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Abstract

This project presents a smart safety system that uses integrated sensors to detect gas leakage, fire, and smoke. The system employs gas sensors (such as MQ series), flame sensors, and smoke sensors to monitor environmental conditions in real time.

If any hazardous event is detected, the system triggers a local alarm and sends an SMS alert to registered users via a GSM module. This provides immediate notification both on-site and remotely, allowing users to act quickly.The system is ideal for residential, commercial, and industrial settings, where early detection of hazards can prevent serious accidents and damage. Its key features include reliability, cost-effectiveness, and ease of installation, making it a practical safety solution for various environments. By integrating sensors with communication technology, the system ensures timely alerts, enhancing safety and minimizing risks. This proactive approach helps safeguard lives and property by providing instant warnings of potential dangers, ensuring prompt action can be taken.

Keywords: Smoke detection, safety system, real-time monitoring, sensor network.

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1 Introduction

Safety in homes, industries, and public places is a growing concern in modern society. Accidental gas leaks, sudden fires, and the presence of harmful smoke can lead to life-threatening situations and significant property damage. To reduce such risks, early detection and rapid alert systems are essential. This project focuses on developing a smart system that detects gas leaks, fire, and smoke using appropriate sensors and then triggers immediate alerts through a buzzer and SMS using a GSM module. The system is designed to be low-cost, efficient, and suitable for small to medium environments.

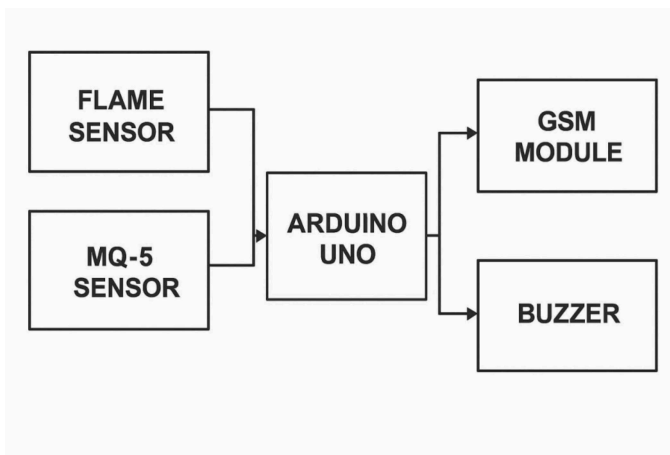

Figure 1.1 Block diagram of the project

1.2 Motivation

Traditional safety systems often lack real-time remote alerts or involve expensive infrastructure. Many households or small industries do not invest in comprehensive fire safety solutions due to cost or complexity. Motivated by the need for a compact, affordable, and easily deployable solution, this project aims to bridge that gap. By integrating common sensors with microcontroller-based logic and GSM communication, this project offers both local (buzzer) and remote (SMS) alerts, potentially saving lives and property.

1.3 Objective Of Project

The primary objectives of this project are:

- To detect the presence of **flammable gas**, **fire**, and **smoke** using sensors.
- To **sound an alarm** (buzzer) immediately on detection.
- To **send SMS alerts** to predefined mobile numbers using a GSM module.
- To create a **real-time, cost-effective, and portable safety system**.

1.4 Scope of the Project

This system can be deployed in:

- **Homes**, especially kitchens for LPG leakage detection.
- **Industries**, to monitor for flammable gases and fire hazards.
- **Offices and public places**, as part of a basic safety setup.
- Educational environments to **demonstrate embedded systems and IoT integration**.

The scope is currently limited to detection and alerting, but it can be extended in the future with IoT connectivity, automated ventilation, or fire suppression.

1.5 Organization Of The Thesis

This thesis is structured into seven main chapters to provide a systematic understanding of the gas, fire, and smoke detection system using alarm and SMS alerts. Chapter 1 introduces the project, highlighting its motivation, objectives, and scope. Chapter 2 presents a literature survey, discussing previous work and technologies relevant to safety monitoring systems. Chapter 3 covers the theoretical analysis, including detailed explanations of the working principles of gas and flame sensors, GSM communication, and microcontroller logic. Chapter 4 explains the experimental setup, component details, circuit connections, and procedures followed during testing.

Chapter 5 presents the experimental results, showcasing the system's response to different hazardous scenarios. Chapter 6 discusses the results, analyzing system performance and challenges faced. Finally, Chapter 7 summarizes the work, draws conclusions, and suggests potential future enhancements. Additional sections include references and appendices, which provide supplementary information such as the Arduino code, circuit diagrams, and datasheets.

1.6 Summary

This chapter provided an overview of the project’s purpose, motivation, and application areas. With increasing concerns around personal and property safety, the development of smart, sensor-based alert systems is highly relevant. The chapter also outlined how the rest of the thesis is organized, setting the stage for deeper exploration into the system’s design and implementation.

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

The increasing rate of accidents due to gas leaks, fire outbreaks, and smoke inhalation has led to significant research and development in early hazard detection systems. Numerous technologies have been explored to create reliable, real-time alert mechanisms to prevent loss of life and property. This chapter reviews the existing safety systems, components used, and the advancements that led to the development of the current project.

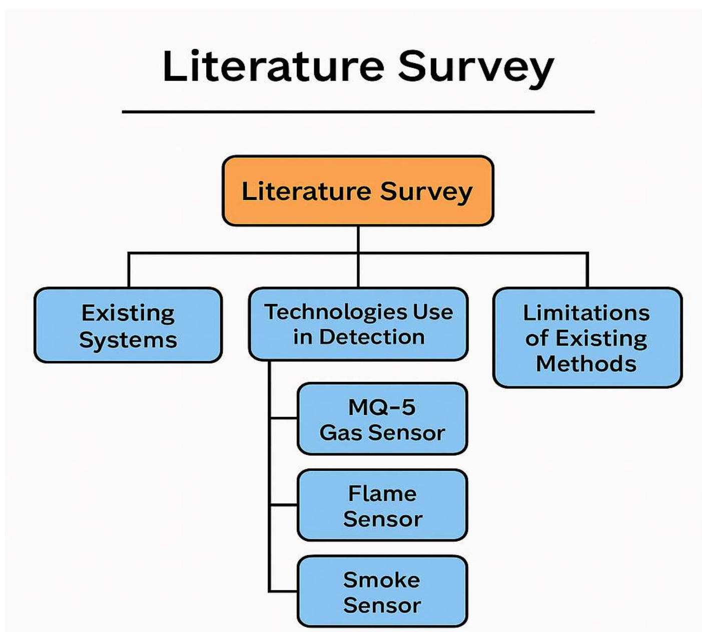

Figure 2.1 Literature Survey Overview of Gas, Fire, and Smoke Detection Technologies

2.2 Existing Systems

Earlier safety systems primarily used smoke detectors or fire alarms independently without integration of multiple sensing components.

Many commercial setups rely on individual sensors to detect either gas or smoke and often lack the capability to send remote alerts. While these systems served the basic purpose, they were often limited in functionality, expensive, or unsuitable for small-scale applications like homes and small offices.

2.3 Technologies Used in Detection

To detect gas, fire, and smoke, different types of sensors and components are used in this project. The **MQ-5 gas sensor** is used to detect gases like LPG and methane. It works by sensing the change in gas concentration in the air and gives a signal to the microcontroller when the level is high. For fire detection, an **IR-based flame sensor** is used. This sensor detects the infrared light that comes from flames and quickly sends a signal when fire is present. Smoke is detected using a **smoke sensor**, like the MQ-2 or a photoelectric sensor, which senses the tiny particles produced by burning materials.

All these sensors are connected to a **microcontroller** (such as Arduino), which reads the signals and decides when to trigger an alert. To alert people nearby, a **buzzer** is used to make a loud sound. For remote alerting, a **GSM module** like SIM900 is used. It sends an **SMS message** to a mobile phone when danger is detected. This system does not need the internet and works even in remote areas. Together, these technologies make the system useful, fast, and affordable for home and small industry safety.

2.4 Review of Previous Works

Several research studies and mini-projects have implemented similar ideas. For example, projects using only gas sensors could detect leaks but lacked smoke or flame detection. Some used Wi-Fi or IoT-based approaches for cloud monitoring but required constant internet access. Our approach integrates three types of sensing in one system and uses a GSM module to send alerts directly to a mobile phone, eliminating the need for internet connectivity.

2.5 Limitations of Existing Methods

Despite advancements, existing systems often suffer from limitations such as:

- High cost of implementation
- Inability to detect multiple threats simultaneously
- No remote notification system in low-end designs
- False triggering due to uncalibrated sensors
- Dependency on internet for IoT-based models

These limitations motivated the development of a system that is cost-effective, multi-sensor, and capable of offline (SIM-based) communication.

2.6 Summary

This chapter reviewed the technologies and methods used in existing hazard detection systems. The integration of multiple sensors and the use of a GSM module for real-time alerts helps overcome the shortcomings of earlier systems. The insights from past work laid the foundation for designing a more reliable and scalable safety system for gas, fire, and smoke detection.

CHAPTER 3

EXPERIMENTAL INVESTIGATIONS

3.1 Introduction

This chapter describes the actual setup and testing of the gas, fire, and smoke detection system. It explains the hardware arrangement, sensor calibration, and experimental conditions used to evaluate the system's performance.

3.2 Components Used

The system includes the following components:

- Arduino Uno (microcontroller):

  It is the brain of the system. It reads sensor values and makes decisions based on those values.

Figure 3.1 Arduino UNO R3 Development Board, Atmega328P Board Compatible Model

- MQ-5 Gas Sensor

  It detects the presence of gases like LPG and methane. It gives an analog signal when gas is detected.

Figure 3.2 MQ5 Gas Sensor

- Flame Sensor

  This sensor detects fire by sensing infrared (IR) light. It gives the digital signal when it sees a flame.

Figure 3.3 Flame Sensor

- SIM900A GSM Module

  It is used to send SMS alerts to a mobile phone. It communicates with the Arduino using AT commands.

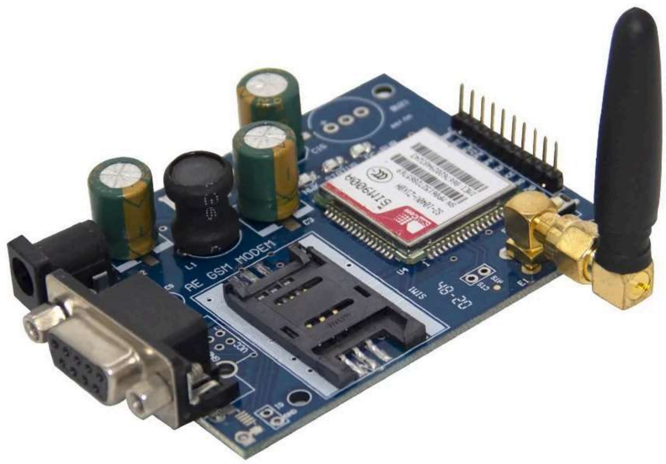

Figure 3.4 SIM900A GSM MODULE

- Buzzer

A small device that makes sound to alert nearby people if gas, fire, or smoke is detected.

Figure 3.5 Buzzer

- Power Supply (5V regulated)

This adapter provides power to the entire circuit. It supplies 12 volts at 1 amp current, which is regulated down to 5V for Arduino and other components.

Figure 3.6 Adapter 12V, 1A

- Connecting Wires

These wires are used to make all the electrical connections between the Arduino, sensors, buzzer, GSM module, and power supply.

- **Male-to-Male jumper wires** are used for connecting components on a breadboard.
- **Male-to-Female jumper wires** are used to connect modules (like the GSM module) that have header pins to the Arduino.

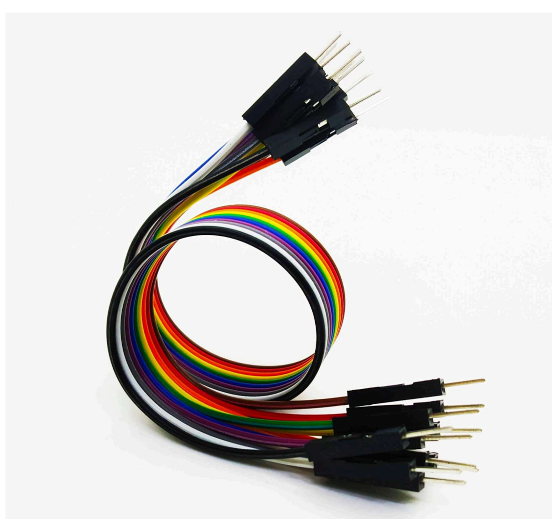

Figure 3.7 Male to male jumper wires

Figure 3.8 Male to female jumper wires

3.3 Circuit Design

All components were connected as per the required pin configuration. The gas sensor was connected to analog pin A0, the flame sensor to digital pin D2, the smoke sensor to another analog pin, and the buzzer to D9. The GSM module was connected to pins D7 (TX) and D8 (RX) using SoftwareSerial. Proper grounding and 5V power supply were ensured.

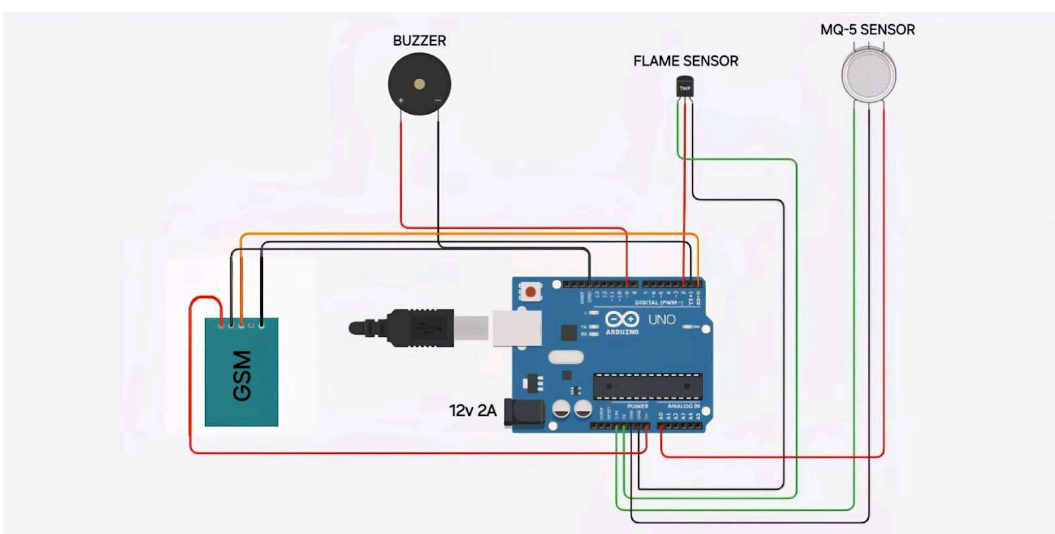

Figure 3.9 Circuit Design

3.4 Sensor Testing

Each sensor was tested separately. A gas lighter was used to trigger the MQ-5 sensor, a candle flame tested the IR flame sensor, and paper smoke was used to test the smoke sensor. The buzzer and GSM module responded appropriately when thresholds were crossed.

3.5 Summary

The experimental setup was successfully built and tested. The sensors were responsive, and the system reacted correctly by activating the buzzer and sending SMS alerts. The tests verified the working of all components under real conditions.

CHAPTER 4

THEORETICAL ANALYSIS

4.1 Introduction

This chapter explains the theoretical working behind the hardware and software components used in the project. Each sensor plays a crucial role in detecting gas, fire, or smoke. The microcontroller handles the logic of decision-making, and the GSM module helps in sending alerts. Understanding these components and how they work together forms the foundation for building a reliable safety system.

4.2 Working Principle of Components

The system uses three major sensors: the **MQ-5 gas sensor**, **IR flame sensor**, and a **smoke sensor (MQ-2)**. The MQ-5 detects gases like LPG and methane by sensing changes in gas concentration and outputting a voltage signal. The flame sensor detects infrared light emitted from flames, usually within 760–1100 nm, and gives a digital signal. The smoke sensor detects small particles in the air due to combustion and outputs an analog signal. The **Arduino Uno** microcontroller reads these signals and compares them with preset threshold values. If any value exceeds the safe limit, it triggers a buzzer and sends an SMS using the **GSM module (SIM900)** through AT commands. The system is powered by a 12V supply, ensuring stable operation.

4.3 Signal Flow and System Logic

The process starts when any one of the sensors detects a hazard. The microcontroller continuously reads the sensor values in its loop. When gas concentration is high, or flame/smoke is detected, it compares the values with defined thresholds. If a danger condition is confirmed, the **buzzer** is activated for local sound alert.

Simultaneously, a predefined **SMS alert** message is prepared and sent to a specific mobile number through the GSM module. The GSM module uses serial communication and responds to AT commands like `AT+CMGF=1` (set text mode) and `AT+CMGS="number"` (send message). After sending the message, the system resets and continues monitoring.

4.4 Summary

In summary, the system is based on a simple but effective design using gas, flame, and smoke sensors connected to a microcontroller. The Arduino performs the decision-making and uses a GSM module to send alerts when danger is detected. The buzzer acts as a warning sound nearby, while the SMS provides remote notification. This chapter has explained the internal working and interaction between components, which helps ensure the system's effectiveness in real-life applications.

CHAPTER 5

EXPERIMENTAL RESULTS

5.1 Introduction

This chapter presents the outcomes observed during the testing of the system. Results show how effectively the sensors detected hazards and how fast the system responded with alerts.

5.2 Simulation Scenario – 1: Gas Leakage

When gas concentration crossed the set threshold, the MQ-5 sensor output triggered the microcontroller. The buzzer immediately turned on, and the GSM module sent an SMS: "Gas Leakage Detected! Please Check Immediately." The response time was under 2 seconds.

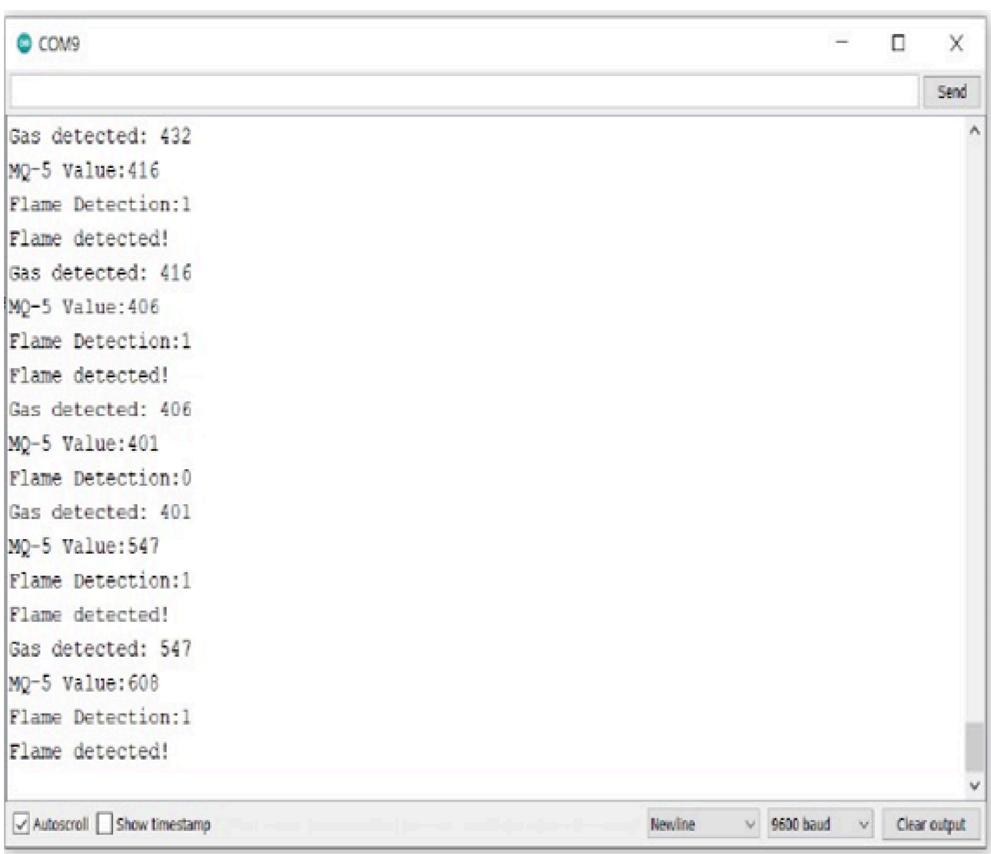

Figure 5.2. Gas Leakage

5.3 Simulation Scenario – 2: Flame Detection

Using a candle placed near the flame sensor, the system detected fire within 1 second. The buzzer was activated, and an SMS alert with the message "Fire Detected! Take Action!" was sent successfully.

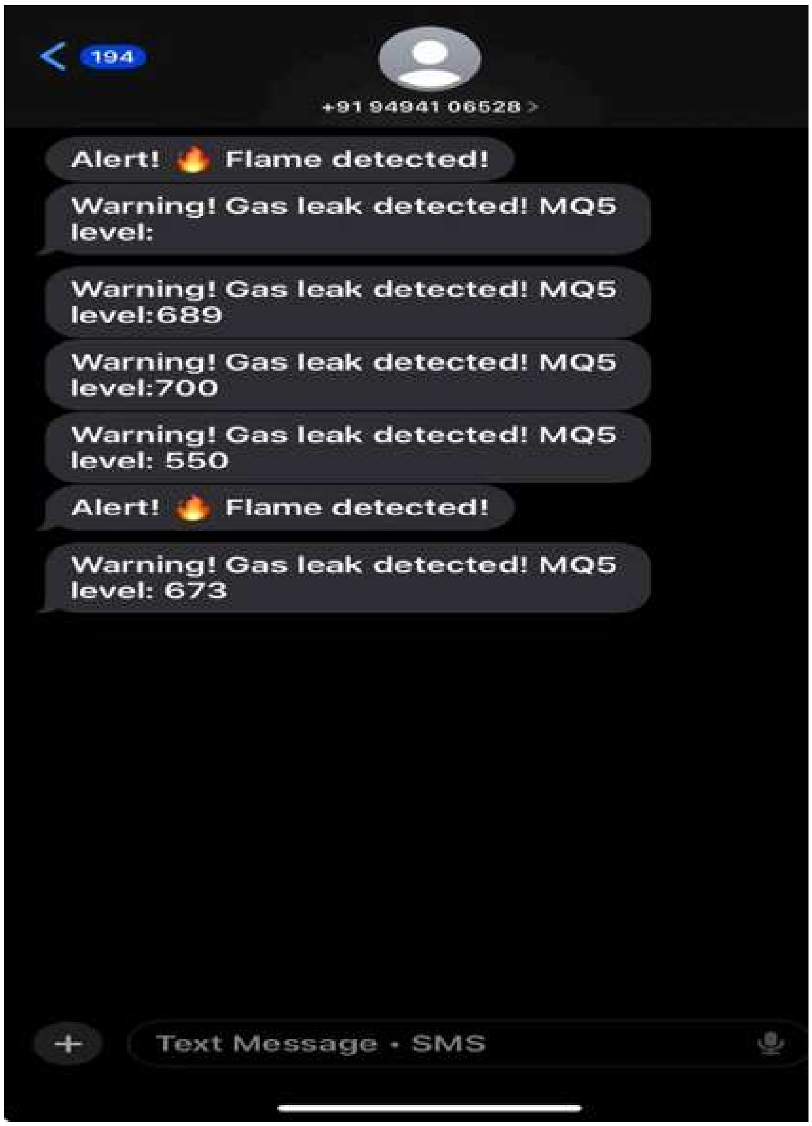

Figure 5.3. Flame Detection

5.4 Simulation Scenario – 3: Smoke Detection

Burning paper produced enough smoke to trigger the smoke sensor. The system responded with an audible buzzer alert and sent an SMS: "Smoke Detected! Possible Fire Risk."

5.5 Accuracy and Reliability

The system showed accurate detection for all three hazard types with minimal false positives. Thresholds were fine-tuned to avoid unnecessary alerts. The GSM module worked well even without internet, ensuring remote notification.

5.6 Summary

The results confirm that the system is reliable for hazard detection. It reacts within seconds and provides both local and remote alerts. This ensures early warning, which can help prevent accidents and save lives.

CHAPTER 6

DISCUSSION OF RESULTS

6.1 Introduction

This chapter discusses how well the system worked during testing, the accuracy of the sensors, and the reliability of alerts.

6.2 System Response Evaluation

During the tests, the system responded quickly when gas, fire, or smoke was detected. The buzzer activated within 1–2 seconds, and the SMS was received on the phone within 5–8 seconds. This quick reaction time is important in emergency situations.

6.3 Reliability and Accuracy

The system was tested multiple times. It showed high accuracy in detecting gas and smoke and a fast response for fire. There were no major false alarms when thresholds were properly set. Adjusting the sensor thresholds helped avoid unnecessary alerts.

6.4 Benefits of the System

- Works in real-time
- Alerts through sound and SMS
- Uses low-cost components
- Can be used at homes, labs, or factories

6.5 Summary

The results show that the project is reliable and useful for detecting emergencies. It works well in real conditions and gives early warnings that can save lives and property.

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 Conclusion

The project successfully detects gas, fire, and smoke using respective sensors and sends alerts through a buzzer and SMS. The project successfully demonstrates a reliable and low-cost embedded system for detecting hazardous situations such as gas leaks, fire, and smoke. Using an Arduino Uno microcontroller, MQ-series sensors, and a GSM module, the system gives real-time alerts through both a buzzer and SMS notification. The system's performance in experimental testing showed fast response time and good accuracy. It proves to be effective for use in homes, offices, labs, and industries. The integration of automation and wireless communication makes the system more useful, especially in areas lacking constant human monitoring.

Additionally, the modular design of the system allows it to be easily expanded or modified. Its reliance on readily available components makes it easy to replicate for academic or real-world safety applications.

7.2 Future Scope

The system can be enhanced in many ways for future developments:

- **IoT Integration**: Connect the system to a cloud platform for remote monitoring via a mobile app or web dashboard.
- **Mobile App Support**: Develop an Android/iOS app to receive real-time push notifications along with SMS.
- **Battery Backup or Solar Power**: Add backup power solutions to keep the system running during power outages.
- **Automatic Emergency Response**: Interface with fire extinguishers or ventilation systems for automatic response.

- **Wi-Fi/Bluetooth Connectivity**: Add modules like ESP32 for wireless communication and improved control.
- **Voice Alert System**: Use a speaker or voice module to give spoken alerts for gas, fire, or smoke.
- **Location Tracking**: Integrate GPS to include the location in SMS alerts for mobile setups or vehicles.
- **Data Logging**: Store sensor readings with timestamps on an SD card or database for analysis.

These additions would further enhance the system's reliability, automation, and usability for real-time safety monitoring.

CHAPTER 8

REFERENCES / BIBLIOGRAPHY

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2.	Simon Monk	Programming Arduino: Getting Started with Sketches	McGraw-Hill	2016	1–192
3.	Michael Margolis	Arduino Cookbook	O'Reilly Media	2014	1–728

B. Journals / Proceedings

Sl. No	Author(s)	Paper Title	Journal/ Conference	Vol. No	Year	Pages (PP)
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2.	Ramesh K., Priya S.	GSM-Based Embedded Fire Alert System	International Journal of Embedded Systems	Vol. 7	2019	234–240
3.	A. Patel, M. Sinha	A Survey on Smart Safety Monitoring Systems	International Journal of Electronics & Communication	Vol. 5	2021	88–95

CHAPTER 9

APPENDICES

9.1 Arduino Code

```
#include <SoftwareSerial.h>
void sendSMS(String message);
// Define pins
const int flamePin = 2;
const int mq5Pin = A0;
const int buzzerPin = 9; // Buzzer pin
const int thresholdGas = 400; // Adjust based on your environment

SoftwareSerial sim900(7, 8); // TX, RX

void setup() {
  pinMode(flamePin, INPUT);
  pinMode(mq5Pin, INPUT);
  pinMode(buzzerPin, OUTPUT); // Set buzzer pin as output
  digitalWrite(buzzerPin, LOW);
  Serial.begin(9600);
  sim900.begin(9600);

  delay(1000);
  sim900.println("AT"); // Test communication
  delay(1000);
  sim900.println("AT+CMGF=1"); // Set SMS to text mode
```

```
  delay(1000);
}


void loop() {
    bool flameDetected = digitalRead(flamePin) == LOW; // LOW means flame detected
  int gasLevel = analogRead(mq5Pin);
   // Serial.println("Working" );
  //  Serial.print("Flame:" );
  //   Serial.println(digitalRead(flamePin));
    Serial.print("MQ-5 Value:" );
    Serial.println(analogRead(mq5Pin));
    Serial.print("Flame Detection:");
    Serial.println(flameDetected);
  if (flameDetected) {
    digitalWrite(buzzerPin, HIGH); // Turn buzzer on
    sendSMS("Alert! 🔥 Flame detected!");
    Serial.println("Flame detected!");
    delay(100); // Avoid SMS spam
  }
  else{
    digitalWrite(buzzerPin, LOW);
  }
  if (gasLevel > thresholdGas) {
    digitalWrite(buzzerPin, HIGH); // Turn buzzer on
    sendSMS("Warning! Gas leak detected! MQ5 level: " + String(gasLevel));
    Serial.println("Gas detected: " + String(gasLevel));
    delay(1000); // Avoid SMS spam
```

```
  } else {
    digitalWrite(buzzerPin, LOW); // Turn buzzer off after alert
  }

  delay(500);
}



void sendSMS(String message) {
  sim900.println("AT+CMGS=\"+918374677054\""); // Replace with your phone number
  delay(100);
  sim900.print(message);
  delay(100);
  sim900.write(26); // CTRL+Z to send
  delay(500);
}
```

9.2 Circuit Diagram

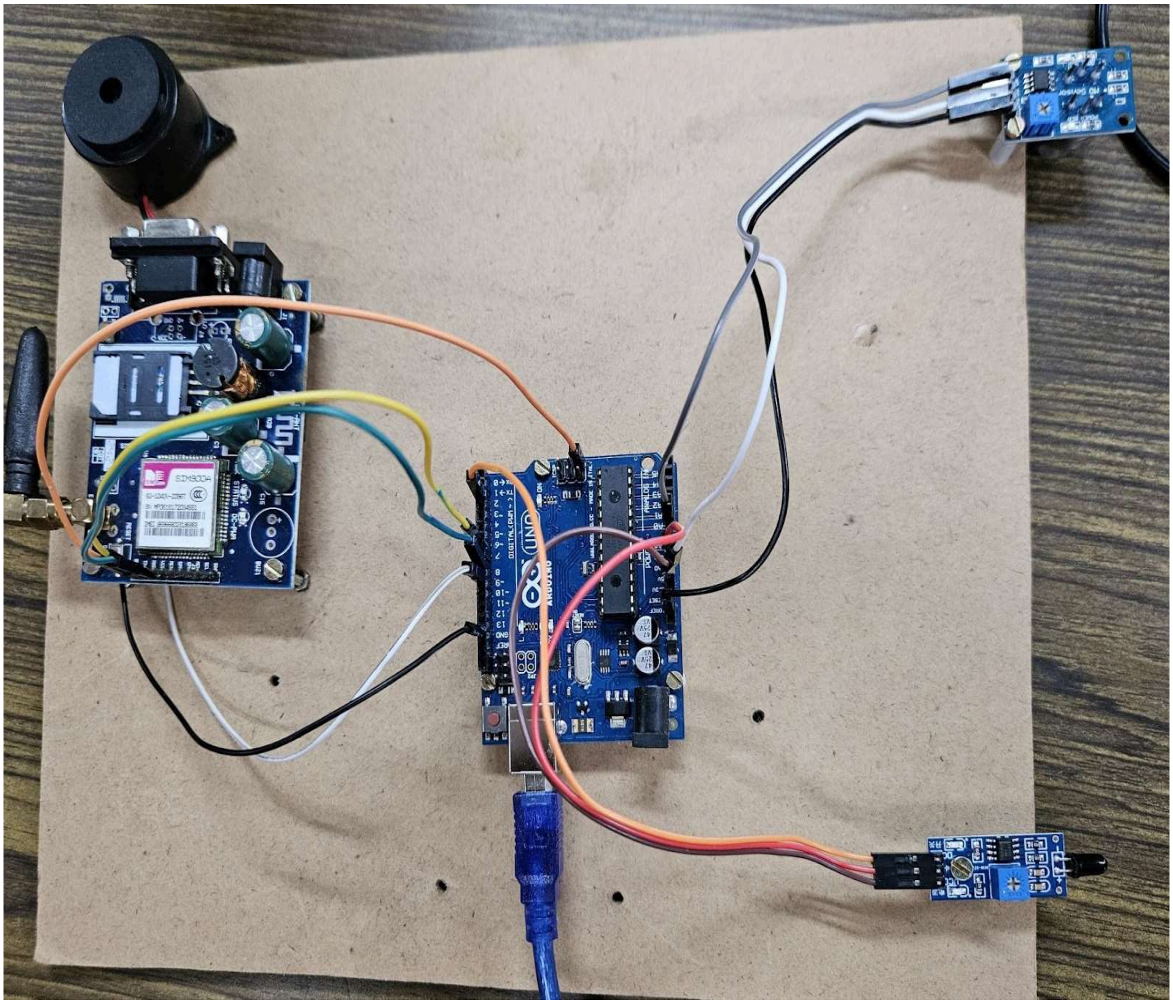

Figure 9.2. Circuit Diagram