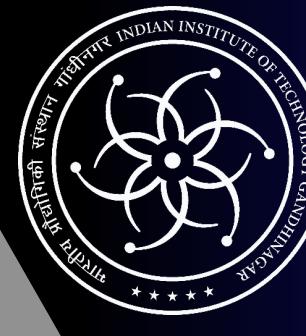


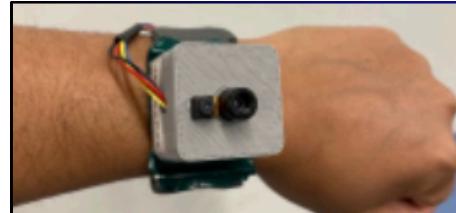
# SUSTAINABILITY LAB



**Professor Nipun Batra**  
sustainability-lab.github.io

**Indian Institute of Technology  
Gandhinagar**

## Health

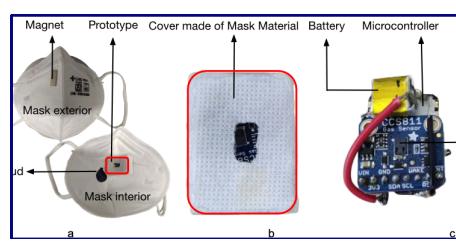
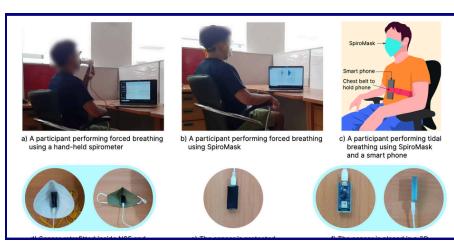


### ApneaEye

A thermal camera-based, non-intrusive system to monitor Respiration signals during sleep.

### JoulesEye

A Thermal camera system that accurately estimates calorie expenditure during exercise by monitoring respiration rate.



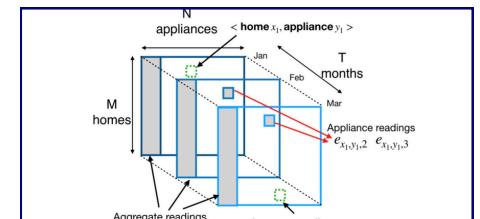
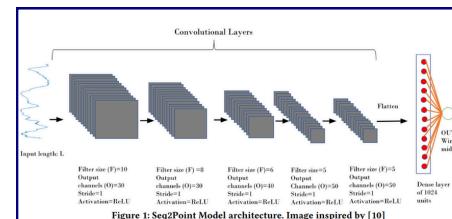
### SpiroMask

A smart mask with integrated microphones for accurate, non-invasive lung health monitoring.

### Continuous Respiration Rate

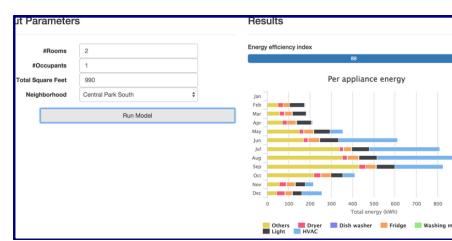
A CO<sub>2</sub> sensor in an N95 mask enables continuous respiration rate monitoring during walking and rest.

## Energy Analytics



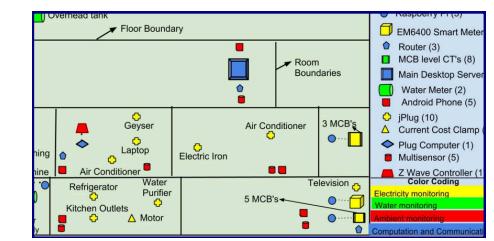
### EdgeNILM

A multi-task learning approach to compress neural networks for efficient Non-Intrusive Load Monitoring (NILM).



### Scalable Energy Breakdown

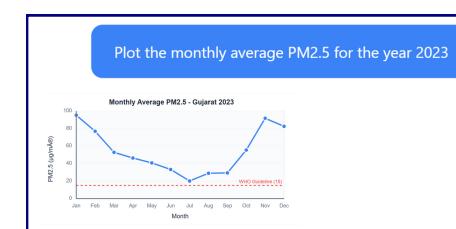
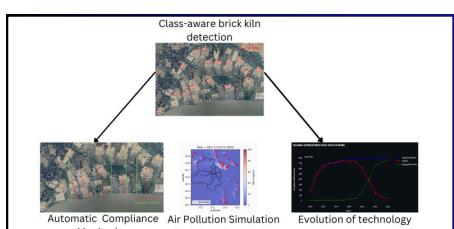
Matrix factorization method for energy breakdown in homes without requiring additional hardware installation



### It's Different

A sensor network deployment for monitoring energy, water, and ambient parameters in a Delhi home

## Air Quality

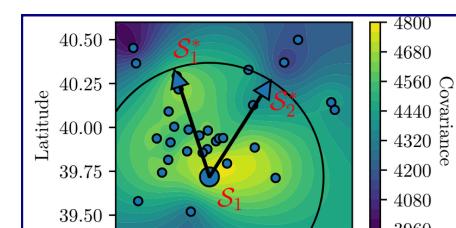
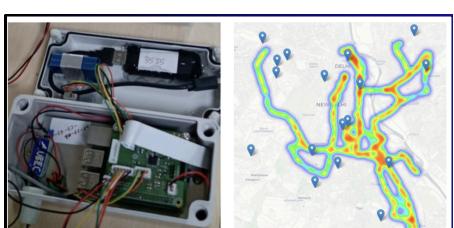


### Space to Policy

A Scalable system that Automates Brick Kiln Detection with Geospatial Data

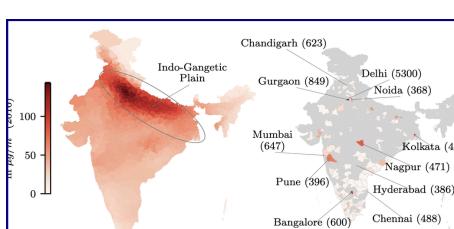
### VayuChat

LLM-Powered Chatbot to Democratize Air Quality Insights for the masses.



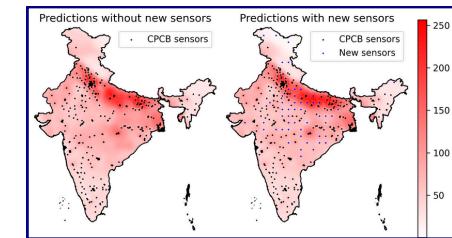
### AIRDELHI

A novel mobile sensor based dataset for Delhi, enabling air pollution analysis and benchmarking.



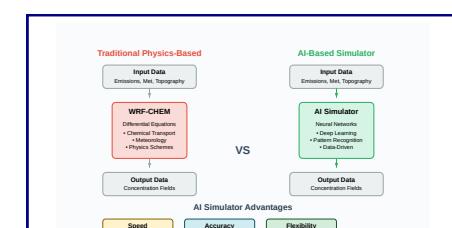
### Scalable AQ Inference

Gaussian processes method with advanced kernels for accurate air quality estimation



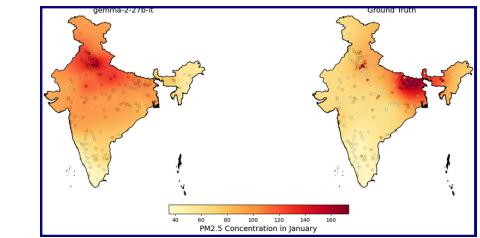
### AQ Sensor Placement

Recommending sensor installation based using machine learning/information theory



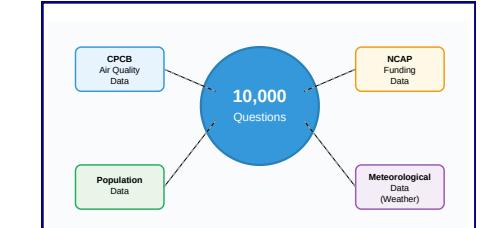
### AQ AI Emulator

Neural networks replacing differential equations in atmospheric modeling



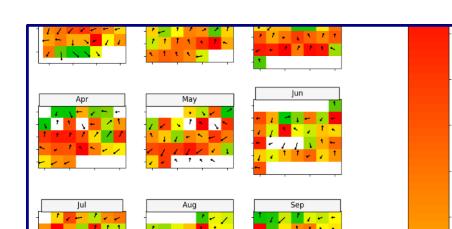
### AirInequityBench

Benchmarking LLMs to Reveal and Address Biases in Air Pollution Predictions.



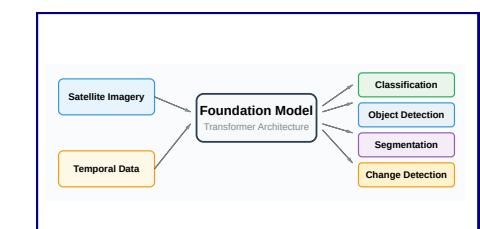
### VayuBench

Benchmarking natural language to code generation for air quality data analysis



### Vayu

Python library for air quality data visualisations.

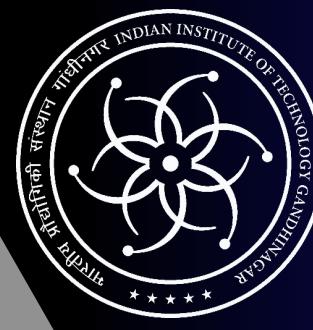


### Foundational Remote Sensing model

Pre-trained transformer for scalable Earth observation tasks

## LAB COMPUTATIONAL RESOURCES

The Lab features modern computational servers with up to **512GB RAM, 64 CPUs and Intel Xeon processors** for intensive computational tasks. The following are the high-end GPUs: **4xNVIDIA A100 (4x80 GB), 2xNVIDIA RTX A5000 (24GB), 2xRTX A4000 (2x16GB), 1xNVIDIA RTX A2000 and Titan XP.**



**Prof. Nipun Batra**

Nipun Batra is an Associate Professor of Computer Science at IIT Gandhinagar. He completed his postdoctoral research at the University of Virginia and earned his PhD from IIIT Delhi. His research group focuses on utilizing machine learning and sensing technologies to address computational sustainability challenges, particularly in smart buildings, air quality, and healthcare.

#### Awards won by Prof. Nipun Batra:

- ACM SIGEnergy Rising Star 2025 Award
- ACM SIGEnergy Test of Time Award
- Excellence in Teaching Award by IIT Gandhinagar 2024
- Young Alumni Award from IIIT Delhi 2023
- Keynote talk at ACM COMPASS 2024 Doctoral Colloquium
- Best Graduate Presentation at ACM Sensys 2015 (first and only winner from India)
- Best demo award at ACM Buildsys 2014

#### Awards won by the lab students:

- PhD student Zeel Patel awarded Microsoft PhD fellowship 2024 (one in ten in India)
- PhD student Rishiraj Adhikary is a finalist in the ACM Ubicomp (A\*) graduate award
- PhD student Rishiraj Adhikary selected for prestigious Lindau Laureate Program 2024
- PhD student Rishiraj Adhikary won the Fullbright Nehru visitationn fellowship (1 in 3 in STEM that year)
- MTech Student Ankita Jain won Gold Medal in Research in 2023 convocation.
- PhD student Rishiraj Adhikary won Commendation for Outstanding Research (PhD) in 2025 convocation.

#### Alumni Across the Globe

Caltech



UMASS  
AMHERST

ORACLE

University of  
ILLINOIS  
URBANA-CHAMPAIGN



Microsoft  
Research

UC San Diego

Carnegie  
Mellon  
University

Google DeepMind

#### Sponsors



Department of Science & Technology  
Government of Gujarat



## MEDIA COVERAGE

#### Research scholar at IITGN develops device to overcome fitness monitoring limitations

The trial study was conducted in the SMASH lab of Carnegie Mellon University (CMU) in Pittsburgh, the United States, during Adhikary's stint as a Fulbright scholar between August 2022 and May 2023 where Prof Mayank Goel from the CMU and Prof Nipun Batra from IIT Gandhinagar were his advisors for this project.



#### IIT-Gn chatbot eases air pollution data

Chatbot developed by IIT-Gn leverages artificial intelligence to answer queries about air quality

[Ahmedabad Mirror Bureau](https://ahmedabadmirror.com/posts/@ahmedabadmirror.com)

Posts @ahmedabadmirror.com



A chatbot developed by the Indian Institute of Technology, Gandhinagar (IIT-Gn), Vayubuddy, is designed to make air-quality data accessible to the layperson. It uses a Large Language Model powered tool to simplify complex datasets into comprehensible insights.

IIT-Gn officials said that Vayubuddy leverages artificial intelligence to respond to natural language queries about air quality. For example, users can ask questions like, "What were the PM2.5 levels in Ahmedabad last month?" or "Which cities are the cleanest in winter?" The chatbot processes the query, analyses data from India's Air Quality Pollution Control Board (CPCB), and delivers answers in plain language, such as graphs and heatmaps.

"Our aim was to reduce the gap

between raw data and public understanding," says Prof Nipun Batra, a lead researcher on the project. He adds, "Vayubuddy gives people a way to interact with air-quality data in a user-friendly manner, empowering them to make informed decisions."

The broader implications: "Air pollution is a shared challenge, and tools like Vayubuddy can foster collective awareness and action. When people see clear, localised data, they're more likely to advocate for cleaner policies."

**Why Vayubuddy matters**

Vayubuddy is built out for its ability to cover different insights tailored to various stakeholders. Policymakers can track compliance with air-quality standards, parents can evaluate their children's exposure, and individuals can report trends using ready-to-publish charts.

Zeel Patel, one of the researchers, underscores the versatility of the tool, "By combining data analysis with AI-powered conversational AI, Vayubuddy opens up new possibilities for engaging with air-quality data. It's designed to work for everyone, not just experts."

Existing tools have difficulties to cover multiple pollutants like NO<sub>2</sub> and ozone, integrating multilingual features, and incorporating datasets from other countries are all on the horizon.

**Versatile tool**

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#### IIT-Gn researchers devise mask to measure lung health

SpiroMask assesses lung health parameters using microphone, derives vital statistics and monitors rate of respiration to spot and treat disease in its early stages

[Niyati Ram](https://ahmedabadmirror.in/posts/@ahmedabadmirror.in)

Tweets @ahmedabadmirror.in



respiratory functioning in 14 participants using the SpiroMask, of which 14 participants were found with lung ailments. SpiroMask is also important as late diagnosis of the disease can lead to complications.

Our work is a step towards proactive health management. The idea is to catch and treat the disease in the early stages via regular monitoring.

-Prof Nipun Batra

form Spirometry," he said. "We have a SpiroMask device which costs Rs. 2,000 against a Rs. 40,000 Spirometer."

The researchers said that SpiroMask can help them to monitor their lung health without the need to visit a clinic. As a majority of patients aggravate, detecting lung health early can help them from worsening.

Currently, the team analyzes the