DESIGN AND DEVELOPMENT OF
"IoT-Based Multi-Sensor Gas Leakage Monitoring and Automatic Ventilation System"

BY

Showrav Das
ID: 221-15-5425

Adnan Rahman Sayeem
ID: 221-15-5505

Niloy Biswas
221-15-5894

Shahnewaz Saeem
221-15-5442

AND

Pronob Chandra Sarkar
221-15-4840

Supervised By

Indrojit Sarkar
Lecturer
Department of CSE
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY
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DECLARATION

We hereby declare that; this project has been done by us under the supervision of **Indrojit Sarkar**, Lecturer, Department of CSE Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

_____

Indrojit Sarkar
Lecturer
Department of CSE
Daffodil International University

Submitted by:

_____

Showrav Das
ID: 221-15-5425
Department of CSE
Daffodil International University

Adnan Rahman Sayeem
ID: 221-15-5505
Department of CSE
Daffodil International University

Niloy Biswas
ID: 221-15-5894
Department of CSE
Daffodil International University

Shahnewaz Saeem
ID: 221-15-5442
Department of CSE
Daffodil International University

Pronob Chandra Sarkar
ID: 221-15-4840
Department of CSE
Daffodil International University

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ABSTRACT

The IoT-Based Multi-Sensor Gas Leakage Monitoring and Automatic Ventilation System project presents an IoT-based multi-sensor gas leakage monitoring and automatic ventilation system using the ESP32 DevKit V1 microcontroller. The system employs three MQ2 gas sensors to detect gas leakage and continuously monitor the surrounding environment. Real-time sensor data is displayed on an I2C LCD and transmitted to the Blynk mobile application for remote monitoring and notifications. When gas concentration exceeds a predefined threshold, the system triggers a buzzer, turns on a red LED, and automatically activates a ventilation fan via a relay module (SPD-05VDC-SLC). A green LED indicates safe conditions. This cost-effective and reliable system enhances safety in homes, laboratories, and industrial facilities by providing both local alerts and IoT-enabled remote notifications.

IoT-Based Multi-Sensor Gas Leakage Monitoring and Automatic Ventilation System

1. Introduction

Gas leakage poses serious threats in residential, industrial, and laboratory environments. Undetected buildup can lead to explosions, fires, or severe health hazards. Traditional gas alarms provide only local alerts, which may not reach users in time.

To address this, we designed a system that combines **embedded hardware (ESP32, MQ2 sensors, relay, fan, buzzer, LCD)** with **IoT features (Blynk app, notifications, email alerts).** The system not only **detects leaks** but also **acts automatically** to reduce gas concentration.

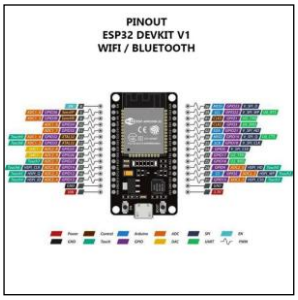
2. Objectives

- To design an IoT-enabled system for real-time gas monitoring using multiple MQ2 sensors.
- To provide local alerts through LCD, LEDs, and a buzzer.
- To enable remote monitoring and notifications using Blynk.
- To implement automatic fan control via relay for ventilation.
- To enhance safety and reliability in gas-prone environments.

3. Components Used

3.1 ESP32 DevKit V1

- Built-in Wi-Fi → perfect for IoT integration.
- Multiple ADC pins for connecting 3 MQ2 sensors



ESP32 DevKit V1

3.2 MQ2 Gas Sensors (x3)

- Detect LPG, methane, propane, smoke.
- Placed at different locations (stove height, ceiling, ventilation outlet).

MQ2 Gas Sensors

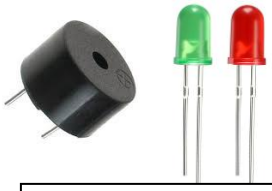
3.3 Relay Module (SPD-05VDC-SLC)

- Control fans automatically.
- Active LOW → GPIO18 switches the fan ON when pulled LOW.

Relay Module

3.4 Buzzer and LEDs (Red, Green)

- Red LED + buzzer = gas detected.
- Green LED = safe.



Buzzer & LED

3.5 I2C LCD (16×2)

- Displays sensor values + system status in real time.

I2C LCD

3.6 Ventilation Fan (DC Motor)

- Dispels leaked gas automatically.

Ventilation Fan

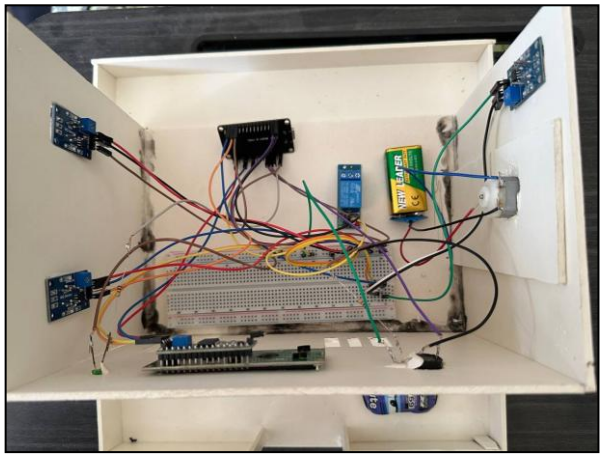
3.7 Blynk Platform

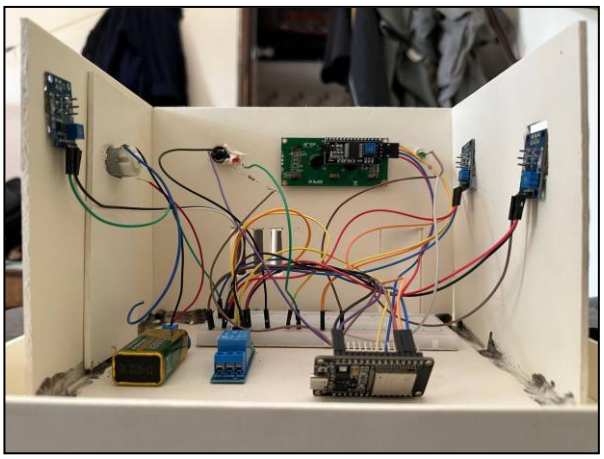
- Live dashboard.
- Push notifications + automated emails.
- Uses Virtual Pins (V0–V8).

Blynk Platform

4. Real Implementation

The following images showcase the physical implementation of the **IoT-Based Multi-Sensor Gas Leakage Monitoring and Automatic Ventilation System**:





Figures 4.1–4.5 show the actual prototype, including ESP32, MQ2 sensors, relay, fan, buzzer, and LCD.

4. Circuit Diagram

The circuit diagram below (Figure 4.1) illustrates the complete hardware setup of the system. The ESP32 DevKit V1 is the central controller, connected to three MQ2 gas sensors for detecting gas concentration. An I2C LCD is used to display sensor readings and alerts. The buzzer and LEDs provide local warning signals, while a relay module controls the fan for automatic ventilation. Power and ground lines are shared across the breadboard to supply all components.

Pin Connections (as per code):

- MQ2 Sensor 1 → GPIO39 (VN)
- MQ2 Sensor 2 → GPIO36 (VP)
- MQ2 Sensor 3 → GPIO34
- Relay → GPIO18
- Buzzer → GPIO4
- Green LED → GPIO15
- Red LED → GPIO2
- LCD (I2C) → SDA = GPIO21, SCL = GPIO22

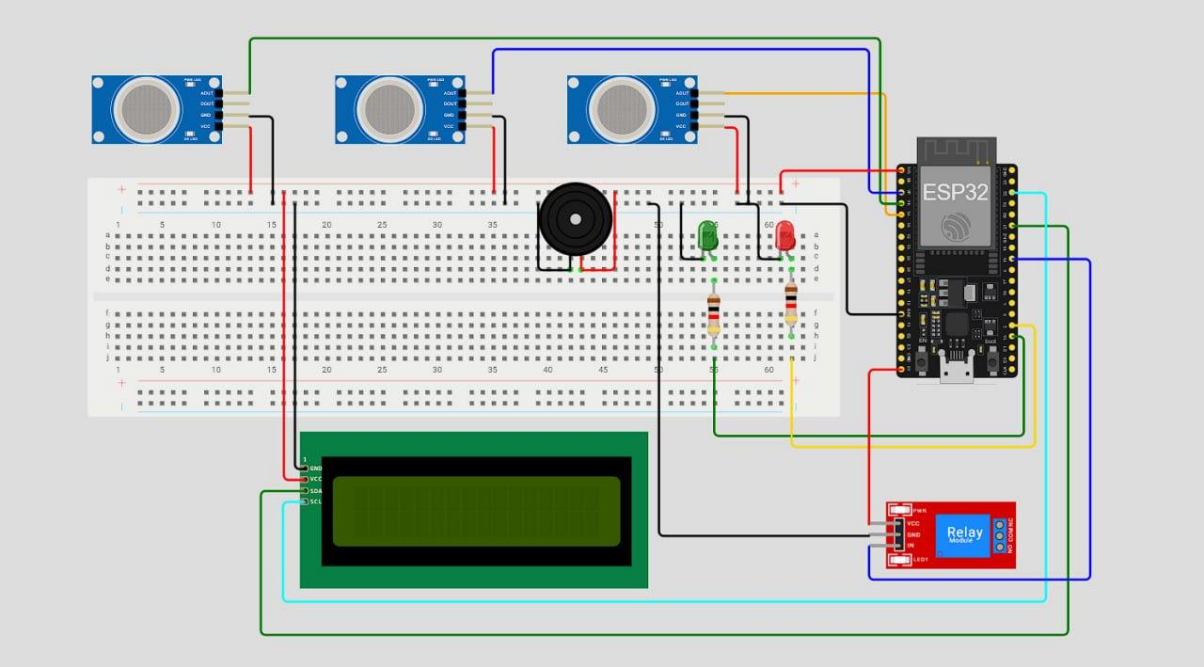


Figure 5.1: Complete Circuit Diagram of IoT-Based Multi-Sensor Gas Leakage Monitoring and Automatic Ventilation System
(Showing ESP32 DevKit V1 microcontroller, three MQ2 gas sensors, relay module for fan control, buzzer, red & green LEDs, I2C LCD (16×2), and DC exhaust fan. Power supply and common ground connections are also included.)

6. Working Principle

1. ESP32 continuously reads analog values from MQ2 sensors.
2. If all readings are **below thresholds (1400, 350, 1600):**
    - Green LED ON, Red LED OFF, Fan OFF, Buzzer OFF.
    - LCD shows *"All Normal"*.
    - Blynk dashboard shows safe values.
3. If any sensor **crosses threshold:**
    - Red LED + buzzer ON, Fan activated.
    - LCD shows *"Gas Detected"* with sensor readings.
    - Blynk app updates widgets (V3–V8) and sends notification + email alert.

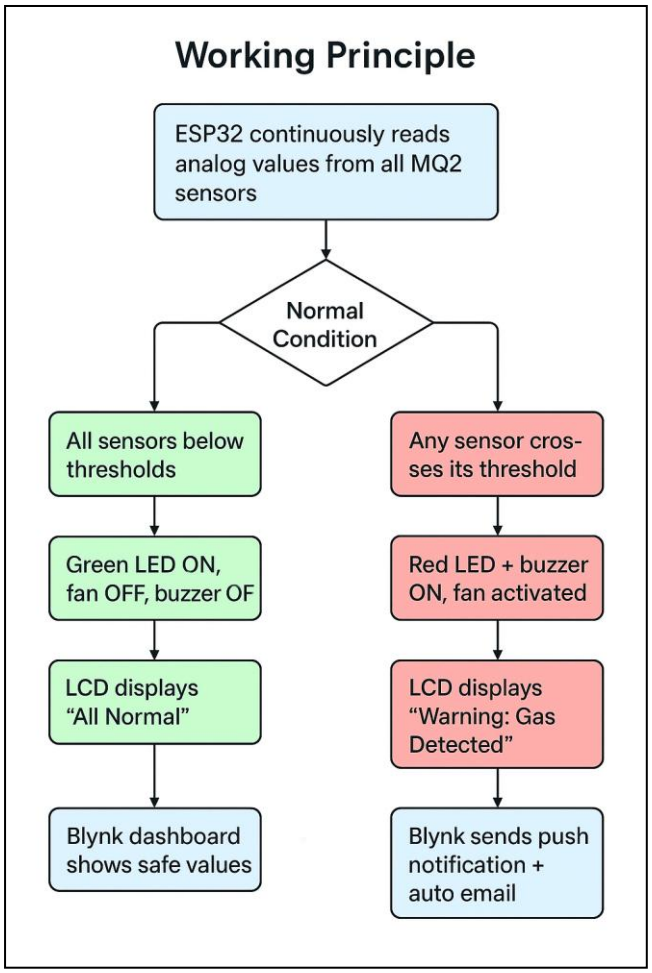


Figure: 6.1 Working Principle

7. Threshold Justification

Since MQ2 sensors output different analog values depending on placement and environment, one universal threshold would be inaccurate. Each sensor was **individually calibrated** in controlled leak tests.

1) Calibration Results

Sensor	Location	Safe Baseline	Leak Test Peak	Final Threshold	Reason
Sensor 1	Ceiling	300–500	1800–2200	**1400**	Gas rises slowly; higher threshold avoids false alarms.
Sensor 2	Stove height	200–300	700–1200	**350**	Closest to source; small increases above baseline signal a leak, so threshold kept low.
Sensor 3	Vent outlet	250–400	2000–2500	**1600**	Airflow dilutes gas; higher threshold ensures detection only in severe leaks.

2) Key Points

- Thresholds chosen after **empirical calibration** during controlled leaks.
- Adjusted for **sensor placement and airflow** differences.
- Supported by MQ2 datasheet + IoT gas safety studies (Kumar & Prasad, IJERT 2021).

8. Software Implementation

- **IDE:** Arduino IDE (C/C++).
- **Libraries:** Blynk, WiFi, LiquidCrystal_I2C.
- **Functions:**
  - Analog read (GasSensor1–3).
  - Threshold checks for each sensor.
  - Control LEDs, buzzer, relay, LCD.
  - Update Blynk Virtual Pins:
    - V0–V2 → sensor readings
    - V3 → sensor status
    - V4 → fan status
    - V5 → green LED
    - V6 → red LED
    - V7 → buzzer
    - V8 → fan ON/OFF
- **Blynk log events:** Trigger notifications + emails when thresholds exceeded.

Arduino IDE Code Snippet

The ESP32 was programmed using Arduino IDE in C/C++. The code initializes Wi-Fi and Blynk, reads sensor data from three MQ2 sensors, and controls LEDs, buzzer, relay, and LCD accordingly.

```
/***** Gas Leakage Monitoring - Core Logic *****/

int GasSensor1 = 39, GasSensor2 = 36, GasSensor3 = 34;
#define GreenLED 15
#define RedLED   2
#define Buzzer   4
#define RelayPin 18

// Thresholds
int th1 = 1400, th2 = 350, th3 = 1600;

void sendSensor() {
  int g1 = analogRead(GasSensor1);
  int g2 = analogRead(GasSensor2);
  int g3 = analogRead(GasSensor3);

  bool leak = (g1 > th1 || g2 > th2 || g3 > th3);

  if(leak) {
    digitalWrite(GreenLED, LOW);
    digitalWrite(RedLED, HIGH);
    digitalWrite(Buzzer, HIGH);
    digitalWrite(RelayPin, LOW);   // Fan ON
    lcd.print("Gas Leak!");
  } else {
    digitalWrite(GreenLED, HIGH);
    digitalWrite(RedLED, LOW);
    digitalWrite(Buzzer, LOW);
    digitalWrite(RelayPin, HIGH);  // Fan OFF
    lcd.print("All Normal");
  }
}
```

9. Results

9.1 Test Case Table

Scenario	S1 (Th=1400)	S2 (Th=350)	S3 (Th=1600)	System Response
Safe (No Leak)	300–500 (below)	200–300 (below)	250–400 (below)	Green LED ON, Fan OFF, "All Normal", no alerts.
Leak near Stove	600–800 (below)	900–1100 (above)	300–450 (below)	Red LED + buzzer ON, Fan ON, LCD Warning, Push + Email alerts.
Leak near Ceiling	1600–1800 (above)	320–340 (below)	400–600 (below)	Red LED + buzzer ON, Fan ON, "Gas Detected (S1)", Alerts sent.
Leak near Vent	1200–1400 (below)	330–340 (below)	1900–2100 (above)	Red LED + buzzer ON, Fan ON, "Gas Detected (S3)", Alerts sent.
Major Leak (All)	1800–2200 (above)	900–1200 (above)	2000–2500 (above)	**Critical Mode**: Multi-sensor alert, Fan ON, Push + Email alerts.

9.2 Screenshots (Insert Figures)

3)

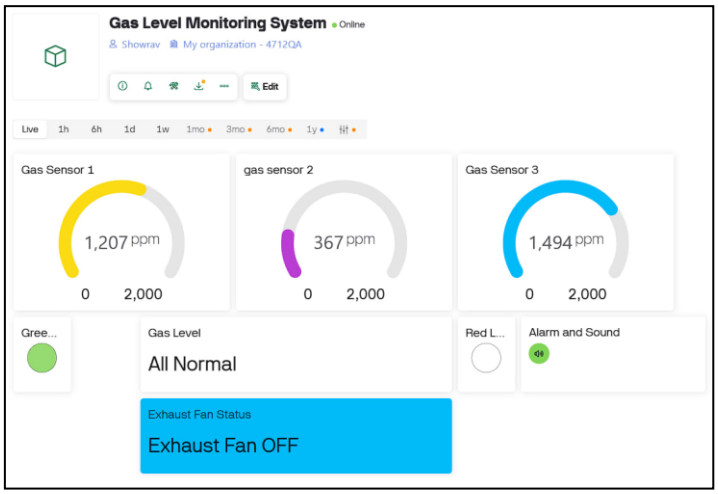


Fig 9.1: Blynk – Safe Condition (all green).

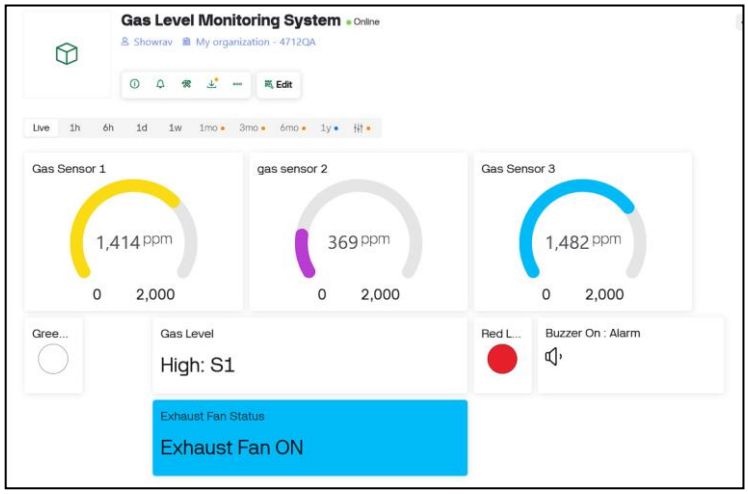


Fig 9.2: Single Sensor Leak detected (S2 alert).

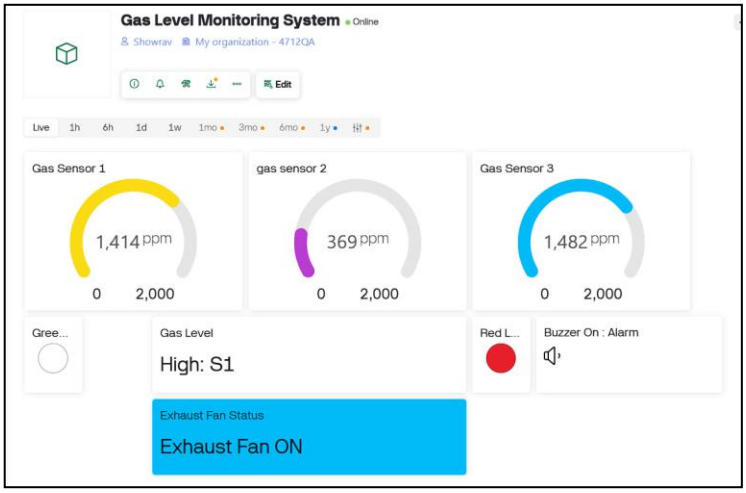


Fig 93: Single Sensor Leak detected (S1 alert).

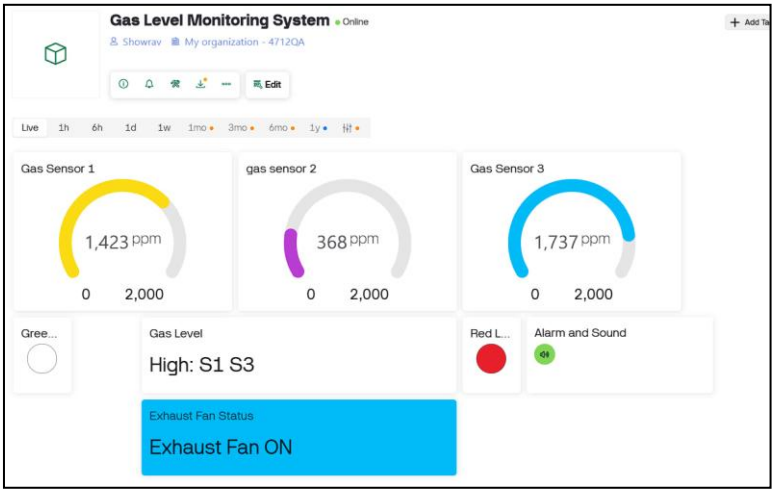


Fig 9.4: Blynk multi-Sensor leak detected(S1,S3)

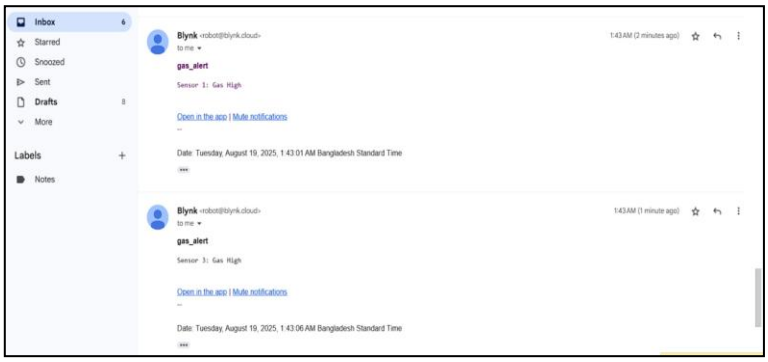


Fig 9.5: Auto Email alert.

Fig 9.6: Push notification on smartphone.

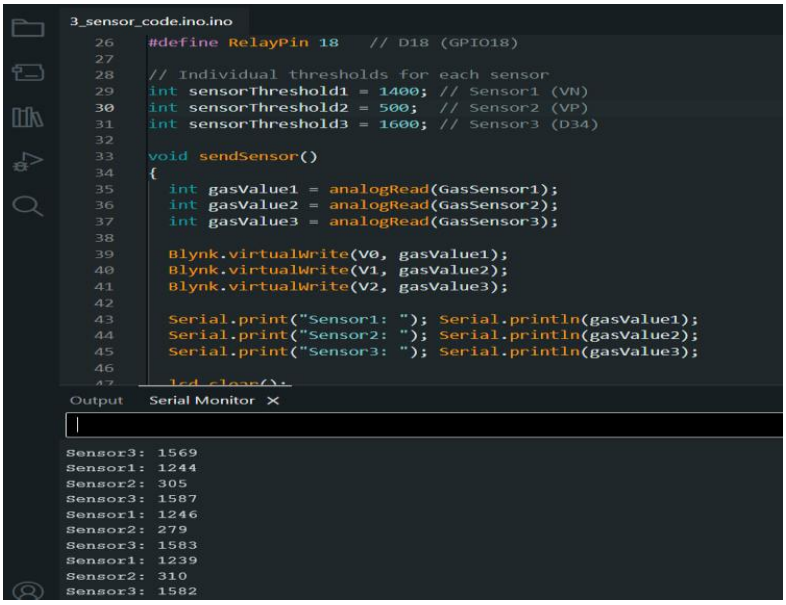


Fig 9.7: Arduino IDE Serial Monitor showing sensor values

9.3 Observations

- **No false alarms** recorded in the extended safe test.
- **Early detection** via Sensor 2 (low threshold near source).
- **Severity confirmation** via Sensor 1 & 3.
- **Fan response** reduced concentration immediately.
- **IoT features** worked with <1s delay for notifications.

10. Applications

- Kitchens (LPG monitoring).
- Laboratories (chemical gases).
- Industrial facilities.
- Parking lots (CO detection).

11. Conclusion

This system successfully integrates **multi-sensor calibration, IoT monitoring, and automatic mitigation** into one safety solution. Using thresholds of **1400, 350, and 1600**, the system:

- Detected **small leaks near the source quickly** (Sensor 2 at stove height, 350 threshold).
- Confirmed **gas accumulation at ceiling level** (Sensor 1, 1400 threshold).
- Escalated response during **severe leaks reaching ventilation points** (Sensor 3, 1600 threshold).
- Provided **local alarms** (LEDs, buzzer, LCD) and **remote alerts** (Blynk push + email).
- Automatically reduced hazard by activating ventilation.

Novelty

1. **Multi-threshold, multi-sensor calibration** for accurate detection.
2. **Dual-alert strategy** (local + IoT).
3. **Active mitigation** with fan control.

Future Scope

- Cloud data storage & analysis.
- AI-based predictive maintenance.
- SMS/voice alerts for non-smartphone users.
- Integration with smart homes & industries.

This demonstrates a **low-cost, scalable, and reliable safety solution** for modern environments.