materials.
  - Validation of frontal polymerization processes through standard computational and mathematical modelling.
  - A study on metal fabrication using electrochemical machining (ECM), particularly for hard metals or alloys that cannot be machined using conventional methods.
  - Electrochemical machining (ECM) in various electrolytic environments to improve accuracy in producing complex-shaped components from hard-to-cut metals or alloys.
  - Microscopic deformation studies of hard metals or alloys in different chemical electrolytes during the ECM process.

Schematic Representation of Broad Area of Research:

Frontal polymerization   Microscopic deformation during ECM   Flow diagram of the ECM process
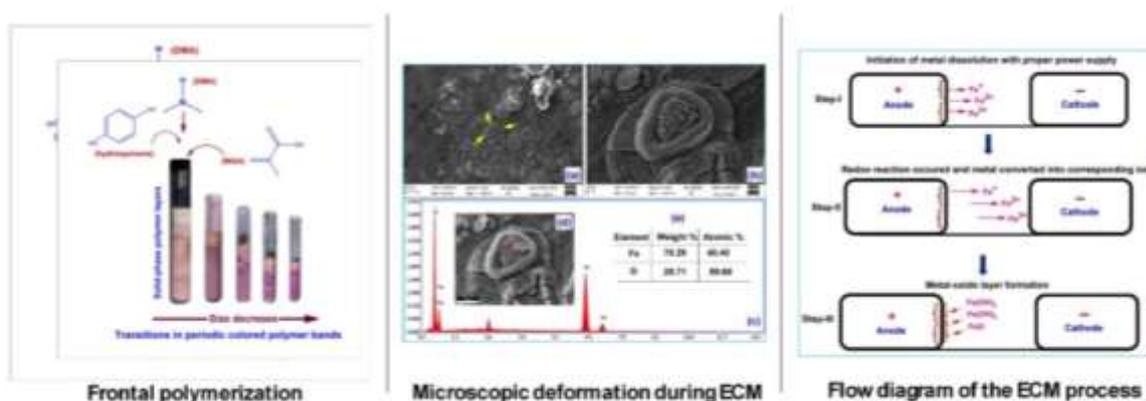
Total Number of Publications by the group: 04 (from 2022 to 2025)

1. Shyam Sundar Majhi, Narendra Yadav, Ashis Kumar Chakraborty. Development of periodic colored bands via frontal polymerization. **Journal of the Indian Chemical Society.** 2022; 99 (10), 100721:1-6. https://doi.org/10.1016/j.jics.2022.100721**. Impact Factor 3.2**
2. Shyam Sundar Majhi , Ashish C. Singh, Ritesh Kumar Upadhyay, Ashis, Kumar Chakraborty, , Narendra Yadav, P.K. Srivastava. Structural modulation in colored polymer bands of methacrylic acid-based frontal polymerization**. Journal of the Indian Chemical Society.** 2024; 101 (11), 101437:1-12. https://doi.org/10.1016/j.jics.2024.101437**. Impact Factor 3.2**
3. Ritesh Kumar Upadhyay, Shyam Sundar Majhi, Susanta Sinha Mahapatra, Narendra Yadav, Ashis Kumar Chakraborty, Ashish Chandra Singh, Bishnu Kumar. A comparative study on material removal rate and surface roughness during electrochemical machining of 100Cr6 steel in oxidizing and

reducing electrolytic environments. *Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering.* 2025;0(0). doi:10.1177/09544089251316751. **Impact Factor 2.3**

4. Ritesh K Upadhyay, Ashis K Chakraborty, Shyam S Majhi, Ashish C Singh, Bishnu Kumar, Narendra Yadav. Influences of redox electrolyte containing AuNPs on microscopic surface structure, material removal and surface roughness of 20MnCr5 steel alloy during electrochemical machining. *Surf. Sci. Technol.* **2025; 3 (11).** https://doi.org/10.1007/s44251-025-00074-9. **Springer**, **Impact Factor** (yet to be declared)

Industry/Academia Collaborations: Group members collaborate with the following individuals:

- **Dr. S. S. Mahapatra**, Associate Professor in the Chemistry Department, BIT Mesra, who provides support in electrochemical analysis and research, particularly focusing on electrochemical machining; and
- **Dr. Narendra Yadav**, Scientific Officer, Central Instrumentation Facility, BIT Mesra, who offers experimental and instrumental support in the areas of frontal polymerization and electrochemical analysis.
- **Note:** Collaborative efforts between industry and academia are also focused on enhancing research and patenting.
- **Targeted Application Area:** Polymer industries/Metal processing industries
- **Achievements:**No significant achievements were made, particularly in securing funding projects. However, group members are consistently putting in effort to achieve outcomes.

Group Members

Dr. Ashis Kumar Chakraborty Associate Professor, Mechanical Engineering, BIT Deoghar	Dr. Ritesh Kumar Upadhyay Assistant Professor, Mechanical Engineering, BIT Deoghar	Dr. Ashish Chandra Singh Assistant Professor, Chemistry Department, BIT Deoghar	Dr. Anjana Pradhan Ghorai Associate Professor, Department of Mathematics, BIT Deoghar	Dr. Bishnu Kumar Assistant Professor, Department of Mathematics, BIT Deoghar
Dr. Narendra Yadav Scientific Officer, Central Instrumentation Facility, BIT Mesra, Ranchi		Dr. S. S. Mahapatra Associate Professor, Department of Chemistry, BIT Mesra, Ranchi.		

Research Group- Cloud-IoT based Distributed Computing in Societies

- **Name of Principal Investigator/ Group Leader**: Dr. Kamta Nath Mishra
- **Research Theme**: Cloud-IoT based Distributed Computing in Societies
- **Broad Area of Research and Scope:**
  - Cloud-IoT Technologies
  - Distributive Computing
  - Cyber and Information Securities

Schematic Representation of Broad Area of Research:
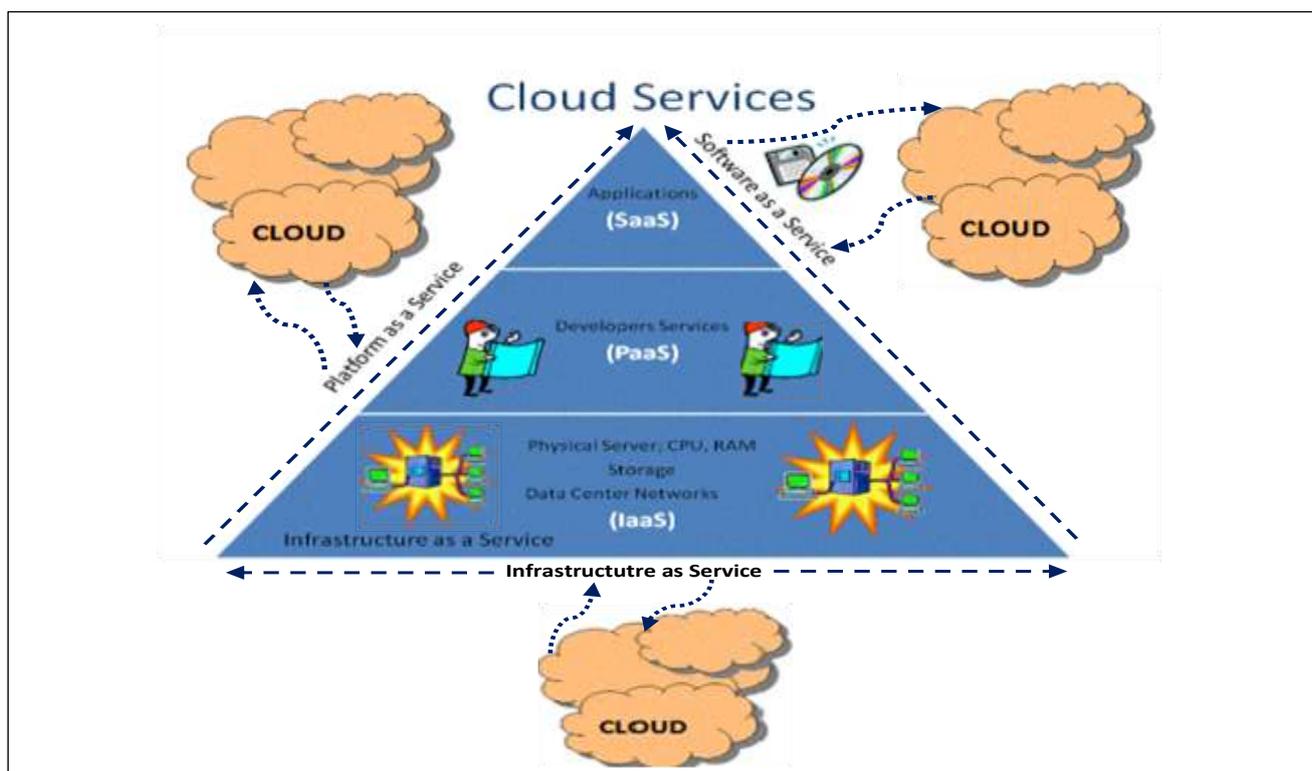
Total Number of Publications by the group: 90

Top 5 Article with impact factor: (Vancouver Style)

1. Mayank Pathak, Kamta Nath Mishra*, S. P. Singh, *Securing data and preserving privacies in cloud-IoT based technologies: An analysis of accessing threats and developing effective safeguards*. Artificial Intelligence Review, 57, 1-53, 2024 (*Impact Factor = 10.70*)

2. Rayees Ahamad, and **Kamta Nath Mishra***, *Exploring Sentiment Analysis in Handwritten and E-text Documents Using Advanced Machine Learning Techniques: A Novel Approach*, Journal of Big Data, Springer, 12 (11), 1 – 32, 2025 (**Impact Factor = 8.60**).

3. Kamta Nath Mishra, Alok Mishra, P. N. Barwal, R. K. Lal, Natural Language Processing and Machine Learning-Based Solution of Cold Start Problem Using Collaborative Filtering Approach, Electronics, MDPI, pp. 1-27, 2024 (*Impact Factor=3.10),*

4. Rayees Ahamad, and Kamta Nath Mishra*, *Hybrid approach for suspicious object surveillance using video clips and UAV images in cloud-IoT-based computing environment*, Cluster Computing, Springer, 27, 1-25, 2023 *(Impact Factor=3.70)*.

5. Kamta Nath Mishra, Vandana Bhattacharya, Shashwat Saket, and Shivam P. Mishra, Security Provisions in Smart Edge Computing Devices using Blockchain and Machine Learning Algorithms: A Novel Approach, Cluster Computing, Springer, 26, 1-32, 2022 *(Impact Factor = 3.70)*.

6. Rayees Ahamad, and Kamta Nath Mishra, Knowledge Discovery of Suspicious Objects Using Hybrid Approach with Video Clips and UAV Images in Distributed Environments: A Novel Approach, Wireless Networks, Springer, 29(8), pp. 3393-3416, 2023 *(Impact Factor= 2.70)*.

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	Tracing the Parents of Orphanage Children using Intelligent Technologies, Kamta Nath Mishra, Soumya Ray, Rajesh Kumar Lal, Anjana Pradan Ghorai	22.04.2025	In Process

Industry/Academia Collaborations:

- We have research collaborations with Jawaharlal Nehru University Delhi, Indian Institute of Information Technology Allahabad, Centre for Development of Advanced Computing (MeitY, Govt. Of India), Noida, Amity University Dubai, Norwagian University of Science & Technology Norway, University of Tripoli Libya, Penn State University USA, University of Maryland USA, and University Sabha Libya, etc.

Targeted Application Area: Cloud-IoT Computing; Medical Technologies, Smart Society

Achievements:

29.

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)

Problem Statement:

Modern prosthetic devices often fail to fully rehabilitate amputees due to their inability to accurately emulate the balance of forces and movements generated by a biological ankle. Thiscan lead to discomfort, asymmetry inga it, and pain in other parts of the body. The challenge is to create prosthetic device that provides a more natural walking experience and reduces these issues.

Applications:

- Medical devices and Orthopedics, Assistive technology
- Healthcare and rehabilitation canters for amputees
- Physical therapy and mobility assistance - sports, elderly and disability services
- Prosthetics manufacturing and development Retail and consumer good

Strategy/ Approach/ Technique/ Experiments used to solve

Modern prosthetic devices often fail to fully rehabilitate amputees due to their inability to accurately emulate the balance of forces and movements generated by a biological ankle. This can lead to discomfort, asymmetry inga it, and pain in other parts of the body. The challenge is to create prosthetic device that provides a more natural walking experience and reduces these issues.

Group Members

Research Group- Drone Technology

- ▪ **Name of Principal Investigator/ Group Leader**: Dr. Deep Shekhar Acharya
- ▪ **Research Theme**: Drone Technology
- ▪ **Broad Area of Research and Scope:**
    - ➢ Defence Research Development Organisation aligned projects

Schematic Representation of Broad Area of Research:
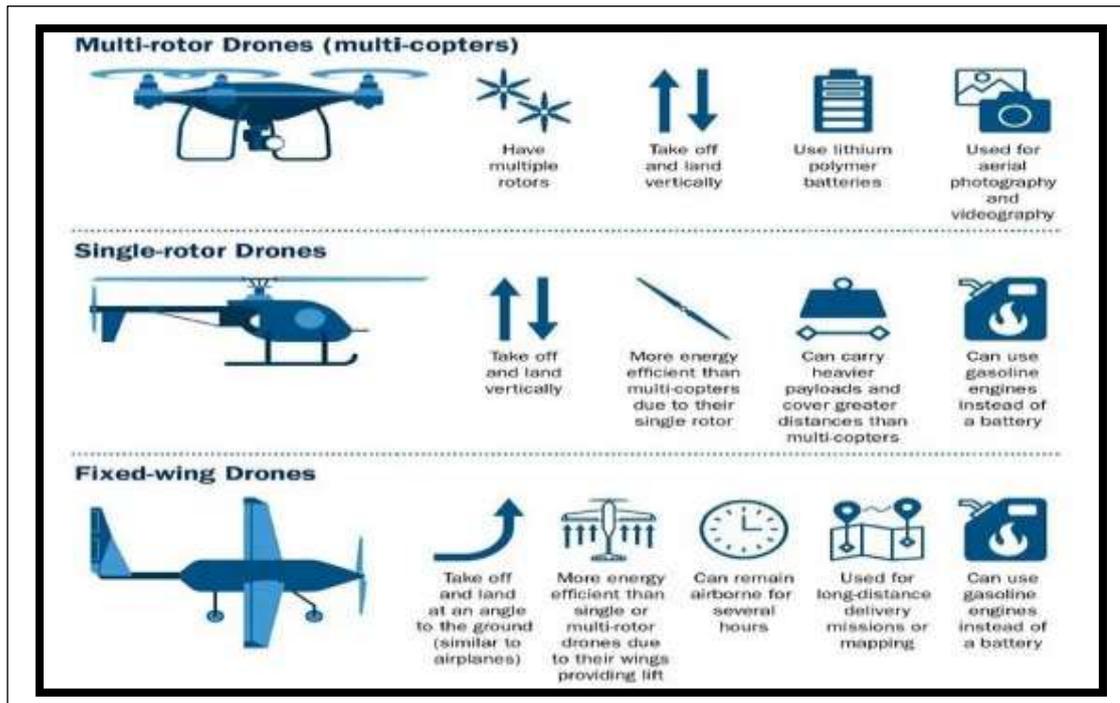
Total Number of Publications by the group: 15

Top 5 Article with impact factor: will be submitted in due course

Industry/Academia Collaborations: Yes – General Aeronautics Pvt. Ltd. Bangalore

Targeted Application Area: Design and development of miniature drone for Army surveillance and spying purpose.

Group Members

Research Group- Intelligent Control and Automation

- **Name of Principal Investigator/ Group Leader:** Dr. Deep Shekhar Acharya
- **Research Theme**: Design of Robust and Intelligent Strategies for Control and Stabilization of Complex Nonlinear Systems
- **Broad Area of Research and Scope:**
  - ➤ Design of controllers for nonlinear plants.
  - ➤ Optimization of controller parameters.
  - ➤ Collision Avoidance of self-driving vehicles
  - ➤ Development of machine learning based control strategies.
  - ➤ Path planning and SLAM for autonomous ground vehicles and UAV.
  - ➤ Formulation of evolutionary algorithms.

Schematic Representation of Broad Area of Research:
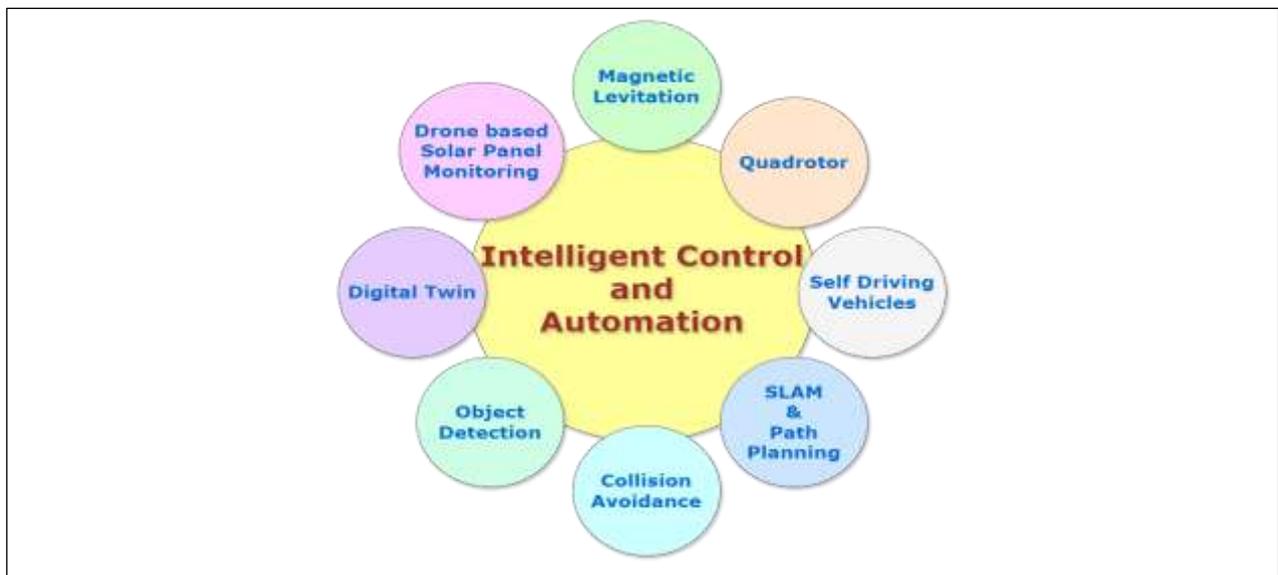
Total Number of Publications by the group: more than 50

Top 5 Article with impact factor:

1. Kumar B, **Swain S.K**, Ghosh S, **Mishra S.K**, Singh Y.K. Radial basis function-based adaptive gain super-twisting controller for magnetic levitation system with time-varying external disturbance. IEEE Transactions on Transportation Electrification. 2024;10(4):9121-32 **(Impact Factor: 7.2)**

2. **Acharya D.S, Mishra S.K, Swain S.K**, Ghosh S. Real-time implementation of fractional-order PID controller for magnetic levitation plant with time delay. IEEE Transactions on Instrumentation and Measurement. 2022;71:1-1.**(Impact Factor: 5.6)**

3. **Swain S.K**, Rath J.J, Veluvolu K.C. Cooperative Game Theory based robust shared lateral control for Driver Vehicle Interactions. Control Engineering Practice. 2023;141:105678. **(Impact Factor: 5.4)**

4. **Acharya D.S, Mishra S.K**. A multi-agent based symbiotic organisms search algorithm for tuning fractional order PID controller. Measurement. 2020;155:107559**(Impact Factor: 5.2)**

5. **Kumar S**. Identification of dominant equivalent circuit elements of voltammetric sensor system. IEEE Sensors Journal. 2024 Jan 12;24(5):6312-9. **(Impact Factor: 4.3)**

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	Title: A non-integer order Controlling System for Second Order System and Method Thereof Inventor(s):Dr. D. S. Acharya, Dr. Sudhansu Kumar Mishra and Dr. Subrat Kumar Swain	App. No.: 202331077668 Date: 15/11/2023	Published on 24/11/2023
2.	Title: Biometric Sensors on Steering Wheel Inventors: Dr. Chetna Nagpal, Dr. Prabhat Kumar Upadhyay, Vidhya KoothupalakkalViswambaran, Dr. Deep Shekhar Acharya, Dr. Sudhansu Kumar Mishra.	Design Number:439404-001 12/12/2024	Granted
3.	Title: Agricultural Health Monitoring Device Inventors: Rohit Kumar, Prity Soni, Sudhansu Kumar Mishra, Subrat Kumar Swain, Sitanshu Shekhar Sahu, Jagannath Sethi,	6300570 11/08/2023	Granted
4.	Title: An intelligent irrigation system and method thereof Inventor: Prity Soni, Rohit Kumar, Sudhansu Kumar Mishra, Subrat Kumar Swain, Sitanshu Shekhar Sahu,	App. no. 202331060280 Date:7/09/2023	Published on20/10/2023
5.	Title: An Autonomous Vehicle Navigation System and Method Thereof Inventors:Ankit Kumar, Abhishek Thakur, Sudhansu Kumar Mishra, Subrat Kumar Swain, Sitanshu Sekhar Sahu	Application No: 202331066870 Date: 05/10/2023	Published on 03/11/2023

Industry/Academia Collaborations:

1. Collaboration with Dr. Subhojit Ghosh, Professor, Dept. of Electrical Engg., NIT Raipur.

Targeted Application Area: Magnetic Levitation.
Drone based solar panel monitoring.
Swarm robotics and its applications to reconnaissance, search and rescue.
SLAM and path planning of self-driving vehicles
Object detection and collision avoidance.

Achievements:

1. Dr. Subrat Kumar Swain received the **Best PhD thesis Gold Award** for the topic 'Shared Control for Intelligent Vehicles using Game Theory and Reinforcement Learning' at **KPIT Shodh Awards** in Pune, March 2025.
2. Dr. Sanjeev Kumar received the **Best Paper Award** in international conference in 2025.
3. Dr. Sudhansu Kumar Mishra received the **Best Paper Award** in international conference in 2024.
4. Dr. Deep Shekhar Acharya received the **Best Paper Award** in international conference in 2019.
5. Dr. Sudhansu Kumar Mishra has been the **Chair / Co-Chair** in several international and national conferences.

Group Members

Research Group- Resource & Cost Optimization

- **Name of Principal Investigator/ Group Leader**: Dr. Sandip Ghosh Hazra
- **Research Theme**: Resource & Cost Optimization
- **Broad Area of Research and Scope:**
     Defence Research Development Organisation aligned projects,
     DBT related projects

Schematic Representation of Broad Area of Research:

The Benefits of Optimal Resource Allocation for Cost Optimization

1. Increased Efficiency
2. Cost Reduction
3. Improved Decision Making
4. Enhanced Flexibility
5. Case Study
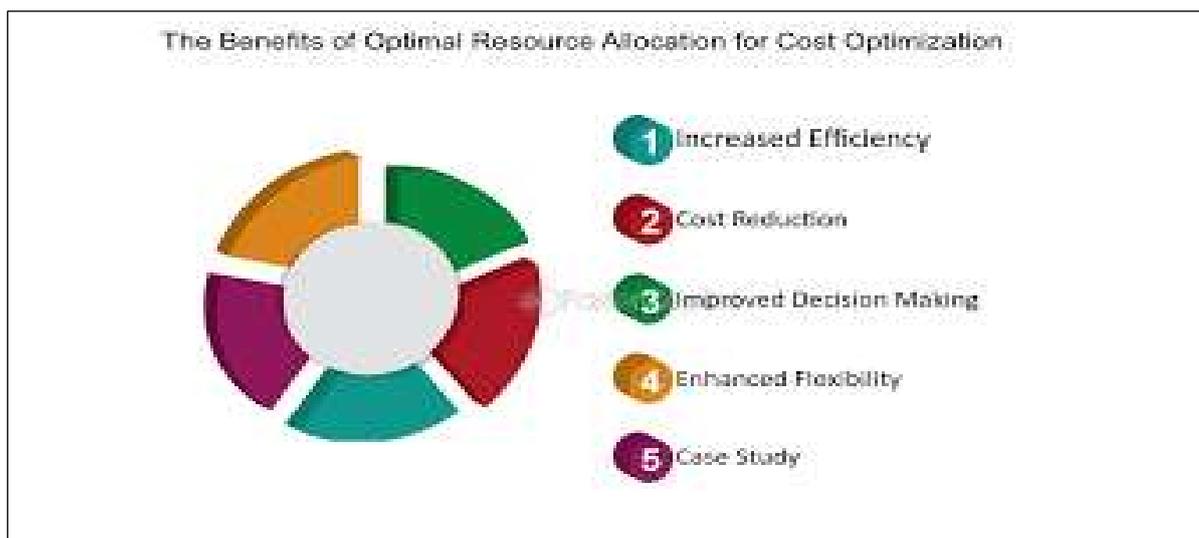
Total Number of Publications by the group: 12

Targeted Application Area: Optimization of the resources and cost cutting for defence and Biotechnology related projects.

## Group Members

BIRLA INSTITUTE OF TECHNOLOGY JAIPUR

Research Group- Cognitive Learning Research Group

- **Name of Principal Investigator/ Group Leader**: Dr. Vishwambhar Pathak
- **Research Theme**: Methods and Systems for Scalable Multimodal Deep Learning and AI Solutions
- **Broad Area of Research and Scope:**
  - ➢ Spatio-temporal-spectral Feature Engineering
  - ➢ Big Data and Cloud based methods
  - ➢ Multimodal Predictive Learning in related application domains including Neurophysiological and Geospatial data
  - ➢ Cognitive AI Solutions

Schematic Representation of Broad Area of Research:
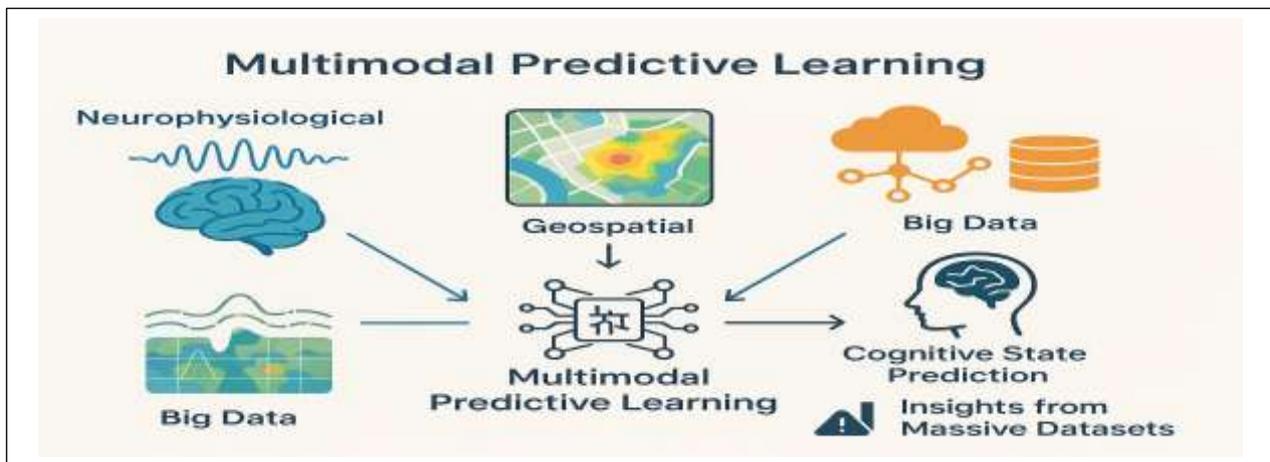
Total Number of Publications by the group:

Top 5 Article with impact factor: (Vancouver Style)

1. (Scopus) Pathak, V., Gaur, V., Mahanti, P. K., & Chandra, S. (2023, June). Exploring the Efficacy of Explainable Deep Learning in Identifying Neuromarkers for Precise Prediction of Epilepsy and Causal Connectivity Analysis. In Proceedings of the 2023 15th International Conference on Computer Modeling and Simulation (pp. 126-132).
2. (Presented) Vishwambhar Pathak, Vivek Gaur, Shubham Shukla, Deep Computational Investigation of Causal brain structures of Epilepsy using EEG, International Conference on Recent Trends in Engineering and Sciences (RTES-2023), May 02-03, 2023
3. Vishwambhar Pathak, Prabhat K Upadhyay, Vivek Gaur, Deep Learning Framework for Causal Connectivity based Epileptic Neuromarkers from Multi-channel EEG, ACCS8: 8th Annual Conference of Cognitive Science, 20-22 Jan 2022, Amrita Mind Brain Center, Amrita Vishwa Vidyapitham, Amritapuri.
4. Pathak V, Dhyani P, Mahanti P, Gaur V. Tracking Slow Modulations of Effective Connectivity for Early Epilepsy Detection: A Review. Knowledge Modelling and Big Data Analytics in Healthcare. 2021. 229-255. [eBook ISBN 9781003142751]

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/Granted)
1.	Title: [Method and System for Identifying Neurological Pattern and Prognostic Management] Inventors: [Vishwambhar Pathak, Prof Varun Gupta, Ccet, Chandigarh, India]; Applicant: Birla Institute Of Technology, Mesra	202431051099[India] date: July 3, 2024	Published on (U/S 11A): July 12, 2024

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of Distributed Deep Learning based Dynamic Causality Analysis Model for Predicting Epilepsy and Simulation of Epileptic Brain	Dr. V. Pathak (PI) Dr. Vivek Gaur (Co-PI)	DST under CSRI scheme	16.88 Lakh	March 2020-Feb 2023

Industry/Academia Collaborations:

1. Prof Prabhat K. Mahanti, Professor, Computer Science, Univ. of New Brunswick, Canada
2. Prof Varun Gupta, Professor, Computer Science, CCET, Chandigarh
3. Dr. Satish Chandra, Associate Professor, Dept of Computer Science & Engineering, Tech Mahindra University, Hyderabad
4. Dr. Prabhat K. Upadhyay, Dept of Electrical Engineering, BIT Mesra

Targeted Application Area:

1. BCI and assistive tools using EEG, NIRS
2. Geospatial predictive models
3. Big data systems Modules

Achievements:

Brief Description of Project : **Development of Distributed Deep Learning basedDynamic Causality Analysis Model for Predicting Epilepsy and Simulation of Epileptic Brain"** funded (duration 2020-2023; 16.88 Lakh) under Cognitive Science Research Initiative (CSRI) scheme of DST, GOI ref-ID DST/CSRI/2018/276

Problem Statement:

- To **predict** an **epileptic seizure** onset using EEG
  - **Classification** of an EEG-pattern **as a "preictal" (vs "interictal")** epileptiform w.r.t. certain seizure prediction horizon (SPH).
  - To prescribe **neuromarkers of epilepsy** in terms of time-varying causal connectivity among pairs of regions of interest (ROIs)

Computations were implemented over Dell tower 7820 equipped with NVIDIA Quadro RTX 5000 (24 GB) GPU

Applications:

➤ Clinical prognosis of neurological disorders, primarily focussed on detection of pre-epileptic patterns

➤ Deep learning based Workflow for robust and explainable mining of inherent complex non-linear dynamic patterns of connectivity among the brain regions

Solution Methodology

1 · Automized data preprocessing, data augmentation

2 · Visual and Statistical Investigation of Discriminative patterns of effective connectivity in different {ROIs xFrequency_band} combinations

3 · 3D CNN based binary classifier to detect preictal pattern of EEG using effective connectivity matrices as input feature-sets

Group Members

281
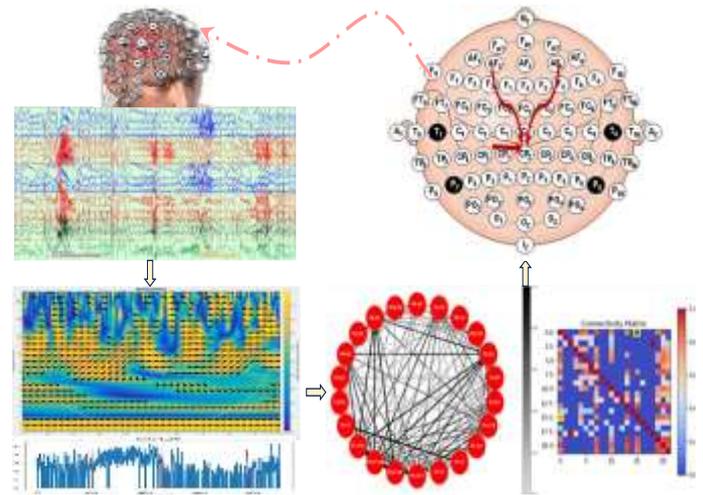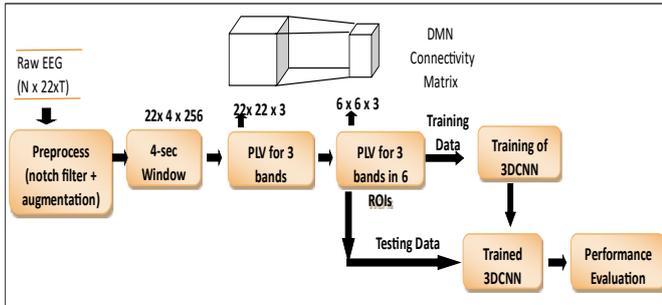
Research Group- Greens Miners

- **Name of Principal Investigator/ Group Leader: Dr. Jitendra Goyal**
- **Research Theme**: Sustainable Blockchain Mining using Proof of Useful \
  Work (PoUW) and Green Energy
- **Broad Area of Research and Scope:**

  ➢ Develop a Proof of Useful Work-based mining algorithm that replaces traditional PoW hashing.
  ➢ Integrate a Proof of Carbon Credit mechanism, prioritizing miners using renewable energy sources.
  ➢ Develop a computational cloud service within the blockchain mining framework.
  ➢ Assess the feasibility, security, and efficiency of the proposed algorithm.
  ➢ Evaluate the environmental impact and carbon footprint reduction.

Schematic Representation of Broad Area of Research

Current blockchain mining models consume vast amounts of electricity without direct societal benefits. This project addresses two major gaps:

1. Replacing wasteful computation with useful cloud-based services in blockchain mining.
2. Integrating carbon credit incentives, ensuring a direct link between mining efficiency and environmental responsibility. The project introduces a novel PoUW + PoCC consensus mechanism, which has the potential to revolutionize sustainable blockchain mining.

Total Number of Publications by the group:

1. Goyal, Jitendra and Ahmed, Mushtaq and Gopalani, Dinesh and Pandey, Neelu and Ahmed, Faisal, "An Efficient Fuzzy-Based Vaccine Distribution Using Blockchain Technology," International Journal of Computing and Digital Systems, vol. 14, pp. 519–530, 1 Aug. 2023. doi: http://dx.doi.org/10.12785/ijcds/140140. [Scopus indexed Journal Articles]
2. Yadav, Akash and Goyal, Jitendra and Ahmed, Mushtaq, "Robust block-based watermarking algorithm with parallelization using multi-level discrete wavelet transformation," Journal of Real-Time Image Processing, vol. 21, no. 6, p. 182, Oct. 2024, issn: 1861-8219. doi: 10.1007/s11554-024-01559-w. [SCIE Journal Articles]
3. Goyal, M. Ahmed, D. Gopalani, D. Z. Bano, and A. Choudhary, "Cemetery allocation management system using ethereum blockchain," in Data Science and Applications, S.J. Nanda, R. P. Yadav, A. H. Gandomi, and M. Saraswat, Eds., Singapore: Springer Nature Singapore, 2024, pp. 113–125, isbn: 978-981-99-7814-4. doi: https://doi.org/10.1007/978-981-99-7814-4_10. [Book Chapters]
4. Sharma, S., & Vijayvargiya, S. (2022). An Optimized Neuro-fuzzy Network for Software Project Effort Estimation. IETE Journal of Research (Taylor &Francis), doi.org/10.1080/03772063.2022.2027282 [SCIE & Scopus Indexed]

Top 5 Article with impact factor: (Vancouver Style)

1. S. Wadhwa et al., "Green Mining: How Renewable Energy Can Power Blockchain," J. Sustainable Computing, vol. 7, no. 2, pp. 89–102, 2023.
2. M.TodoroviÅLc et al., "Proof-of-Useful-Work: Blockchain Mining by Solving Real-Life Optimization Problems," Symmetry, vol. 14, no. 9, p. 1831, 2022.
3. S. Wadhwa et al., "Energy Efficient Consensus Approach of Blockchain for IoT Networks with Edge Computing," Sensors, vol. 22, no. 11, 2022.
4. Davenport, et al., "Using Intel SGX for Secure Computation in Blockchain Mining," in Proc. IEEE S&P, 2018.

5. Frontiersin.org, "Environmental Impact of Bitcoin Mining," [Online]. Available: https://www.frontiersin.org/.

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	Goyal, Jitendra and Mushtaq Ahmed and Dinesh Gopalani and Aditi Sharma and Akash Yadav, "Blockchain and IoT Based Electronics Health Record Device," Patent, The Patent Office, Controller General of Patents, Designs & Trade Marks, Govt. of India, Design Accepted and Published, in class 14: Recording, Communication OrInformation Retrieval Equipment, Dec. 2022. url: https://search.ipindia.gov.in/DynamicUtility/Journal/Patent	Application No. 372608-001 Journal No. 51/2022, Dated 23/12/2022	Published

Targeted Application Area:

1. Blockchain Mining
2. Green Energy
3. Carbon credit and Carbon Footprint

Co-Principal Investigators: Dr. Shripal Vijayvargiya (2494), Associate, Professor, andIn-Charge

Group Members

Research Group- The Tumor Trackers

- ▪ **Name of Principal Investigator/ Group Leader**: Dr. Smitha Jha
- ▪ **Research Theme**: Generative AI for Brain Tumor Analysis
- ▪ **Broad Area of Research and Scope:**

- ➢ **Enhancement of Diagnostic Imaging:** Generative AI improves the resolution and quality of MRI/CT scans, aiding in clearer tumor visualization and more accurate diagnosis.
- ➢ **Synthetic Data Generation and Augmentation:** GANs and VAEs generate realistic medical images, addressing the scarcity of annotated data and improving model training for rare tumor types.
- ➢ **Advanced Model Architectures:** Hybrid approaches combining GANs with CNNs or Transformers demonstrate superior segmentation and classification performance compared to standalone models.
- ➢ **Challenges and Future Directions:** Despite progress, issues like data privacy, model generalization, computational complexity, and ethical concerns persist—prompting research into XAI, federated learning, and real-time clinical deployment.

Schematic Representation of Broad Area of Research
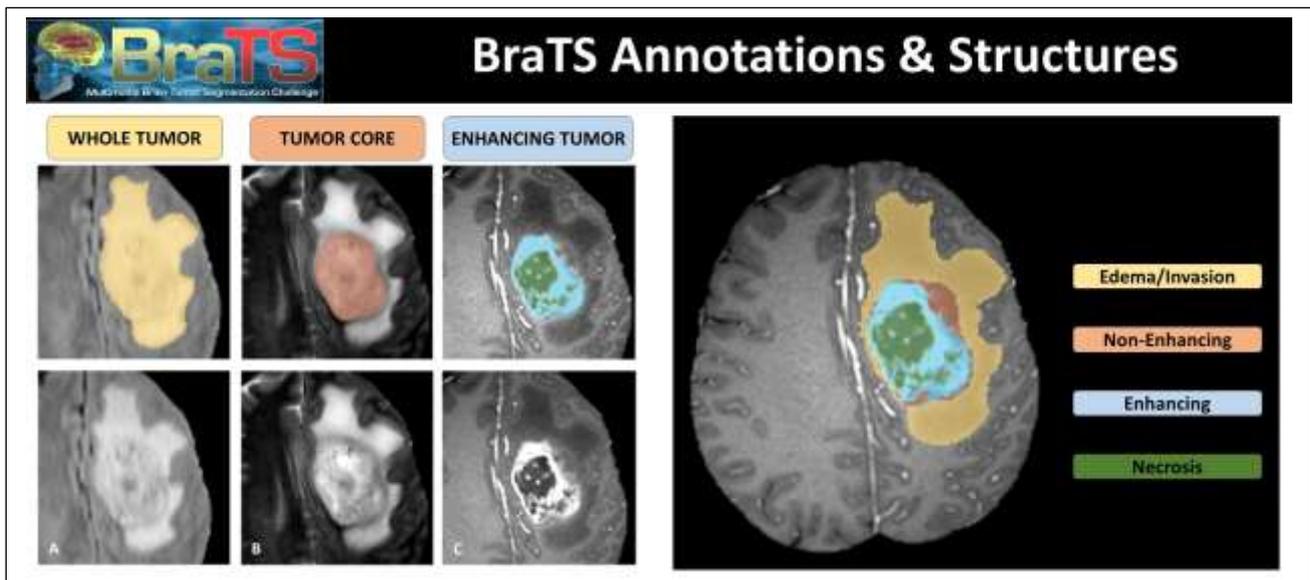
Total Number of Publications by the PI: 10

Publications:

1. Jha S, Cloud Computing security challenges with block chain technology,Zeichen journal, ISSN No: 0932 4747, 2022, 8(2):338.
2. Jha S, Mallick D K, Suri R K, Nature Inspired Algorithm for Dependent Task Scheduling in Grid System. International Journal of Applied Engineering Research ISSN 0973-4562 ,2015, 10(8): 18935-18944.
3. Jha S, Balanced Ant Colony Algorithm for Scheduling DAG to Grid System", International journal of scientific and Engineering Research, 2011,2(6).

4. Jha S, Gupta A, Mallick D K, A New QoS based Load Balancing Approach with Percentage Load Conversion in Grid Heterogeneous System, International Journal of Computer Applications (0975 – 8887),2012, 57(5).

Patents by the PI:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted
1	Solar water filtration	5/5/2023	Published

Achievements:

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)

Problem Statement:

- Fragmented literature, no unified framework
- Inconsistent evaluation protocols
- Limited hybrid model analysis
- Lack of clinical integration pathways

Applications:

- **Synthetic Data**: GANs create MRI/CT scans, address data scarcity
- **Image Enhancement**: Super-resolution GANs, diffusion models improve clarity
- **Data Augmentation**: VAEs generate varied images for classification
- **Segmentation & Classification**: Hybrid models (GAN+CNN, VAE+Transformer)
- **Multi-Modal Integration**: Combines MRI, CT, PET for diagnosis

Graphical Abstract
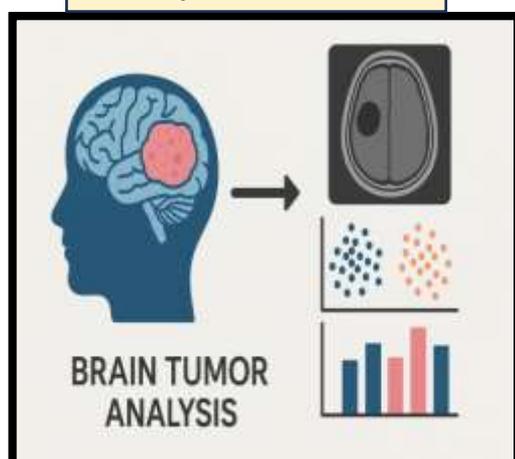
Strategy/ Approach/ Technique/ Experiments used to solve

- Generative Adversarial Networks (GANs) in Medical Imaging
- Autoencoders for Feature Extraction & Augmentation
- Hybrid Approaches (GAN and CNN, VAE and Transformer, etc.)

Group Members

285

Birla Institute of Technology, City Centre Lalpur

Research Group- AI for Mental Health

- **Name of Principal Investigator/ Group Leader**: Dr. Amrita Sarkar
- **Research Theme**: Mental Health Diagnosis and Risk Prediction
- **Broad Area of Research and Scope:**
  - **Artificial Intelligence in Healthcare** – Applying AI techniques for improving mental health diagnostics and care.
  - **Machine Learning and Deep Learning** – Employing ML/DL models to analyse mental health patterns.
 - **Behavioural and Affective Computing** – Understanding emotions and behaviour using computational methods.
  - **Multimodal Data Analytics** – Integrating and analysing data from diverse sources (e.g., voice, facial, sensors).
  - **IoT-based Health Monitoring** – Using smart devices for continuous tracking of mental health indicators.
  - **Mobile and Ubiquitous Computing** – Delivering mental health support via mobile and wearable platforms.
  - **Digital Phenotyping** – Extracting mental health insights from digital behaviour patterns.
  - **Edge AI and Real-time Systems** – Deploying AI on local devices for immediate mental health

Schematic Representation of Broad Area of Research
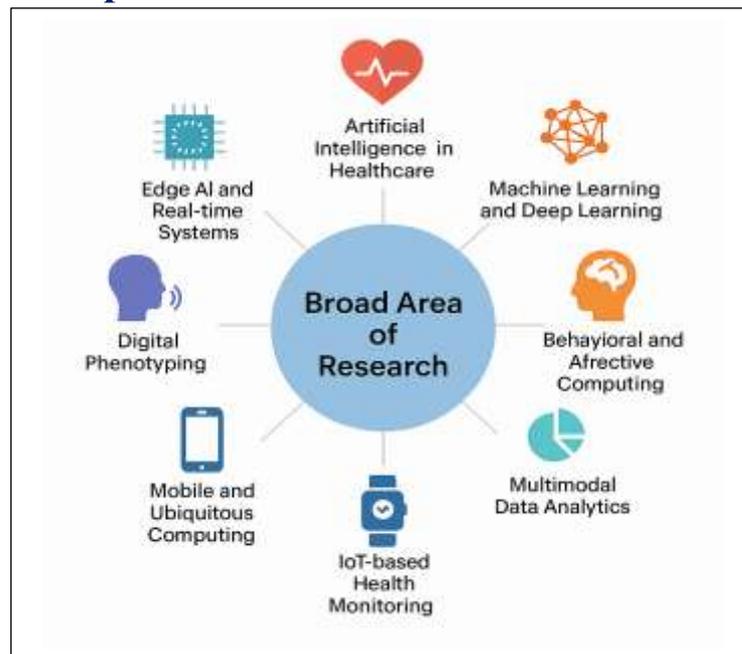
Total Number of Publications by the group: 246

Top 5 Article with impact factor:

Publications of Dr. Amrita Sarkar

1. Sarkar A, Bhattacharjee V, Pandey P. An Empirical Analysis of Deep Learning Models for Temperature Prediction. *Int J Exp Res Rev*. 2025;47:12–24. doi:10.52756/ijerr.2025.v47.002 **(Scopus)**
2. Sarkar A, Bhattacharjee V. A Comparative Study of Accident Black Spot Identification: A Crucial Analysis Using Machine Learning and Statistical Approach. *Int J Exp Res Rev*. 2025;47:84–92. doi:10.52756/ijerr.2025.v47.007 **(Scopus)**

287

3. Sarkar A, Sarkar S. Comparative Assessment Between Statistical and Soft Computing Methods for Accident Severity Classification. *J Inst Eng India Ser A*. 2020;101(2):27–40. doi:10.1007/s40030-019-00422-7 (Scopus)
4. Sarkar A, Sahoo G, Sahoo UC. Feature Selection in Accident Data: An Analysis of its Application in Classification Algorithms. *Int J Data Anal Tech Strateg*. 2016;8(2):108–121. doi:10.1504/IJDATS.2016.077484(Scopus)
5. Sarkar A, Sahoo UC, Sahoo G. Accident prediction models for urban roads. *Int J Veh Saf*. 2012;6(2):149–161. doi:10.1504/IJVS.2012.049020 (Scopus)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1.	Partha Sarathi Bishnu, Abhishek Kumar, and Vandana Bhattacharjee, BIRLA INSTITUTE OF TECHNOLOGY MESRA. System and Method for Optimizing Discounts to Enhance Customer Satisfaction and Company's Revenue	Patent application no. 202431053477. Priority Date: July 12, 2024.	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Non-invasive method for detection and analysis of anemia in pregnant women using deep learning-based model: A Multidisciplinary, Multicentric Study	Co-PI (Vandana Bhattacharjee) PI (Dr. Partha Sarathi Bishnu)	ICMR	27,49,745/-	1st March, 2025 to 29th February, 2028
Visually Evoked EEG Signal Classification and Perceived Image Regeneration using Deep Learning for Brain Fingerprinting (SPR/2022/000154)	Co-PI (**Vandana Bhattacharjee**) PI (Dr. Shamama Anwar)	SERB - SUPRA	Rs. 24,15,705/-	2023 – 2026
Deep learning models for Depression Detection among young adults	PI (Amrita Sarkar)	Seed Money Scheme, BIT Mesra	Rs. 4,00,000 /-	1st July, 2024 to 30th June, 2026
Development of Machine Learning Algorithms for the Early Diagnosis of Delinquent Behaviour of Juveniles	Co-PI (**Vandana Bhattacharjee**) PI (Dr. Subrajeet Mohapatra)	DST	Rs. 22,54,000/-	2019-2022
Development of Metric Suite for Object-Oriented Design	PI (**Vandana Bhattacharjee**)	UGC	Rs. 3,06,740 /-	2008-2011

Industry/Academia Collaborations:

Academic Collaborations

1. Departments of Psychiatry and Psychology: Collaborate for clinical validation, mental health assessments, and ethical compliance.

2. Biomedical Engineering / Neuroscience Departments: Partner for EEG, physiological signal analysis, and sensor integration.
3. Public Health and Social Work Schools: Align with societal mental health goals, outreach strategies, and policy recommendations.
4. Medical Colleges and Hospitals: Joint studies on patient data collection, intervention design, and impact analysis.

Industry Collaborations

1. IoT and Wearable Tech Companies (e.g., Fitbit, Garmin, Oura, Muse); Partner for integration and testing of physiological and activity sensors.
2. Healthcare AI Startups (e.g., Wysa, Mindstrong, Ginger, InnerHour): Collaborate on emotion detection, chatbot integration, and app development.
3. Telehealth Platforms (e.g., Practo, Lybrate, Apollo TeleHealth): Work on deployment and real-world testing of remote monitoring solutions.
4. Mobile and App Development Firms: Co-develop mobile platforms or edge-AI prototypes for mental health tracking.

Achievements 1:

Brief Description of Projects : Non-invasive method for detection and analysis of anaemia in pregnant women using a deep learning-based model: A Multidisciplinary, Multicentric Study

Problem Statement:

To develop a non-invasive deep learning-based system for accurately detecting and analyzing anemia in pregnant women using hematological parameters across multiple clinical centers.

Applications:

- Early detection of anemia in pregnant women without the need for invasive procedures.
- Clinical decision support for obstetricians using AI-assisted diagnosis.
- Improved maternal health outcomes through timely intervention based on model predictions.
- Integration into mobile health platforms for rural and low-resource settings.
- Standardization of anemia **screening** across multiple healthcare centers using a unified AI model.

Strategy/ Approach/ Technique/ Experiments used to solve

Strategy: Develop a non-invasive diagnostic framework combining deep learning with hematological indicators. Approach: Leverage multicentric clinical datasets and feature engineering for robust anemia detection. Technique: Use deep neural networks trained on CBC parameters and clinical labels for classification. Experiments: Perform training, validation, and testing across geographically diverse data sources to assess model accuracy and generalizability.

Graphical Abstract
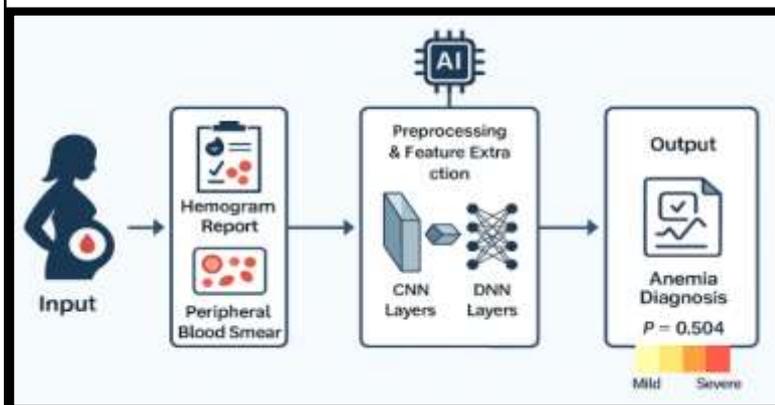
Achievements 2:

Brief Description of Projects : **Deep learning models for Depression Detection among young adults**
Depression is a significant global mental health concern, particularly affecting young adults. Early detection is crucial for timely intervention and improved outcomes. Traditional methods often rely on clinical interviews and standardized assessments, which can be time-consuming and subjective. Deep learning offers a promising avenue for developing automated and objective tools to aid depression detection in young adults.This work proposes a novel approach utilizing Graph Convolutional Networks (GCNs) for depression detection. GCNs excel at analyzing relational data, making them suitable for capturing the complex interactions between various factors that might contribute to depression in young adults.Young adults experience unique social, academic, and personal pressures that can contribute to depression. These factors often intertwine, forming a complex network of influences. Standard deep-learning models might struggle to capture these intricate relationships.GCNs operate on graph-structured data, where nodes represent individuals and edges represent connections between them.
Additionally, GCNs can incorporate diverse data sources, such as:
- Social media activity: Language analysis and interaction patterns on social media platforms can reveal insights into mood and emotional states.
- Survey data: Information on sleep patterns, stress levels, and social support networks can be incorporated into the graph structure.
- Behavioral data: Mobile phone usage patterns and app interactions could explain activity levels and social engagement.
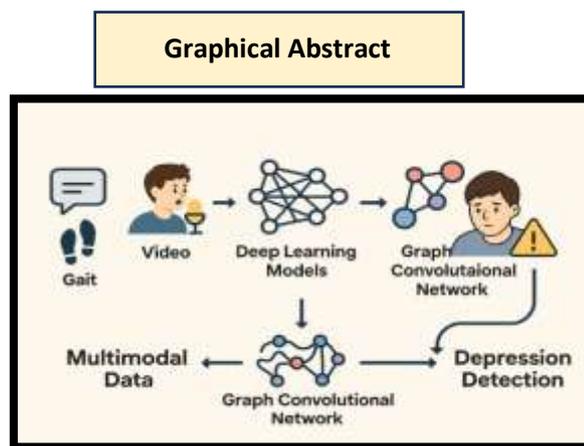
Problem Statement:

Depression, affecting over 300 million individuals globally, remains underdiagnosed due to reliance on traditional manual assessment methods like PHQ-9 questionnaires and clinical interviews, which often delay early detection. With the growing prevalence of social media and digital communication, individuals increasingly express their emotions through text, speech, and video, presenting a valuable opportunity for automated, early depression detection. This research aims to leverage deep learning models—including CNNs, RNNs, and GCNs—to analyze multimodal data such as social media content, facial expressions, speech, and movement patterns. By integrating these diverse data sources into a unified framework, the study seeks to build predictive models for timely identification of depressive behaviour among young adults, ultimately enabling early intervention and personalized mental health support.

Applications:

- Early Detection and Intervention: Automatically identifies early signs of depression from speech, text, and video data, enabling timely mental health support.
- Personalized Mental Health Monitoring: Provides individualized assessments by analyzing multimodal behavioural patterns, helping tailor treatment plans.
- Suicide Risk Prevention: Flags high-risk individuals based on emotional and behavioural cues for immediate intervention and support.

290

- **Strategy/ Approach/ Technique/ Experiments used to solve**
- **Multimodal Data Collection & Preprocessing**: Selected and pre-processed text, speech, and video data; transformed inputs into graph format for GCN.
- **Deep Learning Model Development**: Designed and trained modality-specific models (CNN, RNN), then integrated features using Graph Convolutional Networks (GCNs).
- **Performance Evaluation**:
- Assessed model using metrics like accuracy, F1-score; applied cross-validation and baseline comparisons.
- **Ethical AI Practices**:
  Ensured data privacy, informed consent, and responsible use of sensitive mental health data.

Graphical Abstract

Next Project:"SmartCare: An IoT-Enabled Machine Learning Framework for Cognitive and Emotional Health Monitoring in the Elderly"

Problem Statement

Elderly individuals often face undetected emotional and cognitive issues such as loneliness, depression, and memory decline due to infrequent assessments and lack of continuous care. Traditional methods fail to provide real-time monitoring, leading to delayed interventions. This project proposes SmartCare, an IoT-enabled machine learning framework that passively collects and analyzes multimodal data to detect and predict emotional distress and cognitive deterioration, enabling timely support and improved elderly well-being.

Applications

- **Early detection of depression and cognitive decline** through continuous monitoring of behavior and physiological signals.
- **Real-time alerts for caregivers** in case of emotional distress, inactivity, or unusual behavior patterns.
- **Remote mental health monitoring** for elderly individuals in home or assisted-living settings.
- **Personalized wellness suggestions** based on mood, activity, and sleep patterns.

Strategy/ Approach/ Technique/ Experiments used to solve

- Multimodal Data Collection: Use IoT devices (wearables, smart home sensors, smartphones) to gather physiological, behavioral, and environmental data.
- Feature Extraction and Fusion: Extract key features (e.g., heart rate variability, sleep patterns, mobility) and fuse data from multiple sources for deeper insights.
- Machine Learning/Deep Learning Models: Train classification and prediction models (e.g., SVM, Random Forest, LSTM, CNN) for emotion and cognitive state detection.
- Real-time Analytics and Alert System: Deploy edge/cloud-based models to monitor changes and generate alerts for caregivers or health

Graphical Abstract

Group Members

291
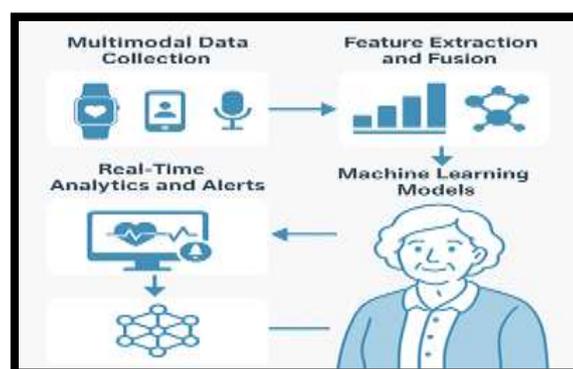
Research Group- Deep-Solve X

(AI-powered solutions for complex engineering problems)

- **Name of Principal Investigator/ Group Leader: Dr. Partha Sarathi Bishnu**
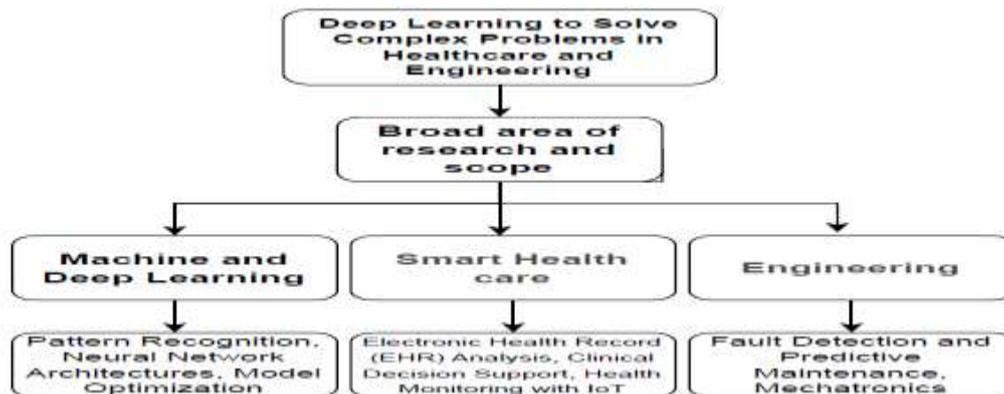- **Research Theme:** Deep Learning to Solve Complex Problems in Healthcare and Engineering
- **Broad Area of Research and Scope:** Machine Learning and Deep Learning, Medical Informatics, Algorithm, Data structure

Schematic Representation of Broad Area of Research

Total Number of Publications by the group: PSB (10) + VB (27) + SA(20) + KN(7)

Top 5 Article with impact factor: (Vancouver Style)

1. Kumar A, Bishnu PS. Identification of products for campaigning with budget constraint. International Journal of Information Technology, 2024, 17(2):727-48.

2. Baghel D, Bishnu PS. Diabetes prediction enhancement via cellular automata and machine learning. In: *Proceedings of the Fourth Asian Symposium on Cellular Automata Technology (ASCAT 2025)*; 2025 Mar 6-8; BIT Mesra, Ranchi, India.

3. Kumari, N. Anwar, S, Bhattacharjee, V. (Feb, 2022). "Time series dependent feature of EEG signals for improved visually evoked emotion classification using EmotionCapsNet", Neural Computing and Applications, Special Issue for Deep Learning in Time-series data, pp. 1-13, Vol. 43, Issue 4, Online ISSN: 1433-3058, Print ISSN: 0941-0643 https://doi.org/10.1007/s00521-022-06942-x[**SCIE**, IF:5.606]

4. Kumari, N. Anwar, S, Bhattacharjee, V. (Jan, 2022). "Automated Visual Stimuli Evoked Multi-channel EEG Signal Classification Using EEGCapsNet ", Pattern Recognition Letters, Elsevier, Vol. 153, pp. 29 – 35, ISSN: 0167-8655 doi:https://doi.org/10.1016/j.patrec.2021.11.019 [***SCI***, IF: 4.757]

5. Kumari, N. Anwar, S, Bhattacharjee, V. (Feb, 2022). "A Deep Learning based approach for accurate diagnosis of Alcohol usage severity using EEG signal", IETE Journal of Research. Pp. 1-16 ISSN: Print ISSN: 0377-2063 Online ISSN: 0974780X,

   https://doi.org/10.1080/03772063.2022.2038705 [***SCIE***, IF: 2.333]

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted
1	Partha Sarathi Bishnu, Abhishek Kumar, and Vandana Bhattacharjee, BIRLA INSTITUTE OF TECHNOLOGY MESRA. System and Method for Optimizing Discounts to Enhance Customer Satisfaction and Company's Revenue,	Patent application no 202431053477. Priority Date: July 12 2024.	Published
2	Shamama Anwar, Prashant Pranav, Sandip Dutta, An encryption based portable device for generating Electronic Health Records (EHRs) and method thereoy	Patent application no 202431032969Date: May 03, 2024	Published
3.	Shamama Anwar, Adla Sanober, An Internet of medical things (IoMT) based data management system for enhancing user's data security	Patent application no 202431049664Date: June 28, 2024	Filed
4.	Komal Naaz, Niraj Kumar Singh, A Digital Hindi Critic Device and Method Thereof	Patent Application No. 202431039960, Date: May 31, 2024	Published

Research Projects:

SN	Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
1	Non-invasive method for detection and analysis of anaemia in pregnant women using a deep learning-based model: A Multidisciplinary, Multicentric Study. (Partha Sarathi Bishnu, and Vandana Bhattacharjee)	PI	ICMR	27.28 Lacs	3 Years
2	Development of Intelligent Blockchain techniques for providing efficient management and storage security solutions for E-healthcare (BT/AGCJC0094/01/22)	PI (Shamama Anwar)	BIRAC, DBT	₹ 10 L	9 months

Industry/Academia Collaborations: With RIMS, Ranchi, Physics Department (Thapar University)

Targeted Application Area: Medical Informatics, Physics Informed learning

Achievements:

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)

Problem Statement:	Applications:
To develop a non-invasive deep learning-based system for accurately detecting and analyzing anemia in pregnant women using hematological parameters across multiple clinical centers.	• Early detection of anemia in pregnant women without the need for invasive procedures. • Clinical decision support for obstetricians using AI-assisted diagnosis. • Improved maternal health outcomes through timely intervention based on model predictions. • Integration into mobile health platforms for

Strategy/ Approach/ Technique/ Experiments used to solve	**Applications:**

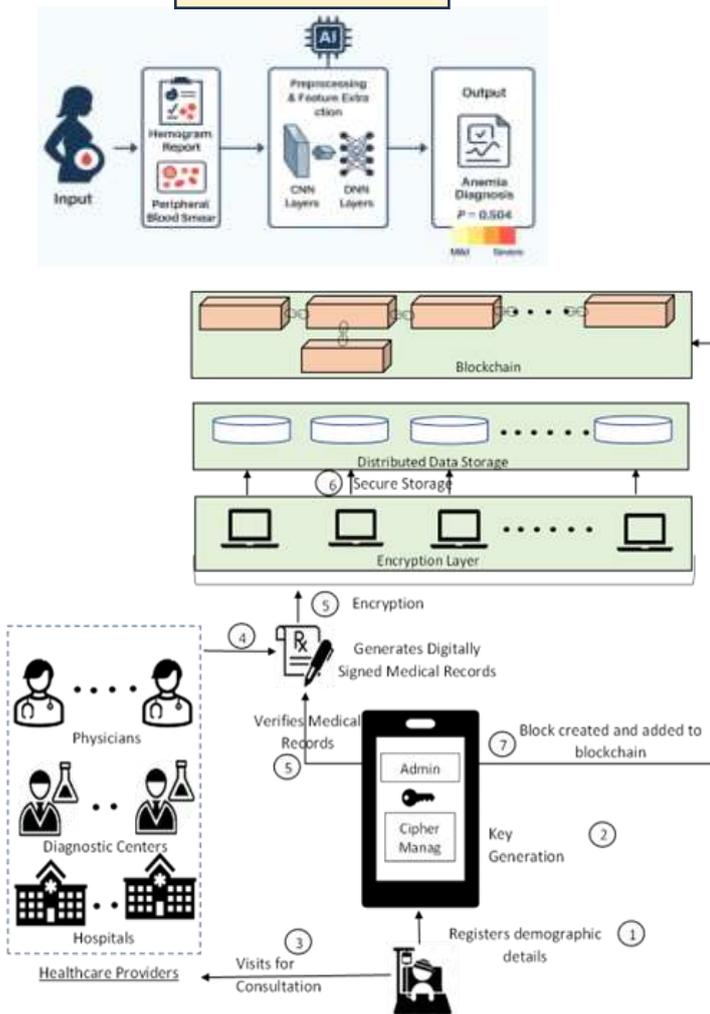**Strategy/ Approach/ Technique/ Experiments used to solve**

Strategy: Develop a non-invasive diagnostic framework combining deep learning with hematological indicators. Approach: Leverage multicentric clinical datasets and feature engineering for robust anemia detection. Technique: Use deep neural networks trained on CBC parameters and clinical labels for classification. Experiments: Perform training, validation, and testing across geographically diverse data sources to assess model accuracy and generalizability.

Applications:

To establish an accessible digital health systems levaraging basic Machine Learning, Data analytics and Blockchain tools and techniques.

To establish data repositiries based on personal health records to facilitate easy access of records among authenticated stake holders.

Graphical Abstract

Strategy/ Approach/ Technique/ Experiments used to solve

Solutions provided by the Proposal: The proposed model aims to provide solutions to the identified issues through: i The proposal aims at using lightweight cryptographic technique Elliptic Curve Cryptography and PRESENT80 to enable easy encryption without compromising on the speed and complexity. ii Access time is given preference as quick retrieval of data is an essential requirement in the medical field.iii Security against attacks: the proposal where the data is maintained at the generation site hence eliminating a single point of failure and also lessens the burden on a single site.

Group Members

294

Research Group - Social Science

- **Name of Principal Investigator/ Group Leader**: Dr. Pradeep Munda
- **Research Theme**: Social Science
- **Broad Area of Research and Scope:**
  - Ancient Administrative Management
  - Economy, Banking & Finance
  - Social issues
  - Current Management Practices

Total Number of Publications by the group: 10

Top Article with impact factor:

- Minz, & Munda. (2015). Struggle, challenges and work life balance of women in Jharkhand: a case study of women police in Ranchi, Jharkhand. *Human Rights of International Research Journal*, ISSN/ISBN No 2320-6942.
- Minz, & Munda. (2016). career oriented women and their worklife balance: a case study of women police jharkhand. *I J A B E R(Indian Journal of Applied Business and Economic Research)*, *Vol. 14*(No. 12), ISSN No 8361–8369.
- Minz, & Munda. (2018). Work life struggle of working women. *International Journal of Applied Business and Economics Research, Print ISSN 2228-7019 Online ISSN 2228-7027 Volume 8(Issue 4), pages 97-103*.
- Minz, & Munda. (2020). Reality of worklife balance and challenges of a working woman,.*Journal of Critical Reviews*, *volume 7*(ISSUE 11), Article ISSN 2394-5125. https://doi.org/10.31838/jcr.07.11.298Link:http://www.jcreview.com/?mno=101211
- Minz, & Munda. (2020),Determining components in worklife balance among womenemployees in police department with respect to attitude of colleagues, marriage status and family struc*ture, Journal of critical Reviews VOL 7, ISSUE 15, ISSN 2394-5125, https://doi.org/*10.31838/jcr.07.15.292
  Link :http://www.jcreview.com/?mno=101721
- Kumar, Munda, & Bhattacharjee. (2023). Evolution of new Tax System in the light of the previous system for an Individual. International Journal of Humanities Social Science and Management, Volume 3(Issue 4), page no.1–9. Link: https://www.ijhssm.org/past-issue volume.
- Minz, Munda, &Tigga. (2023). Influences on police women's work life balance : A structural equation modelling approach. *International Journal of Advances in Engineering and Management (IJEM)*, *Volume 5*(Issue 7), page no.205–212, ISSN : 2395-5252, *https://doi.org/*10.35629/5252-0507205212
- Munda, Pandey, & Agarwal. (2024) India's foreign financial policy with Russia & Europe in recent time: Challenges & Opportunities *Educational Administration: theory & Practice* E-ISSN:2148-2403, P-ISSN: 1300-4832 (Paper accepted on 2 Apr 2024, PaperID : 2298)
- Munda, Pandey, & Agarwal. (2024) Understanding Microfinance Is Important To India's Economy, Library Progress International Vol.44, No.4, Jul-Dec 2024: P. 344-351Print version ISSN 0970 1052, Online version ISSN 2320 317X

Dr. A R Srivastava (Total 40 publications)

- Yadav P, Srivastava, A R. Unleashing the Potential: How Employee Engagement Ignites Job Satisfaction in Public Sector Banking. Empirical Economic Letters. 2025; SplIss 3; 95-117(Impact Factor<1)
- Yadav P, Srivastava, A R. Embedding Ethical Values in HR Practices: A Strategic Approach to
- Elevate Employee Engagement and Reduce Turnover Intention. Purushartha. 2023-2024; 16(2): 1-20(Impact Factor<1)
- Yasmin Y, Dutta T, Singh A K, Srivastava A R. Extending training predictors link with training transfer through mediation of motivation. Evidence Based HRM: A Global Forum for EmpiricalScholarship. 2024; 12(3): 512-530. (Impact Factor<1)
- Sinha K, Srivastava A R, Koul Pawan. Robotics & Hospitality Industry – A Study of India's FirstRobotic Restaurant "ROBO CHEF". Journal of Hospitality & Research. 2024;19(2)1-20 (ImpactFactor<1)
- Kumari G, Srivastava A R. The role of the state in saving Paitker painting in Jharkhand. 2021; 12(1);pp79-104 (Impact Factor<1)

Dr. Sunil Kr. Pandey

- Munda, Pandey, & Agarwal. (2024) India's foreign financial policy with Russia & Europe in recent time: Challenges & Opportunities *Educational Administration: theory & Practice* E-ISSN:2148-2403, P-ISSN: 1300-4832 (Paper accepted on 2 Apr 2024, Paper ID : 2298)
- Munda, Pandey, & Agarwal. (2024) Understanding Microfinance Is Important To India's Economy, Library Progress International Vol.44, No.4, Jul-Dec 2024: P. 344-351Print version ISSN 0970 1052, Online version ISSN 2320 317X

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Method and System for Providing Cross Selling with Banking Environment" Dr. Prashant Kumar Singh, Mr. Paul, Dr. Pradeep Munda	Application No. 202331055362 Dat of Filing 16/08/2023	Published

Industry/Academia Collaborations:

1. Working on Collaboration with NGOs like Vikas Bharti, TATA CSR, CCL CCR etc.

Targeted Application Area:

1. Tribal Social Economic Issues, Banking & Finance at Local level, Ancient Administrative Management and Leadership issues, etc.

Achievements:

Problem Statement:

Despite the existence of state policies and programs aimed at tribal development, the tribal groups in Jharkhand continue to experience socio-economic disparities, marginalization, and a disconnect between state initiatives and their indigenous knowledge systems. This disparity manifests in several areasincluding :

Literacy
Financial Education
Infrastructure

Applications:

➢ **Land Rights:**
➢ Disputes over land ownership and access to resources continue to create economic instability and social unrest among tribal communities.
➢ **Economic Opportunities:**
➢ Lack of access to education, healthcare, and sustainable livelihoods creates a cycle of poverty and limits economic mobility for tribal groups.
➢ **Resource Access:**

Strategy/ Approach/ Technique/ Experiments used to solve

Addressing the socioeconomic disparities and promoting the inclusion of indigenous knowledge systems within state policies are crucial for the sustainable development and well-being of tribal groups in Jharkhand. This requires a comprehensive approach that acknowledges the unique needs.

Group Members

BIRLA INSTITUTE OF TECHNOLOGY, PATNA

Research Group- Functional &Numerical Analysis

- **Name of Principal Investigator/ Group Leader: Dr. Prakash Chandra Srivastava**
- **Research Theme:** Hahn–Banach Extension Theorem & Boundary Value Problems.
- **Broad Area of Research and Scope**

Research work is focused on the study of "Hahn-Banach Extension theorem on various spaces" which is a central tool of functional analysis. I am exclusively concentrated on the study of extension problems under different conditions so that the known results may be generalized on one hand and some independent results may be obtained on the other and present time group focused on Numerical Simulation and Applications for Boundary Value Problem and Singular perturbation Boundary value problems. The scope of the research are as follows:

> - Applications and uses of Hahn-Banach extension theorem for personal identification.
> - Application and uses of Boundary Value Problem and Singular perturbation Boundary value problems in various Engineering problems.

Schematic Representation of Broad Area of Research

In Functional Analysis: My research initiatives shall be in analysing extension problems under different conditions so that results may be generalized on one hand and some independent results may be obtained on the other.

1. Hahn-Banach extension theorem for K-quasi affine set-valued map on real linear topological spaces.
2. Hahn-Banach extension type theorems for partially ordered totally K - convex, partially ordered positively K-convex, partially ordered super K-convex modules with the application of Sandwich theorem.
3. Hahn-Banach extension theorem for asymmetric norm lattices.
4. Hahn-Banach extension type theorem for a random quasi-semi norm module.

- In Numerical Analysis: My research initiatives shall be in analysing the convergence of methods in Numerical Analysis.
- Numerical Simulation and Applications for Boundary Value Problem and Singular perturbation boundary value problems in various Science & Engineering problems.

Total Number of Publications by the group: 69

Top 5 Article with impact factor:

2. Chaurasia. A, **Srivastava. P.C**, Gupta. Y, "Numerical scheme based on non-polynomial spline functions for the system of second order boundary value problems arising in various engineering applications" Journal of Applied and Computational Mechanics, (2022), Vol.8 (1) P.P -144-152. DOI:10.22055/JACM.2020.32435.2012&ISSN-2383-4536
3. Chaurasia. A, **Srivastava. P. C**, Gupta. Y, "A smooth approximation for non-linear second order boundary value problems using composite non-polynomial spline functions" Studia Universitatis Babes-Bolyai Mathematica (2020), Vol.65 (3) P.P 453-470.

4. Chaurasia.A, **Srivastava. P.C**,Gupta.Y, Bhardwaj.A, "Composite Non-polynomial Spline Solution of Boundary Value Problems in Plate Deflection Theory" International Journal for computational Methods in Engineering Science & Mechanics, (2019),Vol. 20(5), P.P.372-379. https://doi.org/10.1080/15502287.2019.1650311&ISSN-1550-2287

5. Chaurasia. A, **Srivastava.P.C**, Gupta. Y, "Exponential Spline Approximation for the Solution of Third-Order Boundary Value Problems" , Data Management, Analytics and Innovation, (2019), Vol. 808 P.P 341-351. DOI: 10.1007/978-981-13-1402-5-26

Industry/Academia Collaborations: A workshop on the title "Mathematics and its applications in Porous Media organized on 31st July, 2021 at Dept. Of Mathematics, BIT Patna Campus in Collaboration with University of Bergen, Norway.

(1) Dr. P C Srivastava, Assistant Professor, Dept. of Mathematics, BIT Patna Campus
(2) Dr. Yogesh Gupta, Associate Professor Dept. of Mathematics, JIIT Noida.
(3) Dr. S. K. Pandey, Assistant Professor, Dept. of Management, BIT Patna Campus
(4) Dr. Binay Bhushan, Assistant Professor, Dept. of Physics, BIT Patna Campus

Targeted Application Area:

(1) Hahn- Banach Extension Theorems for personal Identification.
(2) Boundary Value Problem and Singular perturbation Boundary value problems in various Science & Engineering problems.

Group Members

Research group- Composite Materials Robotics

- **Name of Principal Investigator/ Group Leader**: Dr. S. K. Pradhan
- **Research Theme**: Composite Materials Robotics
- **Broad Area of Research and Scope:**
  - Nano materials
  - Robotics
  - Drone technology

Total Number of Publications by the group: 24

Top 5 Article with impact factor: (Vancouver Style)

1. Pradhan S K et al.Effect of nano filler.Applied Physics.2023; A 129 (11):805.
2. Pradhan S K et al.Electromagnetic radiation of Alminum in compression and tension.CRC.2024;63-71.
3. Pradhan S K et al.Review on different materials and their characteristics as rocket propellent.Materials today proceeding.2020;33:5269-5272.
4. Pradhan S K et al.Piezoelectric and Mechanical prp.of PVDF-PZT composite.Ferroelectrics.2020;558(1):59-66.
5. Pradhan S K et al.Study of ferroelectric prop.on PVDF-PZT composite.Ferroelectrics.2017;516(1):18-27.
6. Pradhan S K et al.Aerial innovation:exploring drone applications in manf.sector. LNME.2025(comn)

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted
1.	PVDF Composite, S. K. Pradhan	202431084137/4.11.24	Published
2.	Contactless conveyor system and method, S. K. Pradhan	202531036151/14.04.25	Applied

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Composite material	Co-PI	**ARDB**	34LAKHS	2022-2026
Magnetic material	Co-PI	**UGC-DAE**	1.35lakhs	2022-2026

Industry/Academia Collaborations: IIT Patna, NIT Patna. We do some related to Drone research with Aviocian Tech Pvt. Ltd & my students are doing live project during internship.

Targeted Application Area: Robotics /Drone

Achievements

<table>
<tr>
<td>

Robotics group has presented paper in the Int. Conf at NIT Bhopal 19-20, December 2024

1. Research students has got 1st prize in the Robotics comp.in Technika-2024 at BIT Patna. Delivered an invited talk at IIT Patna in the International conference AC2MP during 8-11 December 2024.

2. Delivered an invited talk on Industry4.0 at MITM one week STC on dt-03.02.2024.

</td>
<td>

Applications:

➢ Robotics gripper

➢ Utility bot

➢ Composite material

➢ Industry 4.0

➢ Application in Manf industry

➢ Application of drone during welding process

</td>
</tr>
</table>

Group Members

Research Group- SHG, Access, Resilience, and Empowerment (SHARE)

- **Name of Principal Investigator/ Group Leader**: Dr. Monika Singh
- **Research Theme**: Digital Inclusion, SHG-based Empowerment Models, and Socio-Economic Sustainability
- **Broad Area of Research and Scope:**
  - Digital Transformation and Rural Inclusion: Technology adoption, Digital skilling and e-literacy
  - Sustainable Development and CSR Strategy: CSR impact assessment and stakeholder engagement, ESG (Environmental, Social, Governance) alignment with community development
  - Social Innovation and Policy Designt: Participatory governance and civic tech adoption, Nudging behavior for better policy uptake
  - Behavioral Insights and Development Marketing: Decision-making under scarcity and uncertainty
  - Knowledge Management and Institutional Innovation: Capacity-building models for SHG federations and NGOs, Process innovations in livelihood missions

Schematic Representation of Broad Area of Research:

Schematic Representation: SHGs, DPI, and Socio-Economic Outcomes
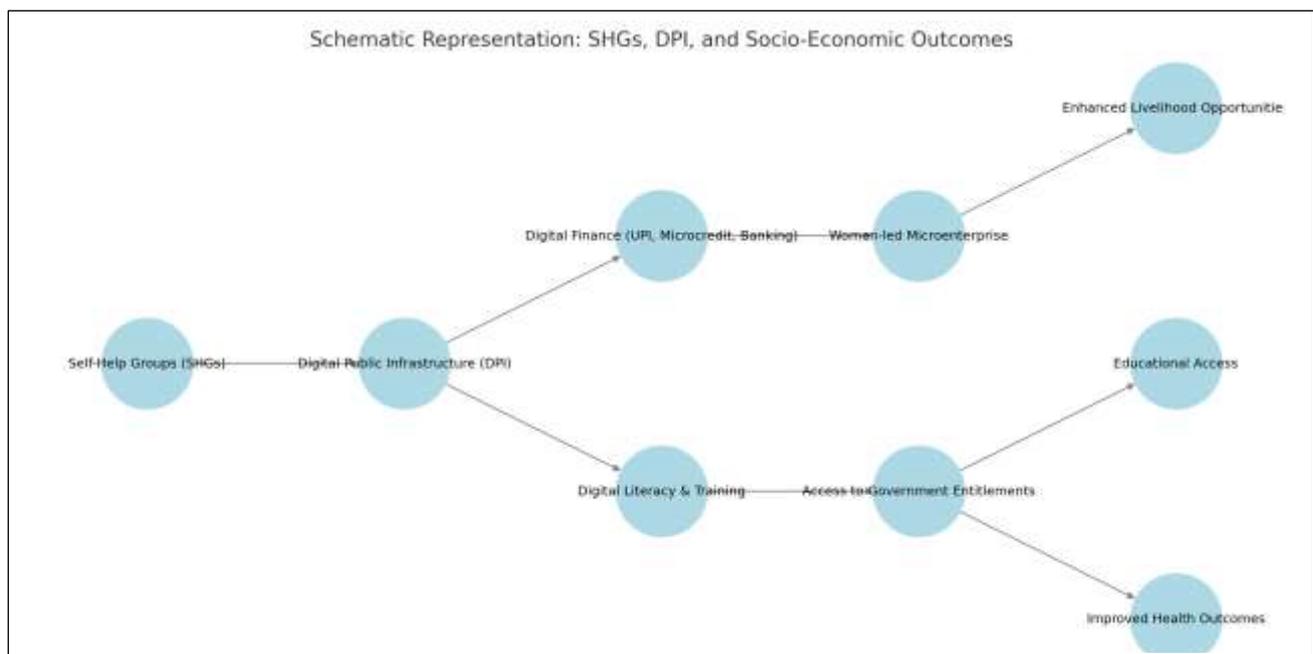
Total Number of Publications by the group: 69 (as of May 2025)

Top 5 Article with impact factor: (Vancouver Style)

1. Singh M, Sahu GP. Towards adoption of Green IS: A literature review using classification methodology. International Journal of Information Management. 2020 Oct 1;54:102147. (IF 19)
2. Chandel SP, Singh M, Sahu PK. Optimizing combustion efficiency and environmental impact: the influence of SUPERTHERM K2R coal catalyst. International Journal of Coal Preparation and Utilization. 2025 Jan 17:1-3. IF 2.2

3. Kumar D, Shandilya AK, Varghese SG. Mapping Sustainable Cities and Communities (SDG 11) Research: A Bibliometric Review. Engineering Proceedings. 2023 Dec 27;59(1):125. (IF 0.83)
4. D. Kumar, S. Choudhuri, A. K. Shandilya, R. Singh, P. Tyagi and A. K. Singh, "Food Waste & Sustainability Through A Lens of Bibliometric Review: A Step Towards Achieving SDG 2030," 2022 International Conference on Innovations in Science and Technology for Sustainable Development (ICISTSD), Kollam, India, 2022, pp. 185-192, doi: 10.1109/ICISTSD55159.2022.10010596..
5. Sehgal R, Dubey AM. Identification of critical success factors for public–private partnership projects. Journal of Public Affairs. 2019 Nov;19(4):e1956. (IF 2.7)

Patents by the group:

Sl. N	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	Indian design patent grant- IoT Based Outdoor Advertisement Kiosk	CBR No. 209189	granted on 22-11-24
2.	Indian Design Patent: Cloud Based customization of a secured kiosk device, .	CBR No. : 211680	granted on 19-05-25

Research Projects

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Ongoing: Research Project under "Special Call for Collaborative Research Projects on Vision Viksit Bharat@2047" from **Indian Council of Social Science Research (ICSSR) – entitled:** "Development and Implementation of AI-Driven Smart Farming Solutions Utilizing IoT and Digital Extension Services for Enhanced Agricultural Productivity"	Co-PI	ICSSR, New Delhi	1500000	12 months
Ongoing: Research Project under "Special Call for Collaborative Research Projects on Vision Viksit Bharat@2047" from **Indian Council of Social Science Research (ICSSR) –** entitled: Unleashing Young India: Assessing the Synergy between Entrepreneurial Education, Digital Ventures, and Social Impact in North and Central India	Co-PI	ICSSR, New Delhi	1100000	12 months
Completed: Research Project under Special Call for Short-term Empirical Research 2023-24 from **Indian Council of Social Science Research (ICSSR) -** In the **capacity of "Project Director"** Project entitled "Assessing the Reach and Socio-economic Impact of Skill India Mission (PM Kaushal Vikas Yojana): A	Co-PI	ICSSR, New Delhi	1500000	6 months

304

Rigorous Evaluation and Model Development for Enhancing the Schemes' Impact in Uttar Pradesh".				
Completed: Project on "Socio-Economic Situation Analysis of Persons with Disabilities in the Current Context of COVID-19 Pandemic"	Co-PI	Education Sector – UNESCO, New Delhi	250000	6 months

Targeted Application Area:

- CSR-funded SHG capacity building initiatives

- Fintech for rural livelihoods

Achievements:

- **Dr. Monika Singh** Won "Best Paper Presentation Award" in Two Days International Seminar on "Environment and Sustainable Development: Perspectives and Issues" on 10-11th February, 2024 at Govt. Shyama Prasad Mukharjee College Sitapur, Surguja, Chhattisgarh, India and Saraswati Mahavidyalaya Ambikapur, Surguja, Chhattisgarh

- **Dr. Abhinav Kumar Shandilya**: Certificate of Excellence for Foundation Program in ICT for education from March 8, 2018 to April 12, 2018 and Pedagogy for Online and Blended Teaching - Learning Process from May 3, 2018 to May 30, 2018 conducted by Indian Institute of Technology, BombayX.

- Best Paper Award in "19th GJ-NatConMITE 2023: Embracing Change & Transformation" for paper titled "Moderating effect of price on the relationship of economic animosity and ethnocentrism with purchase decision of retail consumers of Jharkhand"

Brief Description of Projects :

This project aims to digitally empower women-led Self-Help Groups (SHGs) across selected districts in Bihar, Jharkhand, and Chhattisgarh to enhance their access to government entitlements, digital financial systems, and sustainable livelihood opportunities. Despite the growth of Digital Public Infrastructure (DPI) in India, SHG members—especially from tribal and rural backgrounds—face significant barriers in accessing online services, financial platforms, and market linkages.

The project seeks to address these challenges by conducting a multi-state, three-year study focusing on the digital readiness, financial behavior, and entrepreneurship potential of SHG women. Through mixed-method data collection, including surveys, interviews, and community-level assessments, the project will identify key enablers and bottlenecks in DPI adoption. It will also analyze how tools like UPI, government apps, and digital marketplaces can be better utilized to improve SHG effectiveness.

The expected outcome is the development of a scalable digital empowerment model for SHGs, along with actionable policy recommendations. This initiative will contribute to the CSR objective of inclusive development and support SDGs 1, 5, 8, and 9, by promoting financial inclusion, gender equity, and digitally-enabled micro entrepreneurship.

Group Members

Research Group-Ferroelectric, Magnetic & Energy Nanomaterials (FERMAGEN)

- **Name of Principal Investigator/ Group Leader**: **Dr. Paramjit Kour**
- **Research Theme**: Design and theoretical investigation of multifunctional ceramic and composite materials for integrated applications in EMI shielding, Magnetic sensing, biomedicine, and hydrogen storage
- **Broad Area of Research and Scope:**
  - Electromagnetic Interference (EMI) Shielding
  - Magnetic Sensing
  - Biomedical Applications
  - Hydrogen Storage

Total Number of Publications by the group: 39

Top 5 Article with impact factor: (Vancouver Style)

1. Sen Deboprasad, Sahoo Rakesh K, Mohanty Sunita, Kour P, Sahu Sridhar, Reversible Hydrogen Storage in Li-functionalized [1,1,1,1]paracyclophane: A Computational Insight, International Journal of Hydrogen Energy.2024;53:308-317 IF:8.1

2. Sahoo Rakesh K, Kour P, Sahu Sridhar, Reversible hydrogen storage capacity of Sc and Y functionalized [1,1]paracyclophane: Insights from density functional study, International Journal of Hydrogen Energy.2022;47:29881-29895 IF:8.1

3. Parida Smruti Ranjan,Sahoo Rakesh K, Kour P, Chakraborty Brahmananda, Jaiswal Ankita, Reversible hydrogen storage in Sc functionalized [6]cycloparaphenylene: A density functional Study,Energy Storage.2024;6:e70093: 1-11 IF : 3.6

4. Shukla Anant, Yadav Mukesh Kumar, Rout Sushree Nibedita, Pal Munendra, Asthana Saket, Kour P, Kar Manoranjan, Investigation on coupling between ferro orderings and energy harvesting properties of Nickel ferrite and Strontium modified Barium titanate composite, Journal of Applied Physics.2025; 137(2) IF :2.7

5. Pradhan L K, Mallick J, Shukla Anant , Manglam Murli Kumar , Kumar P. , Kour P, Kar M. Reduction of depolarization field effect on ferroelectric switching process in semiconductor–relaxor ferroelectric composite.Journal of Applied Physics. 2022;131:154102 IF :2.7

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	A method for synthesizing silica nanoparticles from waste plant matter, Kunal Mukhopadhyay, Uzma Afreen, Paramjit Kour, Manish Kumar	20243102704619.04.24	Published
2.	PVDF composite, S. K. Pradhan, P. Kour, Amit Kumar	2024310841374.11.24	Published
3.	Contactless conveyor system and method, S.K. Pradhan, P. Kour, Amit Kumar	20253103615114.04.25	Applied

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Development of Magnetic sensor for Naval Application	Co-PI	NSTL,DRDO	48.64	2024-2026

Microwave Shielding of Quaternary composite for Aerospace Industry	PI	AR&DB, DRDO	31.22	2022-2025
Role of Microstructure and interface Strain engineering in Magneto-Electric Properties of PFN/CZFMO Composite	PI	CRS UGC-DAE	1.35	2022-2025
Crystal and Magnetic Structure study on co-doped $SrFe_{12}O_{19}$ and its Magneto-Electric Properties'	PI	CRS UGC-DAE	1.35	2022-2025
Study of Pb $(Fe_{1/2}Nb_{1/2})O_3$ - $BiFeO_3$ Multiferroic for sensor applications	PI	SEED MONEY,BIT Mesra	0.80	2016-2017

- **Industry/Academia Collaborations:**
  - IIT Patna
  - ISM Dhanbad
  - MGCU Mothihari
  - NIT Patna
  - AKU,Patna
  - Cyprus Institute, Cyprus

Targeted Application Area:
- Aerospace and defense electronics (avionics, radar systems)
- 5G communication devices and infrastructure
- Electric vehicles (EMI shielding in battery enclosures)
- Wearable and flexible electronics
- Military stealth technology (low radar cross-section)
- Biomedical diagnostics (e.g., Magnetocardiography, Magnetoencephalography)
- Navigation systems (e.g., compasses, inertial navigation)
- Non-destructive testing (NDT) and structural health monitoring
- Smart traffic and vehicle detection systems
- Naval surveillance and submarine detection (geomagnetic anomaly sensors)
- Tissue engineering (e.g., magnetically aligned scaffolds)
- Renewable energy storage

Group Members

Research Group-Nanomaterials & Photonics Group

- **Name of Principal Investigator/ Group Leader**: Dr. Binay Bhushan
- **Research Theme**: Nonlinear Optical Studies of Polymer Nanocomposites
- **Broad Area of Research and Scope:**
  - Synthesis/Characterization of Polymers and Polymer-Metal nanocomposites
  - Nonlinear optical studies of nanocomposites
  - Applications of nanomaterials in optical devices
  - Use of nanomaterials in Fertilizers/Pesticides

Schematic Representation of Broad Area of Research
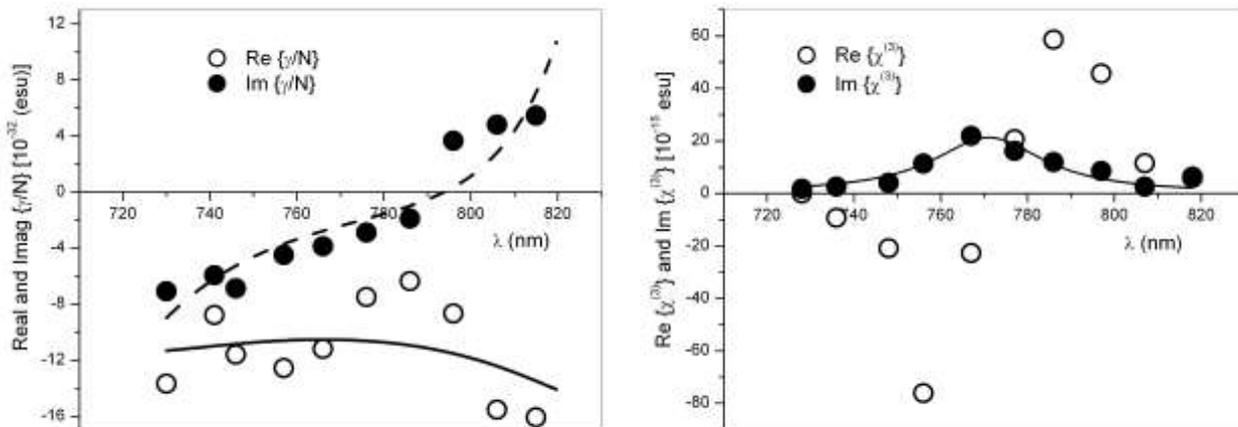
Total Number of Publications by the group: 77

Top 5 Article with impact factor:

1. B. Bhushan, S S Talwar, T Kundu and B P Singh, "Synthesis, characterization and third-order nonlinear optical properties of polydiacetylene nanostructures, silver nanoparticles and polydiacetylene-silver nanocomposites"Pramana – Journal of Physics, (2016) 87:56 (IF: 1.9)
   https://doi.org/10.1007/s12043-016-1264-0

2. B. Bhushan, T. Kundu, B. P. Singh, "Synthesis and nonlinear optical response of silver nanoparticles decorated polydiacetylene composite nanovesicles"Optics Communications(2014), 312, 127-133 (IF: 2.4)
   http://dx.doi.org/10.1016/j.optcom.2013.09.028

3. B. Bhushan, T. Kundu, B. P. Singh, "Two-photon absorption spectrum of silver nanoparticles,"Optics Communications (2012), 285, 5420-5424 (IF: 2.4)
   http://dx.doi.org/10.1016/j.optcom.2012.07.091

4. B. Bhushan, S. K. Kumar, S. S. Talwar, T. Kundu, B. P. Singh, "Nonlinear optical properties of novel tunable, one dimensional molecular superlattice polymers (heteroarylene methines) containing alternating aromatic and quinoid segments,"Applied Physics B(Lasers and Optics) (2012), 109, 201-209 (IF: 2.1)
   https://doi.org/10.1007/s00340-012-5199-y

5. C. Kumar, B. Bhushan, A. K. Sinha, A. K. Jha, S. K. Sinha "Scandium and Niobium incorporated lithium titanate as the anode for Li-ion batteries", Digest Journal of Nanomaterials and Biostructures, (2023), Vol. 18, No. 3, 933-939 (IF: 0.96)

   a. https://doi.org/10.15251/DJNB.2023.183.933

Industry/Academia Collaborations:

- Dr. S K Sinha, Associate Professor, Dept. of Physics, BIT Patna Campus
- Dr. Anish, Assistant Professor, Dept. of Civil Engineering, BIT Patna Campus
- Dr. Chandan Kumar, Assistant Professor, Dept. of Mechanical Engineering, BIT Patna Campus
- Dr. P C Srivastava, Assistant Professor, Dept. of Mathematics, BIT Patna Campus

Targeted Application Area:

(3) Photonic Devices
(4) Li-ion Batteries
**(5) Nano-fertilizers & Nano-pesticides**

Group Members

Research Group- Semiconductor Nanostructure

- **Name of Principal Investigator/ Group Leader**: Dr. K. P. Tiwary
- **Research Theme**: II-VI Compound Semiconductor Nanoparticles and thin films for Photovoltaic and Photocatalytic Applications.
- **Broad Area of Research and Scope:**
  - Synthesis and Characterization of ZnS, CdS, CdSe, CdTe and other II-VI Compound Nanoparticles and thin films for optoelectronic applications
  - Applications of Semiconductor nanoparticles for Photocatalytic degradation of Carcinogenic Organic dyes.
  - Photovoltaic application of compound semiconductors.
  - Simulation work for photovoltaic solar cells.
  - Transition metal doped semiconductor nanoparticles for tuning of energy band gap.

Schematic Representation of Broad Area of Research:
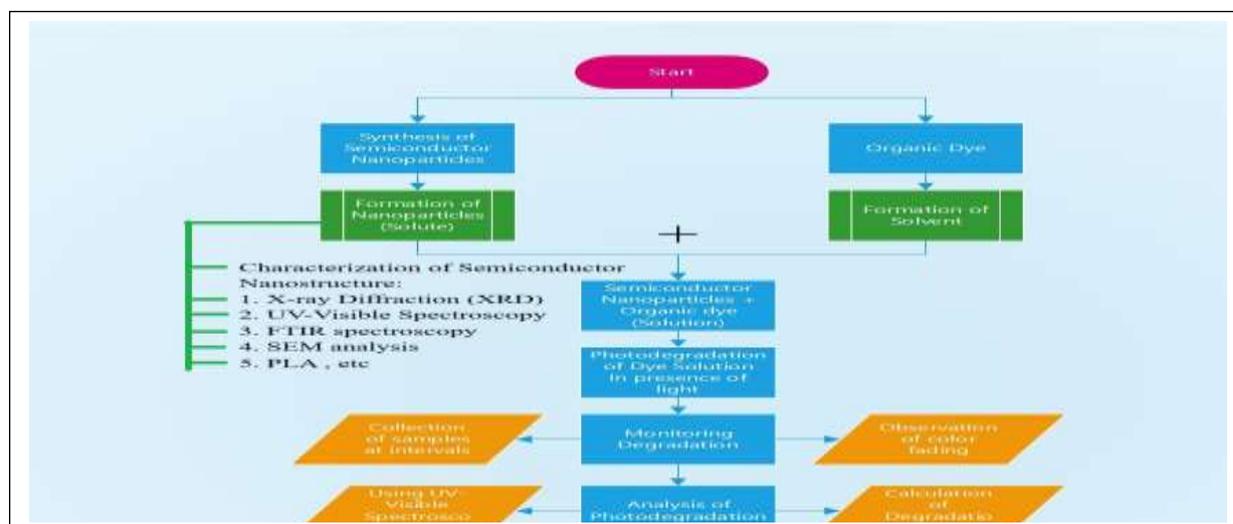
Total Number of Publications by the group: 10

Top 5 Article with impact factor: (Vancouver Style)

1. Investigation of structural, morphological, optical and dielectric properties of Ni2+ modified CdTe nanoparticles, **K P Tiwary**, RK Mishra, K Nikhil, SK Choubey, S Kumar, K Sharma, Physica B: Condensed Matter, (Elsevier Publication) (2025) 417311. **(SCI) (I.F = 2.8)**
2. Comparative studies on pinhole free CBD-CdZnS thin films on ITO and FTO substrate. S Kumar, A Alam, **K P Tiwary**, Chalcogenide Letters. 21(7), (2024), 567- 574. **(SCIE) (I.F = 1.2)**
3. Study of structural, morphological and optical properties of Mn+2 doped CdS nanoparticles synthesized at various doping concentration, R. Ranjan, C. M. S. Negi, S.K.Choubey, **K. P. Tiwary**, Chalcogenide Letters 20 (10), (2023), 709 -724.**(SCIE) (I.F = 1.2)**
4. Synthesis of Mn^{2+} modified CdS nanoparticles and its application as catalyst in photodegradation of methyl red dye, R. Ranjan, C. M. S. Negi, **K. P. Tiwary**, Chalcogenide Letters 20(4), (2023) 251-259. **(SCIE) (I.F = 1.2)**
5. Doping effect of Ni^{2+} ion on structural, morphological and optical properties of Zinc sulfide nanoparticles synthesized by microwave assisted method, **KP Tiwary**, F Ali, SK Choubey, RK Mishra, K Sharma, Optik (Elsevier Publication) (2021) 227, 166045 (**SCI**) **(I.F = 3.1)**

Patents by the group:

Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted
1.	'A CdS nanoparticles doped with Mn and the method for preparation thereof', **K.P. Tiwary**, K Sharma and S.K. Choubey.	**Application No.** 202431076419 Publication Date- 18/10/2024	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Synthesis of Cu and Ni doped ZnS and CdS nanoparticles by Microwave irradiation method and their optical characterization for optoelectronic application.	**PI**	BIT Mesra Ranchi, Seed Money Project grant (Ref No. GO/SMS/2016/2016-17/15 on 22/09/16.	**0.80**	22/09/16-21/09/17

Industry/Academia Collaborations:

Academia Collaborations: (Publications)

1. Prof. Rakesh Kumar, Central University of South Bihar, Gaya
2. Dr. K. D. Kumar, IIT Patna
3. Dr. S. K. Sharma, ISM (IIT) Dhanbad,
4. Dr. S. R. Kumar, NIFT Ranchi.

Targeted Application Area:

1. Application of semiconductor nanoparticles for Photocatalytic degradation of organic dyes used by several industries as leather, textile, paint, cosmetics, paper, etc. to eradicate the carcinogenic impact in our environment.
2. To enhance the efficiency of photovoltaic solar cell using doped or undoped semiconductors/ simulation work on photovoltaic solar cell.
3. Optoelectronic sensors

Achievements:

Brief Description of Projects : **(Maximum 2 project in the following format highlighting your research theme mentioned earlier)**

Problem Statement:

Organic Dyes are used in many industries like textile industries, Plastic, Rubber, Paint, Dye, Leather, Paper, Cosmetics industries, etc. A large quantity of wastewater containing dye with intensive colour and toxicity from textile and other industries is released into the aquatic system resulting a harmful impact on the environment. The challenge is to remove the dye from the wastewater effluent. Semiconductor NPs doped with some transition metals can be a suitable remedy for the Photocatalytic degradation of the organic dyes and environmental remediation.

Group Members

Research Group- Sensors/Transducers and AIML/IoT Applications

- **Name of Principal Investigator/ Group Leader**: **Dr. S.K. Sinha,**
  Associate Prof. of Physics, BITP
- **Research Theme**: Development of Sensors and its AIML/IoT applications
- **Broad Area of Research and Scope:**
  - Sensors for agriculture – crops monitoring
  - Sensors for Methane/Hydrogen/or other gas sensing and monitoring
  - Transducers for Energy Conversion
  - High Capacitance Capacitors fabrication, Lithium ion cell fabrication

Schematic Representation Broad Area of Research:
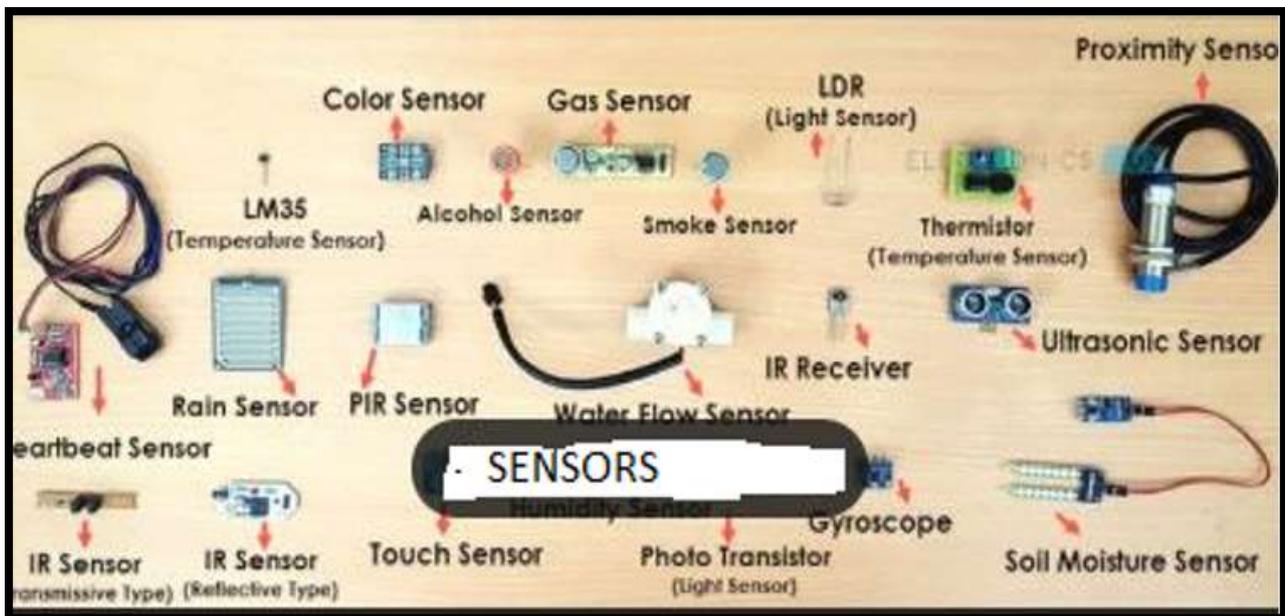
Total Number of Publications by the group: 35

Top 5 Article with impact factor: (Vancouver Style)

1. S.K.Sinha. Perovskite Structure Materials and Contribution to Technology Advancement, Piezoelectric Materials: Design and Applications,Jan , 2025, Copyright © 2024 Jenny Stanford Publishing Pte. Ltd.
2. C.Kumar , B.Bhushan, A.K.Sinha, A.K.Jha and S.K.Sinha, Scandium and Niobium incorporated Lithium Titanate as the anode for Li-ion batteries, Dig.Jr. Nanomaterials, 18(3) (2023) 933-939 (ISSN:1842-3582)
3. S.K.Sinha,S.Kumari, R.K.Chaudhary Dielectric and piezoelectric properties of PbTi 0.8−xSe0.2SmxO3 nanoceramics prepared by high energy ball milling, , A.Phys.A,125(2019)171-175
4. S.K.Sinha, S. Kumari,R.K.Chaudhary, Studies of dielectric and piezoelectric properties of PbTi0:8_x Te0:2GdxO3 nano ceramics prepared by high energy ball milling, Jr of Advance dielectrics,9(2) 2019,1950017.

5. Sona Kumari, R.K.Chaudhary, S.K,.Sinha, Preparation of PbTi 0.8-xTb0.2MgxO3 nano ceramics by high energy ball milling and its characterization, Digest Jr of nanometer.and Biostructure, 13 (4) Oct-Dec (2018)

Patents by the group:

| Sl. No	Title and Inventors	Application No. & Date	Status (Published/ Granted)
1	"Machine learning based approach to study the antimicrobial and anticancer potential of silver nanoparticles"	202341012182-21/2/23	Published

Research Projects:

Title	Role (PI/ Co-PI)	Funding Agency	Amount (in Lacs)	Duration
Preparation and characterization of modified lithium titanate ceramics for low activation energy	PI	BRFST, DAE, Govt of India	35	2010-2013
Preparation and characterization of lithium titanate ceramics pebbles for breeder blanket application	PI	BRFST, DAE, GoI	12	2007-2010
Atmospheric plasma for food Processing Technology,	PI	NMFP, Dept of Industry, GoB	6.5	2013-2014

Industry/Academia Collaborations: 1) EVOS Energy Delhi – working on Hydrogen Energy,

2) Tech- Soft Delhi, - IoT/AIML Application

Targeted Application Area: Application of sensors, transducers in various sectors

Achievements: Developed pressure sensors, gas sensors, temp. sensors

Brief Description of Projects : (Maximum 2 project in the following format highlighting your research theme mentioned earlier)		
Problem Statement: Development of sensors and transducers for the applications in Agriculture, Industries, Defense sectors	**Strategy/ Approach/ Technique/ Experiments used to solve** We have facility for manufacturing nano sensors. Our facility encludes Plasma sputtering machines, Sol gel machines, ball milling machines for fabrication of sensors and transducers	Applications: Pressure Sensing Temperature Sensing Hummidity Sensing Conversion of Mechanical Energy into Electrical Conversion of Heat Energy into Electrical
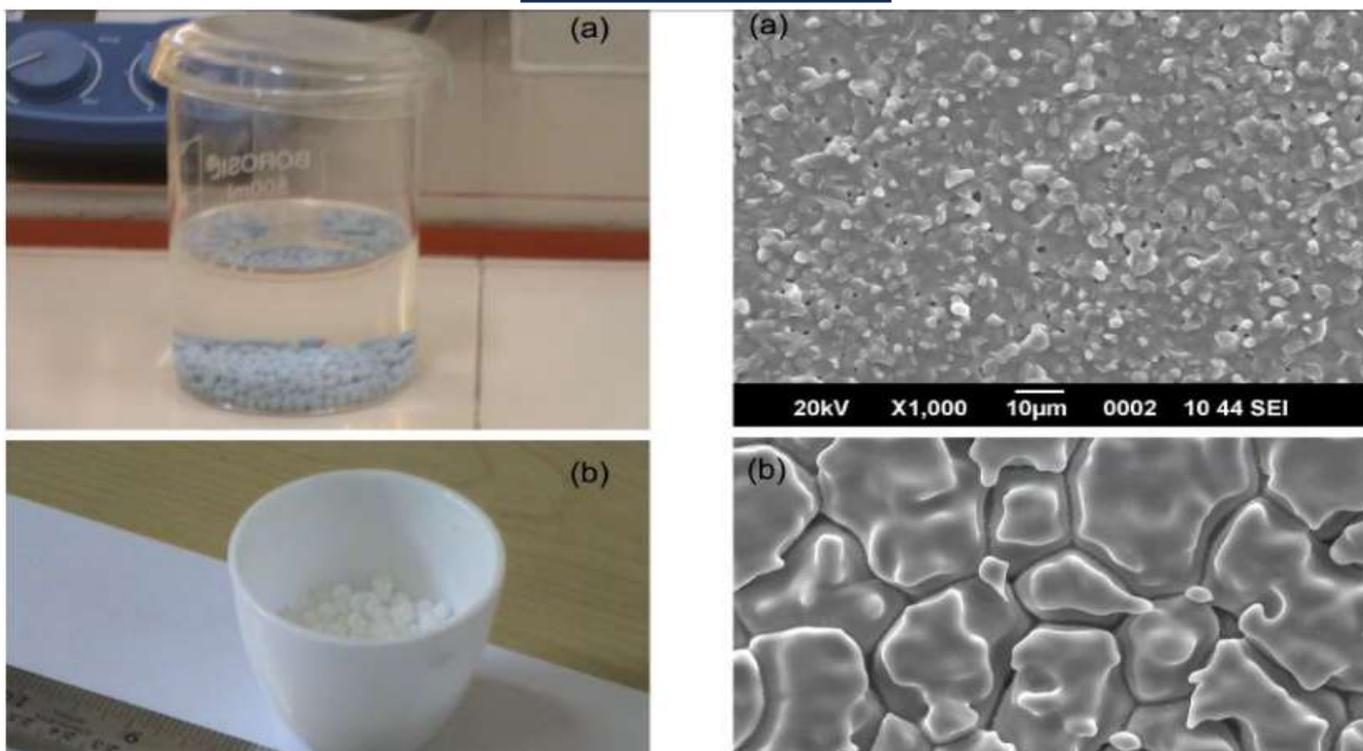
Group Members

Assistant Professor
Dr. Binay Bhushan
📞 : 9471859469
✉ : binay.bhushan@bitmesra.ac.in

Assistant Professor
Dr. Paramjit Kour
📞 : 9304103227
✉ : paramjit.kour@bitmesra.ac.in

Assistant Professor
Dr. Upendra Kumar
📞 : 9006960159
✉ : upendrakr@bitmesra.ac.in

Assistant Professor
Dr. Ratnesh Mishra
📞 : 7706811566
✉ : r.mishra@bitmesra.ac.in

314

Birla Institute of Technology, Mesra Ranchi, Jharkhand-835215

Research, Innovation & Entrepreneurship Cell

RESEARCH GROUPS
@ BIT-MESRA