Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

SIRe Project Number

2025-01-40

(will be assigned by SIRe)

Project Proposal for Ph.D.

Project Details	
Project Title	**"Advanced Pollution Monitoring: A Multi-Tech Approach Using IoT, MEC, REMOTE SENSING, and Semantic Communication"**
Project Summary (Minimum 500 and maximum 2000 characters)	**Problem Statement:** Weather-related pollution—air pollution, extreme weather events, and water contamination—poses major threats to health and the environment. Traditional monitoring methods struggle with coverage and response time, creating a need for a real-time, integrated approach using advanced technologies to mitigate pollution's impact. **Proposed Solution:** This project uses IoT, Machine Learning, remote sensing, climatology, drones, satellite-based hyperspectral and multispectral imaging, Mobile Edge Computing (MEC), and Semantic Communication to monitor and analyze weather-related pollution. The system provides real-time insights to guide urban planning and improve public health outcomes. **Key Components:** ● **IoT Sensors**: Deployed for real-time air quality, temperature, and pollutant data collection. ● **Remote Sensing & GIS**: Satellite and drone imagery offer large-scale environmental monitoring and pollution detection. ● **Climatology**: Integrated models help predict pollution spikes influenced by weather patterns. ● **MEC**: Enables local processing for quick analysis, reducing latency. ● **Semantic Communication**: Optimizes data interpretation and reduces bandwidth, delivering actionable insights to stakeholders. ● **Time Series Forecasting:** Use CNN, RNN or GRU models to predict future pollution levels based on historical data, weather patterns, and other relevant factors. ● **Sensor Fusion:** Combine data from multiple IoT sensors and remote sensing sources using techniques like Kalman Filters or Bayesian Networks to improve accuracy and reliability. **Workflow:** IoT sensors and remote platforms collect data, which MEC servers process locally. GIS and climatology tools analyze the data to predict pollution trends and generate real-time alerts for government and public response. **Expected Outcomes:** The system will improve air quality monitoring, enhance disaster preparedness, promote sustainable urban management, and protect public health through real-time, localized insights. **Telecom Challenges and Solutions:** ● **Network Connectivity**: Remote IoT devices face connectivity challenges. LPWAN, satellite communication, and mesh networks will ensure continuous data transmission. ● **Data Security**: End-to-end encryption and secure data storage protect sensitive environmental and health data. ● **Scalability**: Cloud-based solutions will allow the system to grow efficiently as the number of sensors and users increases. **Conclusion:** By integrating IoT, remote sensing, climatology, MEC and semantic communication, this project provides a scalable solution for monitoring and mitigating weather-related pollution. It will improve air quality, disaster preparedness, and sustainable urban management, driving impactful changes in public health and environmental conservation.

Ph.D. Supervisors

Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Prof. Brejesh Lall	Department of Electrical Engineering, Indian Institute of Technology Delhi	**brejesh@ee.iitd.ac.in**
Supervisor 2	Prof. S. Z. Ahammad	Department of Biochemical Engineering & Biotechnology, Indian Institute of Technology Delhi	**zia@iitd.ac.in**

Project requirements (Student qualifications, experience required, etc)
***The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)**

- B.E./MSc/MTech in EE, ECE/ any other relevant area

Source of fellowship/funding
(CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

Project funding

Role of Faculty Members involved:

The proposed project is a genuinely interdisciplinary effort where the collaborators' expertise complements each other. The research is divided into two main parts. Various air and water quality parameters will be analyzed under the guidance of Prof. SZA in his lab. Prof. BL and Prof. SA will contribute to creating an IoT-enabled surveillance system to map pollutants and develop a mathematical model to assess the impact of these pollutants on both the environment and human health. Assistance will be taken from external experts in developing a sensor framework for monitoring different ate quality parameters and development of the mathematical model .