



Plumule Research LLP

Give Every Student A Dream

At Plumule Research LLP, we started with the Industry 5.0 concepts of imagination-driven empowerment, experiential learning, Make in India principles, and protection of weaker communities — ensuring every student can dream, innovate, and create real-world impact through human-centric technology.



Who We Are?

Plumule Research LLP, a DPIIT-recognized MSME, builds smart and sustainable industrial solutions while empowering learners through experiential innovation for the Industry 5.0 future.



What We Do

Our solutions are custom built and tailored to the exact factory environment and run on ultra-low energy consumption.

- ◆ Industrial IoT system design
- ◆ Embedded AI and automation
- ◆ Cloud-based dashboards
- ◆ Real-time sensing and analytics



Why We're Different

Our uniqueness lies in driving sustainable and managed innovation with imagination.



Train to Transform

We provide experiential learning in Industry 5.0 technologies – including AI, Embedded Systems, Smart Manufacturing, and IoT Security. We empower learners to innovate confidently in a sustainable, human-centric future.



Our Domains



Artificial Intelligence and Computer Vision

IoT Engineering

Industry 5.0-ready scalable IoT platforms



PCB Design

Custom circuit board development.

Robotics and Automation

Smart robots for industrial automation.



Cloud Analytics

Custom cloud-based Analytics

Experiential Learning

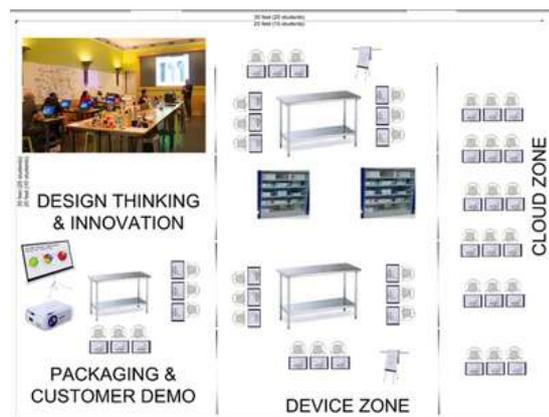
Industry-relevant training programs.



IoT & AI/ML Innovation Labs

Building Industry-Ready Innovation Labs

Plumule Research designs and operates Industry 5.0 Innovation Labs that bridge the gap between academia and real industrial challenges. These labs empower students to work on IoT, AI/ML, automation, analytics, and digital transformation projects using hands-on engineering experience.



Key Focus Areas

- IoT system design & sensor integration
- AI/ML model development and deployment
- Edge computing & cloud-based simulation
- Industry 5.0 automation & digital twins
- Design Thinking methodology for solution building

What Students Learn

- Full-stack IoT product development
- Embedded systems & protocol engineering
- AI vision, robotics & data analytics
- End-to-end solution packaging & integration



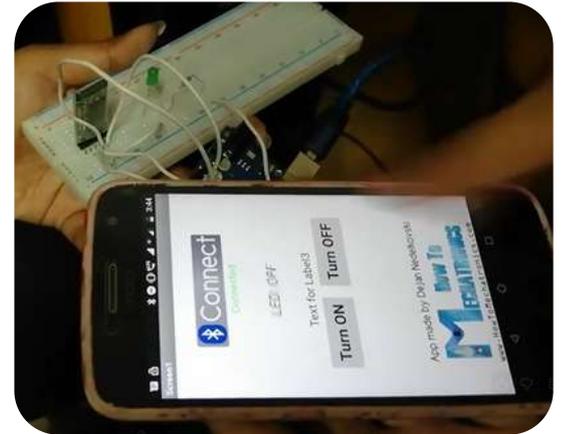
Experiential Learning Programs

1. Techno India College of Technology, NewTown

Students built a working IoT system using Arduino and a custom Android app.

Real-time wireless control with Bluetooth communication.

Hands-on learning in embedded systems and hardware-software integration.



2. IoT Smart Home Automation

Students built energy-efficient automation systems with intelligent sensing and control.

Hands-on learning in embedded IoT, automation, and sustainability.

3. Fujisoft Vara Centre of Excellence

We trained students at the Fujisoft Vara CoE in PCB design, embedded C, microcontrollers (Arduino, Raspberry Pi, Pico), communication modules, the REMY model, and industrial AI – preparing them for real-world smart system development.



Smart Education – Mousuni Island

- Future-skills training in a climate-vulnerable community.
- English, digital literacy & STEM learning for young students.
- Empowering youth for tomorrow's opportunities.
- Aligned with UN SDG-4: Quality Education.

Case Study 1

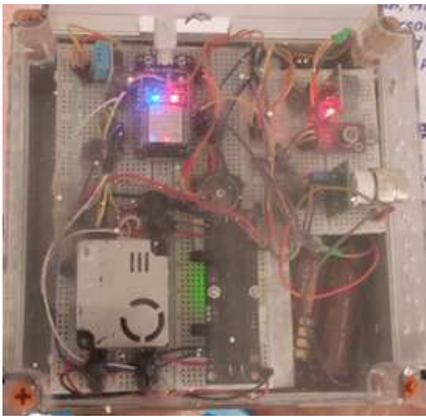
RealTime Air Quality Monitoring System

SCOPE OF THE PROJECT

We will monitor CO, CO₂, PM2.5, PM10, O₂, VOC, humidity, and temperature in real time, send the data to the cloud for AQI and key pollutant calculation, and display live trends on a 43-inch monitor at five sites: Bevedere Park, Rail Minar, Officers Colony, DRM Building, and Sagar Manthan Club.



Location: Sealdah Station

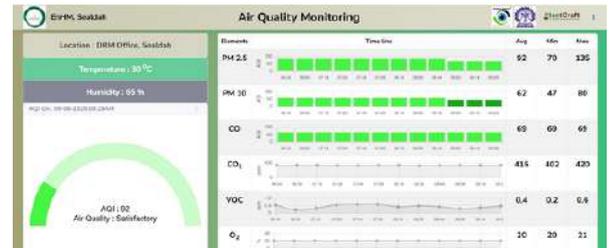


OUR SOLUTION

- Design & engineering of the integrated gas sensor cum microcontroller and battery assembly in a FRP IP65 enclosure
- Collation of sensor data in a microcontroller and sending the data to the cloud over wi-fi
- Self booting 43 inch TV displaying the computed AQI, Prominent Pollutant and real time trend of all the polluting elements
- Installation and commissioning of the entire system

Real-Time Monitoring

- AQI system installed at 5 strategic locations
- 43" self-booting TV displaying live AQI & pollutant trends
- Real-time data sent to cloud via Wi-Fi
- FRP IP65 weatherproof enclosure
- Solar & battery powered
- Integrated PM2.5, PM10, CO₂, CO, VOC, O₂ sensors



Live Dashboards

- <https://aqidev.plantcraftanalytics.com/airmain/Dashboard/realtime/index.php?id=1>
- <https://aqidev.plantcraftanalytics.com/airmain/Dashboard/realtime/index.php?id=2>
- <https://aqidev.plantcraftanalytics.com/airmain/Dashboard/realtime/index.php?id=3>
- <https://aqidev.plantcraftanalytics.com/airmain/Dashboard/realtime/index.php?id=4>
- <https://aqidev.plantcraftanalytics.com/airmain/Dashboard/realtime/index.php?id=5>

Case Study 2

Conveyor Health Monitoring System

SCOPE OF THE PROJECT

Detection of temperature hotspots on a sinter carrying conveyor using a thermal camera. The conveyor is running at a high speed 1.2 m/s. Hot sinters in cluster damage underlying rubber belt and can even cause fires. Temperature profiling over rectangular frames to understand if it is crossing alert zone of $> 98^{\circ}\text{C}$. Remote viewing, data transmission to a central server for further analytics. JIT arrest of any fire hazard by operating a relay to alert / start water sprinklers. Prediction of conveyor fire well in advance and life cycle analysis of conveyor health.



Location: Durgapur Steel Plant Sinter Plant 2 SSB1

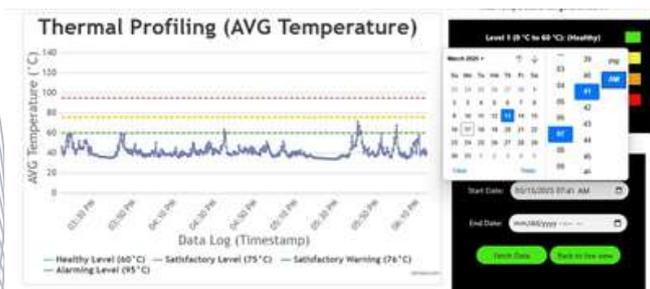
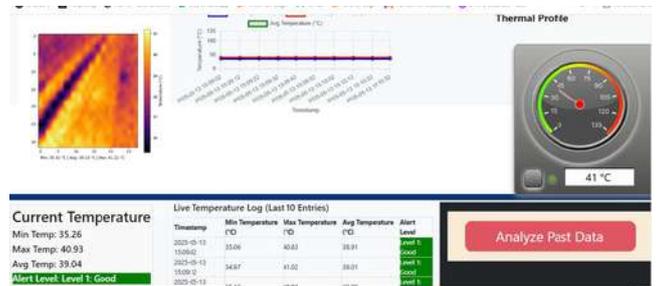


OUR SOLUTION

Design & engineering of a thermal imaging assembly. Use of high end GPU displaying spatiotemporal thermal data in real time. Fiber Optic Transmission and display of image and data in real time over the plant LAN. Relay terminals to operate sprinklers based on temperature setting. Temperature profiling & impact analysis of the EP conveyor belt.

Real-Time Monitoring

This system uses a GPU-based thermal camera to monitor heat on fast-moving conveyor belts. It detects hotspots that can damage the belt or cause fires. A live dashboard shows the temperature, trends, and alerts. If the temperature crosses 98°C , the system triggers sprinklers automatically for fire prevention.



Historical Data Analysis

The system allows users to select a start and end date to view and analyze historical temperature data. The graph shows average temperature trends with clear status zones: Healthy, Satisfactory, Warning, and Alarming. This helps in identifying past anomalies and evaluating the thermal performance over time.

Case Study 3

Unmanned Train Detection & Alert System

PROBLEM

At Matix, freight trains come empty into the plant from Panagarh offtake / virtual junction, enter into the urea and ammonia manufacturing premises at unpredictable times.

Matix was looking for an automated solution that could ring the buzzer and the siren and light the flasher to safeguard the passerby and the labourers who load the bags from conveyors on the 750m long platform

They wanted a flawless automated system for detecting a train and alerting everyone



Location: Matix Fertilizer,
Panagarh Industrial
Estate



OUR SOLUTION

Design & engineering of autonomous detection system using radar and camera and deep learning at the edge
Communication to the platform using M2M SIM

Alert to a series of flashers and sirens spanning the entire platform, so that everyone in and around the area was on alert

Tuning of the system at site to remove the JCBs, the trucks, the bikes and any other irrelevant obstacle
Manual override if the communication failed or the relay failed

System robust to handle storm, rain, fog and extreme heat at Panagarh

Assembled to order from elemental components

Live MQTT Data Stream

The system uses AI-enabled radar and camera sensors to detect incoming freight trains at the Matix plant. Once a train is detected, it publishes live data to MQTT topics like detector/radar1 and detector/camera2. This real-time data triggers the activation of buzzers, flashers, and sirens across the 750-meter platform, instantly alerting nearby workers and laborers. The system communicates using M2M SIMs, is built to withstand harsh weather, and includes a manual override for added safety.



Case Study 4

Gas Sensor Calibration with IIT KGP Sensors

SCOPE OF THE PROJECT

This project aims to support IIT Kharagpur in the calibration and testing of NO_2 and NH_3 gas sensors for accurate PPM (parts per million) level readings. Calibration is critical to ensure reliable data in air quality monitoring, environmental research, and industrial safety applications. The system will be used to simulate known gas concentrations, compare sensor output, and generate calibration curves. This ensures the sensor's response is consistent, traceable, and accurate under real-world conditions.



OUR SOLUTION

We are building a compact PCB board to help IIT Kharagpur calibrate NO_2 and NH_3 gas sensors accurately. It works with Arduino or ESP32 to read real-time sensor data and compare it with standard gas levels. The board supports analog signal processing, digital communication, and data logging, making calibration easy and reliable for both lab and field use.

Collaboration With IIT KGP



Case Study 5

Save Our Souls (SOS) Bangle

SCOPE OF THE PROJECT

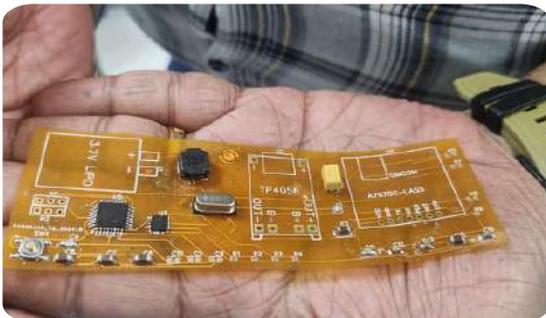
The SOS Bangle is a compact, wearable safety device designed to empower women with a discreet and reliable tool for emergency situations. The scope of this project includes the design, development, and deployment of a smart bangle that can send distress signals using mobile communication technology



OUR SOLUTION

The entire circuit is embedded within a customized bangle, keeping all components hidden from view. The system comprises a battery, charging unit, microcontroller, GPS module, SIM module, and a push-button. When the button is pressed, an SOS message along with the wearer's real-time location is sent to three preconfigured phone numbers.

Custom-soldered and programmed *in-Our Lab*



Case Study 6

GHG / Methane Monitoring Unit

SCOPE OF THE PROJECT

- Track methane emissions in remote paddy fields for climate and agricultural research.
- Measure critical soil parameters including pH, conductivity, moisture, and temperature.
- Transmit real-time field data over MQTT to a central cloud dashboard.
- Ensure uninterrupted monitoring despite rural conditions, weather, and network limitations.



OUR SOLUTION

- Solar-powered climate monitoring for agriculture
- Methane + soil pH, EC, moisture, temperature tracking
- Edge-based intelligent sensing for accurate insights

Cloud-connected via M2M SIM & MQTT

Some Snapshot



Case Study 7

Industrial IoT Gateway

SCOPE OF THE PROJECT

- Modern steel plants require seamless integration between machines, sensors, and cloud analytics.
- A reliable IoT gateway is essential for real-time monitoring, predictive maintenance, and automation.
- Industry 5.0 applications demand stable multi-protocol communication and edge intelligence.



OUR SOLUTION

Plumule Research engineered a next-generation Industrial IoT Gateway, designed to outperform all gateways in its class. It enables AI-driven automation, digital twins, and end-to-end smart factory operations with rugged industrial reliability.

Applications

- Smart factory automation
- Predictive maintenance
- Digital manufacturing and assembly-line monitoring
- Product simulations and real-time process optimization
- End-to-end Industry 5.0 transformation

Case Study 8

Smart AquaSense System

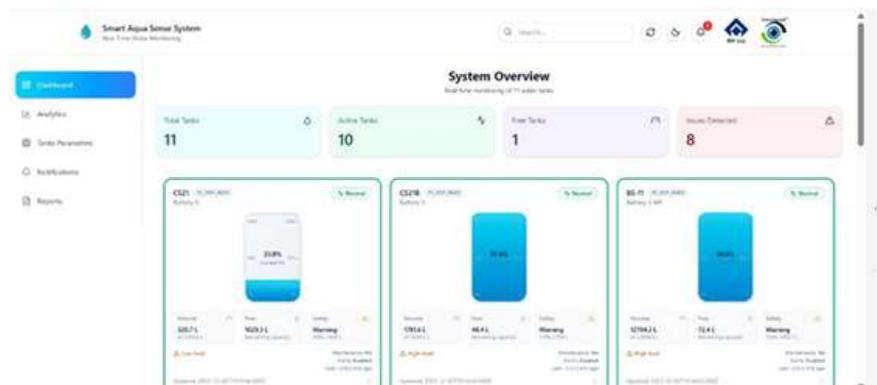
SCOPE OF THE PROJECT

- Measure real-time water levels across all 11 tanks
- Transmit live tank data to a central dashboard
- Enable remote monitoring for plant operations team
- Trigger alerts for overflow, dry-run, or abnormal fluctuations



OUR SOLUTION

- Ultrasonic/pressure sensor-based level measurement
- Industrial IoT node with M2M SIM for communication
- Centralized cloud dashboard showing tank-wise status
- Daily, weekly & monthly usage trends for planning



Benefits

- Prevents overflow and water wastage
- Ensures uninterrupted supply to critical processes
- Reduces manual inspection and improves safety
- Supports data-driven decision-making

◆ We design and develop innovative robotic solutions in-house.

From concept to deployment, we engineer robotic systems tailored to industrial needs – including motion control, sensing, and smart automation – all developed entirely within our facilities.



◆ We work on online Partial Discharge (PD) analysis in transformers.

From concept to deployment, we engineer robotic systems tailored to industrial needs – including motion control, sensing, and smart automation – all developed entirely within our facilities.



◆ We detect and analyze object size using computer vision.

From concept to deployment, we engineer robotic systems tailored to industrial needs – including motion control, sensing, and smart automation – all developed entirely within our facilities.



◆ We conduct driver behavior analysis using Artificial Intelligence (AI).

Using AI and sensors, we monitor rider posture, attention, and fatigue to improve safety and prevent accidents in two-wheelers.





Testimonials / Impact



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