Title: Smart Smoke & Gas Detector Project – Solo Implementation Guide

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1. Project Overview

The Smart Smoke & Gas Detector is an IoT-based early warning system designed to detect smoke, temperature spikes, and hazardous gas leaks. It integrates sensors, microcontrollers, and cloud-based alerts to provide real-time safety monitoring. Optional features include ML-based predictive alerts, location awareness, and gas type identification.

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2. Core Components

Component	Purpose
ESP32 / Arduino	Microcontroller to read sensors, process data, and send alerts
MQ-2 / MQ-135	Smoke and flammable gas detection
Temperature Sensor (DHT11 / LM35)	Detect sudden heat spikes
Accelerometer / Gyroscope (Optional for motion detection)	Detect movements if extended to wearables
Buzzer / LEDs	Immediate local alert
Wi-Fi / GSM module	Cloud notifications and remote alerting
Helmet / Mounting base	Optional wearable or stationary mounting

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3. Basic System Workflow

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[Sensors] --> [ESP32 Microcontroller] --> [Threshold / ML Processing] --> [Al
erts: Buzzer / LED / Cloud / Phone] --> [Dashboard Visualization]
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- Sensors continuously measure environmental parameters.
- ESP32 compares sensor readings to thresholds or sends data to ML models for anomaly detection.
- Alerts are triggered locally and remotely.
- Cloud dashboard logs historical data and visualizes trends.

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4. IoT & Cloud Integration

- Use **ThingSpeak, Firebase, or MQTT brokers** to transmit data from ESP32 to a mobile/web dashboard.
- **Push notifications** for hazardous conditions, including contextual information: gas type, room, severity level.
- **Data logging** enables predictive analytics and model improvement.

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5. ML / Predictive Features

- **Threshold-based alerts**: Immediate detection when readings exceed safe limits.
- **TinyML classification**: Use sensor arrays + ML to predict hazardous situations or classify gas types.
- **Predictive alerts**: Early warning based on rising trends or combined sensor patterns.
- **Implementation**: Python for training, TensorFlow Lite / Edge Impulse for microcontroller deployment.

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6. Optional / Advanced Features

- **Multi-room detection**: Identify which room is affected using multiple ESP32 nodes.
- **Voice / interactive alerts**: Push notifications with voice or emoji-based alerts.
- **Automated response**: Fan, LED, or simulated sprinkler activation via relays.
- **Gas type detection**: Use multiple sensors + ML model to classify type of gas (LPG, CO, smoke, etc.).
- **AR visualization**: Optional augmented reality layer to visualize hazard zones.

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7. Datasets & Research Directions

- **Type of dataset needed**: Multiple sensor readings labeled with gas type and environmental conditions.
- **Sources**: Kaggle, UCI ML Repository, supplementary data from IoT research papers.
- **Key features**: Sensor analog readings, temperature, humidity, labeled gas types.
- **Purpose**: Train ML models for gas type classification and predictive hazard alerts.

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8. Solo Implementation Roadmap

Phase 1: Foundation

- Learn ESP32 basics, sensor reading tutorials.

- Create flowchart: Sensors → Microcontroller → Alerts → Cloud.

Phase 2: Sensor Integration & Basic Alerts

- Connect temperature + gas sensor, test threshold alerts.
- Log data locally or to cloud.

Phase 3: ML / Motion Detection (Optional)

- Collect sensor data, train ML model to detect anomalies.
- Deploy model to ESP32 for real-time prediction.

Phase 4: Cloud Dashboard & Full System

- Implement cloud dashboard for visualization.
- Push notifications with contextual alerts.
- Optional: multi-room, automated response, AR visualization.

Phase 5: Documentation & Demo

- Compile report with system diagram, workflow, ML model description.
- Demo showing local alerts + cloud notifications + dashboard.
- Reference 15–20 research papers on IoT safety, ML anomaly detection, sensor integration.

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9. Estimated Cost

- Basic version: ₹2000–₹2500 (ESP32 + temp + gas sensors + buzzer/LED + cloud).
- Full version: ₹3000–₹4000 (add heart rate, solar panel, multiple sensors, ML deployment).

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10. References / Research Paper Topics

- IoT-based gas detection systems
- Smoke sensor integration for early fire warning
- ML-based anomaly detection on sensor arrays
- Edge computing for predictive alerts
- Cloud dashboards for real-time monitoring
- Wearable safety systems and sensor fusion

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11. Diagrams / Flowcharts

(Use for presentation / report) 1. System architecture: Sensors → ESP32 → Cloud → Alerts / Dashboard 2. ML pipeline: Sensor readings → Feature extraction → Classifier → Prediction / Alert 3. Optional: Multi-room mapping / AR visualization layout

Component	Price Range (₹)
MQ-2 Gas Sensor	105 – 145
MQ-135 Air Quality Sensor	97 – 589
DHT11 Temperature & Humidity Sensor	55 – 180
LM35 Temperature Sensor	65 – 77
ESP32 Microcontroller	479 – 1,643
Subtotal	**801 – 2,634**
Optional Add-ons (Buzzer, Relay, OLED)	270 – 700
Grand Total	**1,071 – 3,334**