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

## 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.

## 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 |

## 3. Basic System Workflow

[Sensors] --> [ESP32 Microcontroller] --> [Threshold / ML Processing] --> [Alerts: Buzzer / LED / Cloud / Phone] --> [Dashboard Visualization]

* 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.

## 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.

## 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.

## 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.

## 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.

## 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.

## 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).

## 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

## 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** |