MAR BASELIOS INSTITUTE OF TECHNOLOGY AND SCIENCE

NELLIMATTOM P.O, KOTHAMANGALAM, KERALA

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRUVANANTHAPURAM

COURSE PROJECT REPORT- MARCH 2025

LPG LEAKAGE DETECTOR

Submitted by

Adarsh K A (MBI23EC001)

Adon Eldho (MBI23EC002)

Albin Eldose (MBI23EC003)

In partial fulfilment for the award of the degree

Of

BACHELOR OF TECHNOLOGY

In

ELECTRONICS AND COMMUNICATION ENGINEERING

MAR BASELIOS INSTITUTE OF TECHNOLOGY AND SCIENCE

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that the course project report on **LPG LEAKAGE DETECTOR** is a bonafide record of the project presented by **Adarsh K A (MBI23EC001), Adon Eldho** (**MBI23EC002**)**, Albin Eldose (MBI23EC003)** in partial fulfilment for the award of the degree of **Bachelor of Technology in Electronics and Communication Engineering of APJ Abdul Kalam Technological University**, Thiruvananthapuram during the academic year 2024-2025

Project Coordinator	**Project Guide**	**Head of the Department**
Prof.Teena Abraham	***Dr. Sajin. C.S***	***Prof. Johny Joseph***
Assistant Professor	***Associate Professor***	***Professor***
Department of ECE	***Department of ECE***	***Department of ECE***

ACKNOWLEDGEMENT

First and the foremost, we thank **ALMIGHTY GOD** who gave as the inner strength, resource and ability to complete my work successfully, without which all my efforts would have been in vain.

We express our sincere gratitude to the **Dr. Thomas George,** Principal for providing as the research facilities and the circumstances to complete the course project in a grant successful manner.

We express our deep sense of gratitude to **Prof. Johny Joseph**, Professor & Head, Department of ECE for his insightful comments, encouragements, and critical inquiries, which inspired as to widen our project from various perspectives. We would like to extend our gratitude to our course project coordinator **Prof. Teena Abraham,** Assistant Professor, ECE Department for the creative suggestions, valuable advice, mental support and guidance as project coordinator.

Words are insufficient to express our heartfelt and sincere gratitude to our guide who have suggested a relevant and interesting project topic and paved the way to the successful completion of this project. With great respect and gratitude, we acknowledge our guide **Dr. Sajin C.S,** Associate Professor, ECE Department for his invaluable guidance, great inspiration, and strong moral support throughout our research work. We are indebted to him for the valuable time he has spared for as during this work.

We use this opportunity to thank all faculties in the department and the friends who have helped as to complete the course project, with their inspiration and co-operation.

Name of Students:

Adarsh K.A

Adon Eldho

Albin Eldose

ABSTRACT

The LPG Leakage Detector with Call Alert is a safety system designed to detect and respond to gas leaks in residential, commercial, and industrial settings. It integrates an Arduino microcontroller, an MQ-series gas sensor, and a GSM module to continuously monitor LPG concentration in the air. When the gas level exceeds a predefined threshold, the system immediately triggers an alert by making a phone call to a pre-configured number, ensuring prompt notification. Additionally, it can activate a buzzer or other warning mechanisms for local alerts, providing a multi-layered safety approach. This cost-effective and reliable solution enhances safety by delivering real-time hazard detection, regardless of the user's location. Its modular and scalable design allows for easy implementation and future upgrades, such as SMS alerts, IoT connectivity, or mobile app integration, making it a versatile choice for LPG-dependent environments.

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LIST OF ABBREVIATIONS

LPG – Liquefied Petroleum Gas

MQ – Metal Oxide Semiconductor (Gas Sensor Series)

GSM – Global System for Mobile Communications

SMS – Short Message Service

UART – Universal Asynchronous Receiver-Transmitter

AT Commands – Attention Commands (Used for GSM Communication)

1.INTRODUCTION

1.1 Background

Gas leakage poses a significant risk to both life and property, leading to potential fires, explosions, and health hazards due to the inhalation of toxic gases. With the widespread use of liquefied petroleum gas (LPG), methane, and other flammable gases in residential, industrial, and commercial settings, undetected leaks can result in catastrophic consequences. Traditional gas leak detection methods, such as manual inspection or odor detection, are often unreliable and may not provide timely warnings, especially in unoccupied areas. This underscores the need for an automated gas leakage detection and alert system that can swiftly identify leaks and notify users before accidents occur.

To address this issue, this project presents a Gas Leakage Detection System utilizing an MQ-series gas sensor, an Arduino microcontroller, and a SIM800L GSM module. The system continuously monitors gas concentration levels in the air and automatically activates safety measures when a leak is detected. Unlike conventional detectors that rely solely on audible alarms, this system integrates remote notification capabilities by sending SMS alerts and making emergency calls to users, ensuring that they can respond promptly even if they are away from the premises.

1.2 Objectives

The primary objectives of this project are:

- To design and implement a gas leakage detection system using an MQ-series gas sensor, Arduino, and a SIM800L GSM module.
- To automate the detection process by continuously monitoring gas concentration levels and activating safety mechanisms when a leak is detected.
- To integrate an alert system that sends SMS notifications and makes emergency calls to ensure timely user response.
- To enhance safety measures by triggering a buzzer alarm, cutting off the gas supply using a motorized valve, and shutting down the power to prevent further leakage and ignition risks.
- To analyse system performance and evaluate its effectiveness in real-world applications.

By achieving these objectives, the project aims to provide an efficient, automated, and real-time gas leakage detection and prevention system, improving safety in residential, industrial, and commercial environments.

1.3 Research Questions

This project seeks to address the following research questions:

- How can an automated gas leakage detection system improve safety in residential and industrial environments?
- What are the advantages of using an MQ-series gas sensor for real-time gas concentration monitoring?
- How can the SIM800L GSM module be effectively integrated to provide remote alerts via SMS and phone calls?
- What are the challenges in designing and implementing a gas cutoff mechanism using a motorized valve, and how can they be addressed?
- How does the proposed system compare to traditional gas leakage detection methods in terms of efficiency and reliability?

2. LITERATURE REVIEW

2.1 Previous Studies

The concept of gas leakage detection has been widely explored in safety and automation research. Early studies focused on basic gas sensors and their ability to detect hazardous gases in industrial and residential environments. Traditional gas detection systems relied on standalone alarms without remote alert capabilities, limiting their effectiveness in unattended areas.

Recent research emphasizes the integration of microcontrollers and wireless communication technologies to enhance gas leakage detection systems. Studies have demonstrated the effectiveness of using MQ-series gas sensors for real-time gas concentration monitoring due to their high sensitivity and cost efficiency. Additionally, the use of GSM modules such as SIM800L has been explored to enable remote alerts via SMS and phone calls, improving response time during emergencies.

Several projects have also investigated automated gas shut-off mechanisms using motorized valves. These studies highlight the importance of cutting off the gas supply immediately after detecting a leak to prevent fire hazards. Different control strategies, including relay-based switching and IoT-enabled gas control systems, have been proposed to enhance safety measures.

By integrating these advancements, this project aims to develop a comprehensive gas leakage detection and prevention system that improves upon traditional methods by incorporating real-time monitoring, remote alerts, and an automated gas shut-off mechanism.

2.2 Theoretical Framework

Gas sensors, such as the MQ-series, detect gases like LPG and methane by changing electrical resistance, producing an analog voltage output proportional to gas concentration. The Arduino microcontroller reads this data and determines if the gas level exceeds a predefined threshold. If a leak is detected, the system activates safety measures, including a buzzer alarm, power shutdown, and gas supply cutoff using a motorized valve.

To enhance safety, the SIM800L GSM module enables SMS alerts and emergency calls, ensuring remote notifications. The system utilizes serial communication (UART) and AT commands to interact with the GSM module. By integrating these technologies, the project provides a real-time, automated, and remotely accessible gas leakage detection system for improved safety in residential and industrial environments.

3. METHODOLOGY

3.1 Block Diagram

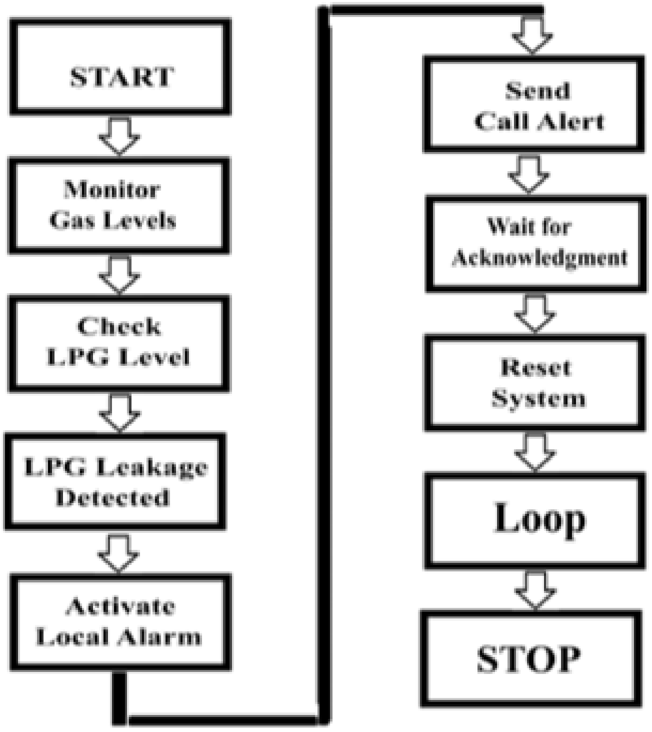

Fig. 3.1 Block Diagram of LPG leakage detector

3.2 System Design Overview

The system consists of the following key components:

- Gas Sensor (MQ-series): Continuously monitors gas concentration and provides an analog voltage output based on the gas level.
- Microcontroller (Arduino): Reads sensor data, compares it to a predefined threshold, and makes real-time decisions on whether to trigger safety mechanisms.
- Motorized Valve (Gas Cutoff): Automatically shuts off the gas supply if a leak is detected, preventing further leakage and reducing fire hazards.
- Buzzer Alarm: Provides an immediate audible alert to warn nearby individuals of the detected gas leak.
- Power Control (Relay): Turns off power to prevent ignition risks when gas levels exceed the safe limit.
- GSM Module (SIM800L): Sends SMS alerts and makes emergency calls to a predefined phone number, notifying users remotely of the leak.

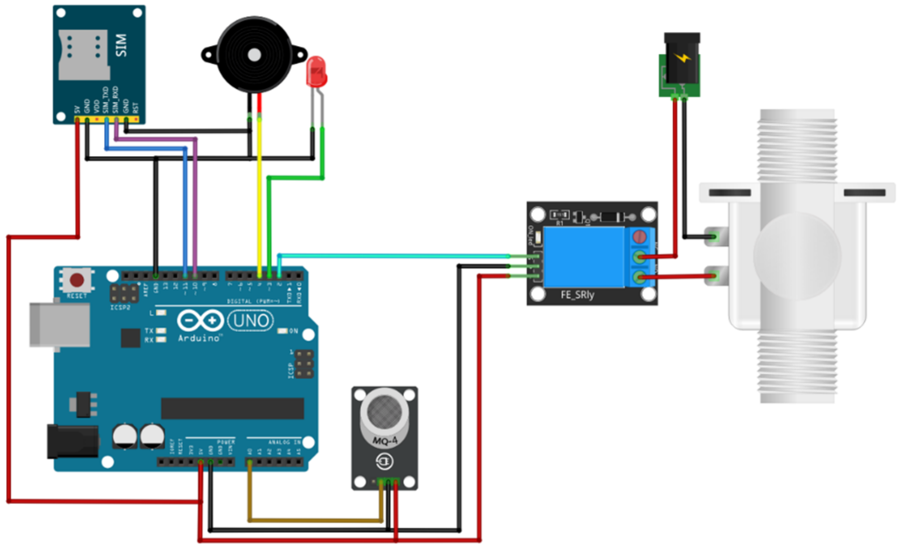

Fig. 3.2 Circuit Diagram of LPG leakage detector

3.3 Algorithm

Step 1: Initialize serial communication and SIM800L GSM module.

Step 2: Set pin modes for gas sensor (input), motor, power control, and buzzer (outputs).

Step 3: Enter an infinite loop:

1. Read gas sensor value.
2. If gas leak detected (value ≥ 300):
   - Activate motor and buzzer.
   - Shut down power.
   - Send SMS alert.
   - Make an emergency call.
3. Else (Normal condition):
   - Deactivate motor and buzzer.
   - Restore power.

Step 4: Repeat continuously.

3.4 Arduino Implementation

The Arduino code for the Gas Leakage Detection and Alert System is structured to encapsulate the sensor reading, alert mechanism, and communication functionalities within the program. Below is the Arduino code:

```
#include <SoftwareSerial.h>

SoftwareSerial sim800l(10, 11); // RX, TX for GSM module

int Input = A0;  // Gas sensor input

int Motor = 2;   // Motorized valve for gas cutoff

int TOT_PWR = 3; // Power shutdown control

int Buzzer = 4;  // Alarm buzzer

int val;

int MAX = 300; // Gas leakage threshold

String phoneNumber = "+1234567890"; // Replace with actual phone
number

void setup()

{

  Serial.begin(9600);

  sim800l.begin(9600); // Initialize GSM module

  pinMode(Input, INPUT);

  pinMode(Motor, OUTPUT);

  pinMode(TOT_PWR, OUTPUT);

  pinMode(Buzzer, OUTPUT);

  Serial.println("GSM Module Initialized...");

}

void loop()

{

  val = analogRead(Input);

  Serial.print("Sensor Value: ");

  Serial.println(val);

  delay(500);
```

```
  if (val >= MAX)
   {
      Serial.println("GAS LEAK DETECTED!");
      digitalWrite(Motor, HIGH);   // Cut off gas supply
      digitalWrite(TOT_PWR, LOW);  // Shut down power
      alertUser();                 // Send SMS and call alert
      buzzAlarm();                 // Activate buzzer alarm
  }
else
  {
    digitalWrite(Motor, LOW);
    digitalWrite(Buzzer, LOW);
    digitalWrite(TOT_PWR, HIGH);
    Serial.println("NORMAL CONDITION");
  }
}
void alertUser() {
  sendSMS();
  makeCall();
}
void sendSMS()
{
  Serial.println("Sending SMS...");
  sim800l.println("AT+CMGF=1"); // Set SMS mode to text
  delay(1000);
  sim800l.print("AT+CMGS=\"");
  sim800l.print(phoneNumber);
  sim800l.println("\"");
  delay(1000);
  sim800l.println("WARNING: GAS LEAK DETECTED! Take immediate
action.");
```

```
  delay(1000);
  sim800l.write(26); // End of SMS (CTRL+Z)
  delay(5000);
  Serial.println("SMS Sent.");
}
void makeCall()
{
  Serial.println("Making Call...");
     sim800l.print("ATD");
     sim800l.print(phoneNumber);
     sim800l.println(";");
     delay(15000); // Call duration (15 seconds)
     sim800l.println("ATH"); // Hang up call
     Serial.println("Call Ended.");
  }
void buzzAlarm()
{
  for (int i = 0; i < 5; i++) // Buzzer beeps 5 times
  {
    digitalWrite(Buzzer, HIGH);
    delay(500);
    digitalWrite(Buzzer, LOW);
    delay(500);
  }
}
```

4. RESULTS AND DISCUSSION

4.1 System Testing and Results

The Gas Leakage Detection and Alert System was tested under various conditions to evaluate its response time, accuracy, and reliability. The tests involved exposing the gas sensor to different concentrations of LPG and monitoring its output in real-time. The Arduino serial monitor was used to display sensor readings, while the buzzer, motorized valve, and GSM module were observed for correct activation upon reaching the predefined threshold.

The results confirmed that the system accurately detected gas leaks and triggered the appropriate safety measures. The buzzer alarm and gas cutoff mechanism responded immediately, and the SIM800L GSM module successfully sent SMS alerts and made emergency calls. Additionally, the system returned to normal operation once the gas concentration fell below the threshold, demonstrating effective automation.

However, minor delays in SMS and call alerts were observed due to network fluctuations, highlighting the need for potential alternative communication methods in future improvements.

Fig. 4.1 Working of LPG leakage detector

4.2 Discussion of Results

The successful detection of gas leaks and the automated activation of safety measures demonstrate the effectiveness of the designed system. The results confirm that the gas sensor accurately detects hazardous gas concentrations, and the microcontroller responds immediately by activating the alarm, shutting off the gas supply, and sending remote alerts. The use of Arduino and the SIM800L GSM module allowed for seamless integration of hardware and communication functionalities, ensuring timely notifications.

However, challenges were encountered during testing, particularly with sensor calibration and network delays in GSM communication. The system's response time depended on signal strength and network availability, which may cause slight delays in sending SMS alerts or making calls. Future improvements could involve adding a backup communication module (Wi-Fi or LoRa) for redundancy, enhancing sensor accuracy, and optimizing power consumption for better efficiency in real-world applications.

5. CONCLUSIONS AND FUTURE RESEARCH

5.1 Conclusion

In conclusion, the Gas Leakage Detection and Alert System successfully demonstrates an automated safety mechanism using gas sensors, Arduino, and GSM communication. The system effectively detects hazardous gas concentrations, triggers safety measures such as a buzzer alarm and gas cutoff, and sends real-time alerts via SMS and phone calls. The implementation of embedded systems and wireless communication ensures reliability in both residential and industrial applications.

This project highlights the importance of automation in safety systems, particularly in preventing accidents due to gas leaks. The integration of sensor technology, microcontroller programming, and GSM communication provides a strong foundation for future advancements in remote monitoring and safety automation.

5.2 Scope of Future Research

Future research may explore improvements to the system, including:

- Sensor Calibration & Accuracy: Enhancing gas detection accuracy by integrating multiple gas sensors to detect a wider range of hazardous gases.
- Alternative Communication Methods: Implementing Wi-Fi, LoRa, or IoT-based connectivity for improved reliability and faster alert transmission.
- Smart Integration: Developing a mobile application for real-time monitoring and remote control of the system.
- Energy Efficiency: Optimizing the system for low-power operation to enhance deployment in battery-powered environments.

These advancements could further improve the efficiency, reliability, and scalability of gas detection systems, making them more adaptable to diverse safety applications.

6. REFERENCES

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