Artificial Intelligence of Things (AIoT): Problem Statements for a 28-Hour Hackathon

Advanced AIoT Hackathon Problem Statements

- 1. Predictive Agriculture with Intelligent Irrigation
- 2. AI-Based Water Leakage Detection and Localization
- 3. AIoT-Based Energy Optimization and Load Forecasting
- 4. Multi-Sensor AIoT Disaster Early-Warning System
- 5. AIoT Solar Panel Fault and Performance Diagnosis
- 6. AI-Enabled Smart Waste Segregation and Collection
- 7. Distributed AIoT Air-Quality Intelligence
- 8. Intelligent Energy Theft and Abnormal Load Detection
- 9. Collaborative AIoT with Distributed Learning
- 10. Self-Learning Predictive Maintenance System

Advanced AIoT Hackathon Problem Statements — 28 Hours

Theme: Artificial Intelligence of Things (AIoT)

Target participants: Engineering students in ECE, EEE, CSE, IT, AI/ML, and related disciplines

Prototype platform: ESP32, Arduino, sensors, actuators, and optional Raspberry Pi or laptop-based AI processing

For a 28-hour hackathon, the challenge should go beyond basic sensor monitoring.

Teams should combine real-time sensor data, AI/ML-based prediction or decision-making, IoT communication, and a working prototype.

The following problem statements are designed to encourage advanced solutions while remaining achievable within the hackathon duration.

1. Edge AI-Predictive Agriculture with Intelligent Irrigation

Problem Statement

Traditional irrigation systems often operate using fixed schedules or simple soil-moisture thresholds. These methods do not adequately consider changing weather conditions, crop water requirements, soil characteristics, or the rate at which soil moisture is changing. Consequently, they can lead to water wastage, over-irrigation, under-irrigation, and unnecessary energy consumption.

The challenge is to develop an Edge AI–enabled predictive irrigation system that continuously monitors agricultural conditions, predicts future soil-moisture levels and irrigation requirements, and automatically controls water delivery. The system should process sensor data locally on an edge device, such as an ESP32 or Raspberry Pi, enabling fast decisions even when internet connectivity is unavailable.

The solution should integrate AI/ML, IoT communication, real-time sensing, and automated irrigation to optimize water usage while maintaining suitable soil-moisture conditions for the selected crop.

Hardware

- Soil moisture ·
- Temperature ·
- Humidity ·

- Light · Optional rain sensor
- ESP32 or Raspberry Pi

Possible algorithms:

- Random Forest
- Decision Tree
- SVM
- KNN

2. AI-Based Water Leakage Detection and Localization

Problem statement

Water leakage in residential buildings, industries, and water distribution pipelines leads to significant water wastage, infrastructure damage, and increased maintenance costs. Conventional leakage detection methods often rely on manual inspection, fixed flow thresholds, or alarms that indicate abnormal water consumption without identifying the probable leakage location.

The challenge is to develop an AI-based water leakage detection and localization system that continuously monitors pipeline conditions using IoT sensors, identifies abnormal flow or pressure patterns using machine learning, and estimates the probable location of a leakage.

The system should process sensor data in real time, distinguish leakage events from normal water usage and temporary pressure variations, and provide immediate alerts through a dashboard. The prototype should demonstrate leakage detection and approximate localization across a multi-section pipeline, using an ESP32 or Arduino-based sensor network.

Hardware

- Flow sensors ·
- Pressure sensors ·
- Optional acoustic/vibration sensors
- ESP32 or Raspberry Pi

Possible algorithms:

- Random Forest
- Decision Tree
- SVM
- KNN

3. AIoT-Based Energy Optimization and Load Forecasting

Problem Statement

Increasing electricity consumption, inefficient use of electrical appliances, peak-demand periods, and unexpected changes in load create challenges for homes, educational institutions, commercial buildings, and industries. Conventional energy-monitoring systems mainly display current consumption or provide alerts when a predefined threshold is exceeded. They generally lack the ability to predict future energy demand, identify unusual consumption patterns, and recommend appropriate energy-saving actions.

The challenge is to develop an AIoT-Based Energy Optimization and Load Forecasting System that continuously monitors electrical parameters, predicts short-term energy demand using machine learning, detects abnormal consumption, and recommends or implements energy-saving actions.

Hardware

- Voltage/current sensors ·
- Power measurement ·
- Energy readings ·
- Load status
- ESP32 or Raspberry Pi

Recommended algorithms

- Linear Regression
- Random Forest Regressor
- Gradient Boosting Regressor
- Isolation Forest
- Rule-based optimizer

4. Multi-Sensor AIoT Disaster Early-Warning System

Problem statement

Natural disasters and environmental emergencies, such as floods, flash floods, landslides, and severe waterlogging, can cause significant damage to human life, infrastructure, agriculture, and the environment. Conventional monitoring systems often rely on individual sensors or fixed threshold-based alarms, which may fail to identify developing risks early or distinguish genuine danger from temporary sensor fluctuations.

The challenge is to develop a Multi-Sensor AIoT Disaster Early-Warning System that continuously monitors environmental conditions, combines data from multiple sensors, and uses artificial intelligence or machine learning to identify developing disaster risks and issue timely warnings.

Hardware

- Water level · Rainfall ·
- Temperature ·
- Humidity ·
- Optional soil moisture or vibration
- ESP32 or Raspberry Pi

Possible algorithms:

- Linear Regression
- Random Forest
- Decision Tree
- SVM

- KNN

5. AIoT Solar Panel Fault and Performance Diagnosis

Problem statement

Solar photovoltaic (PV) systems are increasingly used to generate clean and sustainable electricity. However, their performance can decrease due to dust accumulation, partial shading, abnormal temperature, loose connections, sensor faults, and other operating conditions. Conventional solar monitoring systems generally measure voltage, current, and power but may not identify the cause of reduced performance or detect abnormal operating patterns at an early stage.

The challenge is to develop an AIoT-Based Solar Panel Fault and Performance Diagnosis System that continuously monitors solar-panel operating parameters, estimates expected power generation, detects abnormal performance using artificial intelligence and machine learning, and identifies probable causes of underperformance.

Hardware

- ESP32
- Small solar PV panel
- Suitable voltage-sensing module or calibrated divider
- INA219, INA226, or an appropriately rated current sensor
- DS18B20 or suitable temperature sensor
- BH1750 or a calibrated light sensor

Possible algorithms:

- Linear Regression
- Random Forest
- Decision Tree
- SVM
- KNN

6. AI-Enabled Smart Waste Segregation and Collection

Problem statement

Improper waste disposal and inadequate waste segregation are major challenges in residential areas, educational institutions, hospitals, commercial buildings, and smart cities. When recyclable, organic, and non-recyclable waste are mixed, recycling becomes more difficult, waste-processing costs increase, and environmental pollution can worsen.

Conventional waste bins generally depend on manual segregation and periodic collection. They may not identify the type of waste being deposited, monitor bin capacity intelligently, or optimize collection schedules based on actual waste accumulation.

Hardware

- ESP32
- Soil Moister sensor
- Ph sensor
- DHT-11or suitable temperature sensor
- BH1750 or a calibrated light sensor

Possible algorithms:

- Linear Regression
- Random Forest
- Decision Tree
- SVM
- KNN

7. Distributed AIoT Air-Quality Intelligence

Problem Statement

Air pollution varies significantly from one location to another because of traffic density, industrial emissions, construction activities, weather conditions, and other environmental factors. Conventional air-quality monitoring systems often rely on a limited number of monitoring stations and may not provide sufficiently localized, real-time insights.

The challenge is to develop a Distributed AIoT Air-Quality Intelligence System consisting of multiple low-cost sensor nodes that monitor air quality at different locations, communicate measurements to a central platform, and use artificial intelligence to identify pollution patterns, predict air-quality changes, detect abnormal pollution events, and generate localized alerts.

Each sensor node should collect environmental data and transmit it using an IoT communication protocol. An AI/ML model should analyze the collected data and classify air-quality conditions or predict pollution levels. The system should continue collecting data even when connectivity is temporarily unavailable, where feasible, and synchronize stored readings when communication is restored.

Hardware

- ESP32
- DHT-11or suitable temperature sensor
- BH1750 or a calibrated light sensor
- Optional gas sensor

Possible algorithms:

- Linear Regression
- Random Forest
- Decision Tree
- SVM
- KNN

8. Intelligent Energy Theft and Abnormal Load Detection

Problem statement

Electricity theft, unauthorized connections, meter tampering, and abnormal load consumption can cause financial losses, energy wastage, and instability in electrical distribution networks. Conventional energy meters typically measure consumption but may not provide intelligent, real-time detection of unusual usage patterns or potential irregularities.

The challenge is to develop an Intelligent Energy Theft and Abnormal Load Detection System using IoT-enabled energy monitoring devices and artificial intelligence. The system should continuously measure

electrical parameters, transmit energy-consumption data to a monitoring platform, and analyze usage patterns to identify suspicious consumption, unexpected load changes, and possible meter or sensor abnormalities.
The proposed solution should compare measured electrical parameters and consumption patterns against learned baselines or simulated reference measurements. A machine-learning model should classify abnormal events, assign an anomaly score, and generate alerts through a dashboard or notification system.

Hardware

- ESP32
- LED lamp
- DC loads
- Voltage /Current /Power Meter

Possible algorithms:

- Linear Regression
- Random Forest
- Decision Tree
- SVM
- KNN

9. Collaborative AIoT with Distributed Learning

Problem statement

Traditional IoT systems often collect data from multiple devices and send it to a central server for AI model training and analysis. However, centralizing all sensor data can increase network traffic, create privacy concerns, and make the system dependent on continuous connectivity to a central platform.
The challenge is to develop a Collaborative AIoT System with Distributed Learning, in which multiple IoT devices or edge nodes independently collect data and train local machine-learning models. Instead of sharing their complete raw datasets, the nodes exchange model updates or learned parameters with a central coordinator or a peer-to-peer aggregation mechanism.
The system should combine the knowledge learned by individual nodes to create a collaborative global model that performs better across different devices or environments. The updated global model should then be distributed back to participating nodes for further local learning and inference.

Hardware

- ESP32(3 no’s)
- DHT-11
- MQQT

Possible algorithms:

- Linear Regression
- Random Forest
- Decision Tree
- SVM
- KNN

10. Self-Learning Predictive Maintenance System

Problem statement

Industrial machines such as motors, pumps, fans, and conveyor systems may develop faults due to excessive vibration, overheating, overloading, bearing wear, or changing operating conditions. Traditional maintenance approaches often rely on fixed maintenance schedules or inspections after a fault occurs, resulting in unexpected downtime, increased maintenance costs, and reduced equipment reliability.
The challenge is to develop a Self-Learning Predictive Maintenance System using AIoT that continuously monitors machine operating conditions using IoT-enabled sensors and applies artificial intelligence to identify abnormal behaviour and predict potential equipment failures.

Hardware

- ESP32
- DHT-11or any Temperature sensor
- Vibration sensor
- Current Sensor

Possible algorithms:

- Linear Regression
- Random Forest
- Decision Tree
- SVM
- KNN

28-Hour AIoT Hackathon: Stages and Deliverables

Stage	Time	Mentor Guidance	Activities and Deliverable
Stage 1: Ideation and Design	Hours 0–6	Problem identification and solution planning.	• Mentors announce real-world problem statements. • Teams select a problem and propose a solution. • Prepare the abstract, block diagram and system architecture. • Identify hardware components, sensors and software tools. Deliverable: Approved idea, block diagram and development plan.
Stage 2: Prototype Development	Hours 6–20	Hardware implementation, coding and integration.	• Interface ESP32, Arduino or Raspberry Pi Pico with sensors. • Develop embedded software and IoT

Stage	Time	Mentor Guidance	Activities and Deliverable
			connectivity. • Integrate cloud dashboards, robotics or AI features. • Test the prototype and resolve technical issues. Deliverable: Working minimum viable prototype (MVP).
Stage 3: Testing, Validation and Final Demo	Hours 20–28	Performance evaluation and project presentation.	• Test functionality and improve reliability. • Demonstrate the prototype with real-time results. • Submit source code, documentation and presentation. • Present the solution to the judging panel. Deliverable: Final working demonstration and project presentation.