

Forest Fire Alert & Monitoring System Using ESP32 and LoRa

Project Overview

This system is an intelligent, wireless forest fire detection network that uses ESP32-based sensor nodes and long-range LoRa communication to identify and alert fire incidents in real time. The network is scalable to 100+ sensor nodes, deployed across a forest at 100-meter intervals, and designed to function reliably in remote, low-connectivity environments.

Key Features

- Real-time fire and smoke detection using DHT11 + MQ2 sensors
- LoRa (SX1278) communication for long-range, low-power transmission
- Battery-powered nodes for deep forest deployment
- Central Gateway at outer forest control station
- Firebase Cloud Sync for live dashboard updates
- Node location tracking using pre-mapped Node ID to GPS
- Remote dashboard access for forest officials

System Architecture

1. Sensor Nodes:

Each node contains ESP32, DHT11, MQ2, LoRa SX1278, and a Li-Ion battery. Only transmits if thresholds are exceeded.

2. Central Gateway:

Located at forest control station. Receives LoRa messages and uploads to Firebase.

3. Cloud & Dashboard:

Officials view alerts in real-time with Node ID, location, and fire risk data.

Node Location Mapping

Each Node ID (e.g., Node_73) is mapped to a known GPS coordinate, enabling instant localization during alerts.

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Cost & Impact

- Node Cost: Rs.700 - Rs.1100
- LoRa Range: Up to 10 km (LOS)
- Power: 3.7V Li-Ion Battery
- Response Time: Under 3 seconds
- Use Cases: Forest Fire Detection, Wildlife Protection, Border Security
- Impact: Saves wildlife and prevents widespread forest destruction.

Innovation Highlights

- Autonomous sensing, no human patrol needed
- Event-triggered transmissions
- Long-range LoRa + Firebase cloud integration
- Fully scalable and remotely accessible

Future Enhancements

- Add TinyML risk prediction
- Optional GPS per node
- Solar panel support
- Mobile app for field teams

Conclusion

This project is a practical, scalable IoT solution to monitor and prevent forest fires. Using ESP32, LoRa, and Firebase, it delivers real-time alerts and location-based tracking, empowering forest departments to act swiftly and effectively.