GAS EXPLOSION DETECTING AND ALERTING SYSTEM USING IOT

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this Thesis titled **"**GAS EXPLOSION DETECTING AND ALERTING SYSTEM USING IOT" is the Bonafide work of "Vaishnavi Sri S M (211621070101299), Varshini L (2116210701301), Vilashini G (210701308)**"** who carried out the work under my supervision. Certified furtherthat to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred onan earlier occasion on this or any other candidate.

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ABSTRACT

Hazardous gas leakage occurs in the Oil and Gas Industry and may lead to various environmental effects. This project presents a cost-effective and reliable Internet of Things (IoT) system for detecting gas leaks and promptly alerting occupants and authorities. Our system "Gas explosion detecting and alerting system using IoT" aims to detect the hazardous gas leakage and alert the workers and company management. We have integrated IoT (Internet of Things) and GSM (Global System for Mobile Communication) to send SMS messages conveying the critical situation to the corresponding workers and management. This project uses MQ135 gas leakage detection sensor to detect hazardous gases like NH3(ammonia), sulfur, Benzene, CO2, Smoke and other harmful gases. This sensor is connected with Arduino UNO. When the sensor detects leakage of gas, the arduino will activate the alarm buzzer to alert the workers. Additionally, a red LED illuminates to provide a visual confirmation of the gas leak. and the Arduino is interfaced with GSM module to send alert message to the management of the company.

ACKNOWLEDGMENT

First, we thank the almighty god for the successful completion of the project. Our sincere thanks to our chairman **Mr. S. Meganathan B.E., F.I.E.,** for his sincere endeavor in educating us in his premier institution. We would like to express our deep gratitude to our beloved Chairperson **Dr. Thangam Meganathan Ph.D.,** for her enthusiastic motivation which inspired us a lot in completing this project and Vice Chairman **Mr. Abhay Shankar Meganathan B.E., M.S.,** for providing us with the requisite infrastructure.

We also express our sincere gratitude to our college Principal, **Dr. S. N. Murugesan M.E., PhD.,** and **Dr. P. KUMAR M.E., PhD, Director computing and information science , and Head Of Department of Computer Science and Engineering** and our project coordinator **Dr. K.Ananthajothi M.E.,Ph.D.,** for her encouragement and guiding us throughout the project towards successful completion of this project and to our parents, friends, all faculty members and supporting staffs for their direct and indirect involvement in successful completion of the project for their encouragement and support.

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CHAPTER 1

INTRODUCTION

Gas explosions are a persistent concern in residential and industrial settings. Natural gas leaks can be extremely hazardous, leading to devastating consequences if left undetected. To address this challenge, this project proposes an IoT-based gas explosion detection and alerting system that employs readily available components to create a robust and cost-effective solution.

Our project presents an innovative, IoT-based gas explosion detection and alerting system. By harnessing the capabilities of readily available components, this system provides a cost-effective and robust solution for safeguarding homes, businesses, and industrial facilities. This response goes beyond simply detecting a leak; it offers a multi-layered approach by alerting by means of alert messages.

This MQ-135 gas sensor module, sensor is specifically designed to identify combustible gases like methane, NH3, Sulphur di oxide, Carbon mono oxide and common smoke and some primary components of natural gas. As the gas concentration increases, the MQ-135's electrical resistance changes, sending a clear signal to the Arduino UNO microcontroller.

The GSM shield, another key component, allows the system to connect to a cellular network using a SIM card. This connectivity enables the system to send SMS alerts to pre-programmed phone numbers. These phone numbers can be designated for individuals within the building, such as a building manager, or emergency services personnel, ensuring a response to the gas leak. With an optional LCD display, the system can showcase real-time gas concentration readings, allowing users to monitor gas levels and assess the severity of the leak.

1.1 PROBLEM STATEMENT

Gas explosions pose severe threats to life and property, especially in environments where combustible gases are present. To mitigate such risks, there's a need for a robust Gas Explosion Detecting and Alerting System that can promptly detect the presence of hazardous gases, communicate the danger to relevant authorities or individuals, and activate visible and audible alerts to evacuate the area or take necessary precautions. Our project, “Gas explosion detecting and alerting system using IoT” aims to detect the hazardous gas leakage and alert the workers and company management.

1.2 SCOPE OF THE WORK

Our project “Hazardous gas detecting and alerting system using IoT” provides a module or working model for the industries where hazardous gases are used or stored. This model provides an experimental model to alarm the workers and the management of the industry when gas leakage occurs. Additionally, our project also helps in the field of education. It motivates researchers and students to develop real time models and IoT based projects. This mainly helps in the field of industries and emerging technologies.

1.3AIM AND OBJECTIVES OF THE PROJECT

The primary goal of this project is to develop a cost-effective and reliable Internet of Things (IoT)-based system for detecting gas leaks and promptly alerting authorities by employing a high-sensitivity MQ-135 gas sensor module specifically designed to detect combustible gases like methane, the primary component of natural gas. Continuously monitor gas concentration levels within the designated area

Multi-Layered Alert System for Immediate Action by using a loud buzzer or alarm upon detecting a gas leak to provide an immediate auditory alert to occupants in the vicinity, activating a red LED to offer a clear visual confirmation of the gas leak's presence, also utilizing a GSM shield and SIM card to send SMS alerts to pre-programmed phone numbers, notifying designated individuals or emergency services, ensuring response.

1.4 RESOURCES

This project uses available components to construct a robust and cost-effective gas explosion detection and alerting system.

The following prospectus details a list of resources that will play a primary role in thesuccessful execution of our project:

Hardware:

- MQ-135 Gas Sensor Module: This sensor continuously monitors the environment for the presence of combustible gases like methane. Its electrical resistance changes in response to gas concentration, providing data for analysis.
- Arduino UNO: This versatile microcontroller continuously reads data from the MQ-135 sensor, interprets the readings.
- GSM Shield: By incorporating a SIM card, the GSM shield facilitates the transmission of SMS alerts, notifying designated individuals or emergency services about a gas leak incident.
- Buzzer or Alarm: A loud and persistent sound generated by the buzzer or alarm serves as an auditory alert, to occupants to the imminent danger and prompting them to take immediate action.

Software:

- Arduino IDE: This development environment is used to program the Arduino UNO microcontroller. It allows you to write code that instructs Arduino how to read sensor data, analyze it, and trigger appropriate actions based on the readings.

1.5 MOTIVATION

The motivation behind this project are

- Limitations of Traditional Methods as they often rely on human senses, which can be unreliable, especially for odorless gases
- The advent of the Internet of Things (IoT) presents a unique opportunity to create cost-effective and automated solutions for gas leak detection.

CHAPTER 2
LITRETURE SURVEY

[1]. The paper “Energy-Efficient routing protocol for reliable low-latency internet of Things in oil and gas pipeline monitoring” proposed by karamSN ,Bila K and other published in 2024 says that the oil and gas industries (OGI) are the primary global energy source, with pipelines as vital components for OGI transportation. However, pipeline leaks pose significant risks, including fires, injuries, environmental harm, and property damage. The Internet of Things (IoT) has emerged as a cutting-edge technology for efficient OGI pipeline leak detection. (Karam et al. 2024)

[2].The project “Evaluating a novel gas sensor for ambient monitoring in automated life science laboratories” by MFR,Roddelkopf T and others published in the 2022 says that Air pollution and leakages of hazardous and toxic gases and chemicals are among the dangers that frequently occur at automated chemical and life science laboratories. In this study, a commercial MOX gas sensor, SGP41, was embedded in an IoT environmental sensor node for hazardous gas detection and alarm.(Al-Okby et al. 2022)

[3]. The project “Modeling and implementation of a low-cost IoT-smart weather monitoring station and air quality assessment based on fuzzy inference model and MQTT protocol” by Fahim M,El Mhouti A and other published in 2023 says that with the advancement of smart technologies, the system has evolved into many sensing methods to gather real-time climate data. This article investigates the modeling and implementation of a low-cost weather station device that also functions to measure air quality. The proposed system based on the Internet of Things (IoT) allows access to real-time climate data for a given area.it uses MQ135 sensor and other things to provide the data related to the weather.(Fahim et al. 2023)

[4]. The project “Enhancing data transmission in duct air quality monitoring using mesh network strategy for LoRa” by Mulick A, Abd Rahman AH and others published in 2023 says that Duct air quality monitoring (DAQM) is a typical process for building controls, with multiple infections outbreaks reported over time linked with duct system defilement. A mobile LoRa-based data collection technique is implemented for various data sensors such as DHT22, MQ7, MQ2, MQ135, and DSM50A to identify carbon monoxide, carbon dioxide, smoke, and PM2.5 levels.(Mullick et al. 2022)

[5]. “Quantifying non-steady state natural gas leakage from the pipelines using an innovative sensor network and model for subsurface emissions – InSENSE” by Lo JH ,smits KM and others published in 2024 jan says that Detecting and quantifying subsurface leaks remains a challenge due to the complex nature and extent of belowground leak scenarios. To address these scenarios, monitoring and evaluating changes in gas leakage behavior over space and time are crucial for ensuring safe and efficient responses to known or potential gas leaks. This study demonstrates the capability of linking environmental and gas concentration data obtained using a low-cost, near real-time methane (CH_4) detector network and an inverse gas migration model to capture and quantify non-steady state belowground natural gas (NG) leaks.(Lo et al. 2024)

[6]. The project “High-resolution geoelectrical characterization and monitoring of natural fluids emission systems to understand possible gas leakages from geological carbon storage reservoirs” by salone R,De Paola and others published in the year 2023 says that Gas leakage from deep geologic storage formations to the Earth's surface is one of the main hazards in geological carbon sequestration and storage. In this framework, we propose a combined use of high-resolution geoelectrical investigations (i.e. resistivity tomography and self-potential surveys) for reconstructing shallow buried

fracture networks in the caprock and detecting preferential gas migration pathways before it enters the atmosphere. (Salone et al. 2023)

[7]. “A novel benzo hemicyanine-based fluorescent probe for susceptible visualizing detection of phosgene” by Shao S,Bao C and others published in 2023 says that Leakage and misuse of phosgene, a common and highly hazardous industrial chemical, have always constituted a safety risk. Therefore, it is crucial to develop sensitive detection methods for gaseous phosgene. This work describes the design and development of a new fluorescent dye based on benzohemicyanine, as well as the synthesis of fluorescent probes for the sensitive detection of gaseous phosgene.(Shao et al. 2023)

[8]. “Characterization of H_2S QEPAS detection in methane-based gas leaks dispersed into environment” by Olivieri M,Menduni G and others published in the year 2023 says that the increase in fatal accidents and chronic illnesses caused by hydrogen sulfide (H_2S) exposure occurring in various workplaces is pushing the development of sensing systems for continuous and in-field monitoring of this hazardous gas. We report here on the design and realization of a Near-IR quartz-enhanced photoacoustic sensor (QEPAS) for H_2S leaks detection. H_2S QEPAS signal was measured in matrixes containing up to 1 % of methane (CH_4) and nitrogen (N_2) which were chosen as the laboratory model environment for leakages from oil and gas wells or various industrial processes where H_2S and CH_4 can leak simultaneously. (Olivieri et al. 2023)

[9]. “Evaluating of IAQ-Index and TVOC Parameter-Based Sensors for Hazardous Gases Detection and Alarming Systems” by Al-okby , Neubert S and others published in the year 2021 says that The measurement of air quality parameters for indoor

environments is of increasing importance to provide sufficient safety conditions for workers, especially in places including dangerous chemicals and materials such as laboratories, factories, and industrial locations. n this paper, the IAQ-index and TVOCs have been investigated to identify the best and most flexible solution for air quality threshold selection of hazardous/toxic gases detection and alarming systems.(Al-Okby et al. 2022)

[10]. “Mobile Detection and Alarming Systems for Hazardous Gases and Volatile Chemicals in Laboratories and Industrial Locations” by Al-okby, Neubert S published in the year 2021 says that The leakage of hazardous gases and chemical vapors is considered one of the dangerous accidents that can occur in laboratories, workshops, warehouses, and industrial sites that use or store these substances. The early detection and alarming of hazardous gases and volatile chemicals are significant to keep the safety conditions for the people and life forms who are work in and live around these places. (Al-Okby et al. 2021).

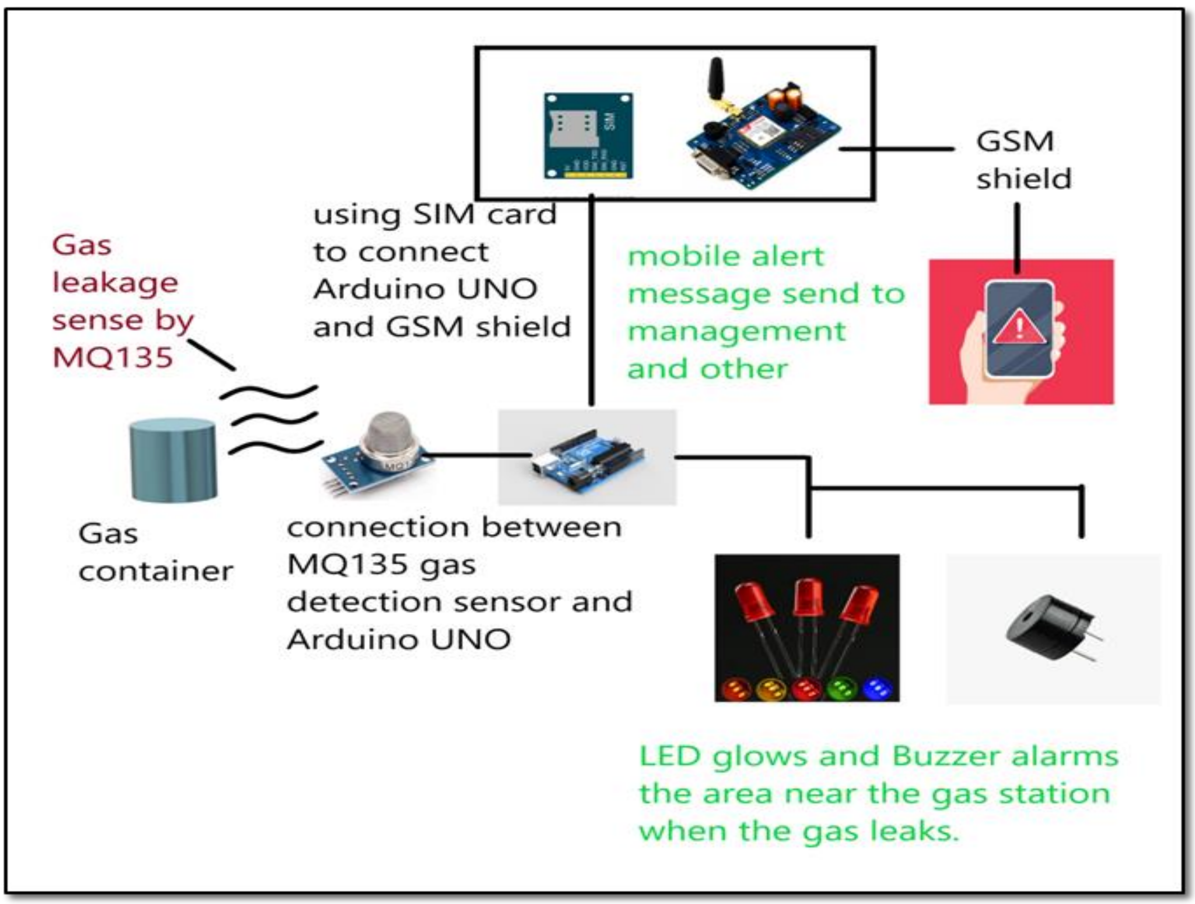
CHAPTER-3

SYSTEM DESIGN

3.1 GENERAL

In this section, we would like to show how the general outline of how all the components end up working when organized and arranged together. It is further represented in the form of a flow chart below.

3.2 SYSTEM ARCHITECTURE DIAGRAM



3.3 DEVELOPMENTAL ENVIRONMENT

3.3.1 HARDWARE REQUIREMENTS

- MQ-135 Gas Sensor Module
- Arduino UNO
- GSM 900A module
- LED Light
- Buzzer
- LCD Display
- Jumper Wires
- Potentiometer 10k
- Breadboard

3.3.2 SOFTWARE REQUIREMENTS

- Arduino IDE

CHAPTER 4

PROJECT DESCRIPTION

4.1 METHODOLODGY

In the development of a cost-effective and reliable Internet of Things (IoT)-based system for detecting gas leaks and promptly alerting occupants and authorities. By leveraging the capabilities of readily available components, this system provides a multi-layered approach to mitigating the risks associated with gas explosions in homes, businesses, and industrial facilities.

Wiring the MQ-135 sensor to the Arduino sensor's datasheet specifications. Typically, the sensor's analog output connects to an analog pin on the Arduino. Also, connect the GSM shield to the Arduino. Integrate the LED with a current-limiting resistor and connect it to a digital pin on the Arduino. Connect the buzzer or alarm directly to the Arduino or via a transistor for driving higher currents. An LCD display is connected using an I2C interface or SPI communication depending on the display's requirements.

In the Arduino IDE the code is integrated such that the code will initialize communication with the MQ-135 sensor and potentially calibrate it for optimal accuracy. Set up the GSM shield and configure the SIM card for SMS message transmission. Define a threshold gas concentration level that triggers the alert system. Continuously read data from the MQ-135 sensor. Compare the sensor readings with the threshold. If the threshold is exceeded, activate the buzzer or alarm to generate an audible alert. Turn on the red LED for a visual indication. Utilize the GSM shield to send an SMS alert to pre-defined phone numbers notifying them of a gas leak.

The system operates continuously, providing real-time gas leak detection and alerting capabilities. The Arduino constantly reads data from the MQ-135 sensor. The sensor output, an analog voltage, corresponds to the gas concentration in the surrounding air. The Arduino code compares the sensor readings with a pre-defined threshold value. This threshold represents the maximum acceptable gas concentration level. If it exceeds alerts will be shown.

4.2 MODULE DESCRIPTION

"Gas Explosion Detecting and Alerting System using IoT" incorporates several modules.

4.2.1 MQ135

MQ135 is a sensor that detects gas like NH3, Sulphur dioxide, carbon mono oxide, methane and smoke etc. This sensor is used to detect gas leakage. It works with the principle of resistance changes in response to the presence of different gases. To use this sensor, we should connect it to a microcontroller. The pins A0, GND, VCC are the main pins that should be connected to the microcontroller.

4.2.2 GSM 900A

Gobal System for Mobile communication module with 900 Hz frequency is used to send message to the connected mobile. It is commonly used in various applications that require cellular communication capabilities, such as IoT (Internet of Things) devices, remote monitoring systems, tracking systems, and communication modules for embedded systems. In our project, GSM is connected with the microcontroller Arduino UNO in order to send alert messages.

4.2.3 Arduino UNO

Arduino UNO is a microcontroller. The Arduino Uno is one of the most popular and widely used development boards in the Arduino ecosystem. It is based on the ATmega328 microcontroller and provides a simple and easy-to-use platform for building electronic projects, prototyping, and learning about electronics and programming.

4.2.4 SIM Card

A SIM card, or Subscriber Identity Module card, is a small electronic chip that is used in mobile phones and other cellular-enabled devices to identify and authenticate users on a mobile network. This SIM card is inserted in the GSM Module to send messages to the respected person or a management.

CHAPTER-5

RESULT AND DISCUSSION

Working model:

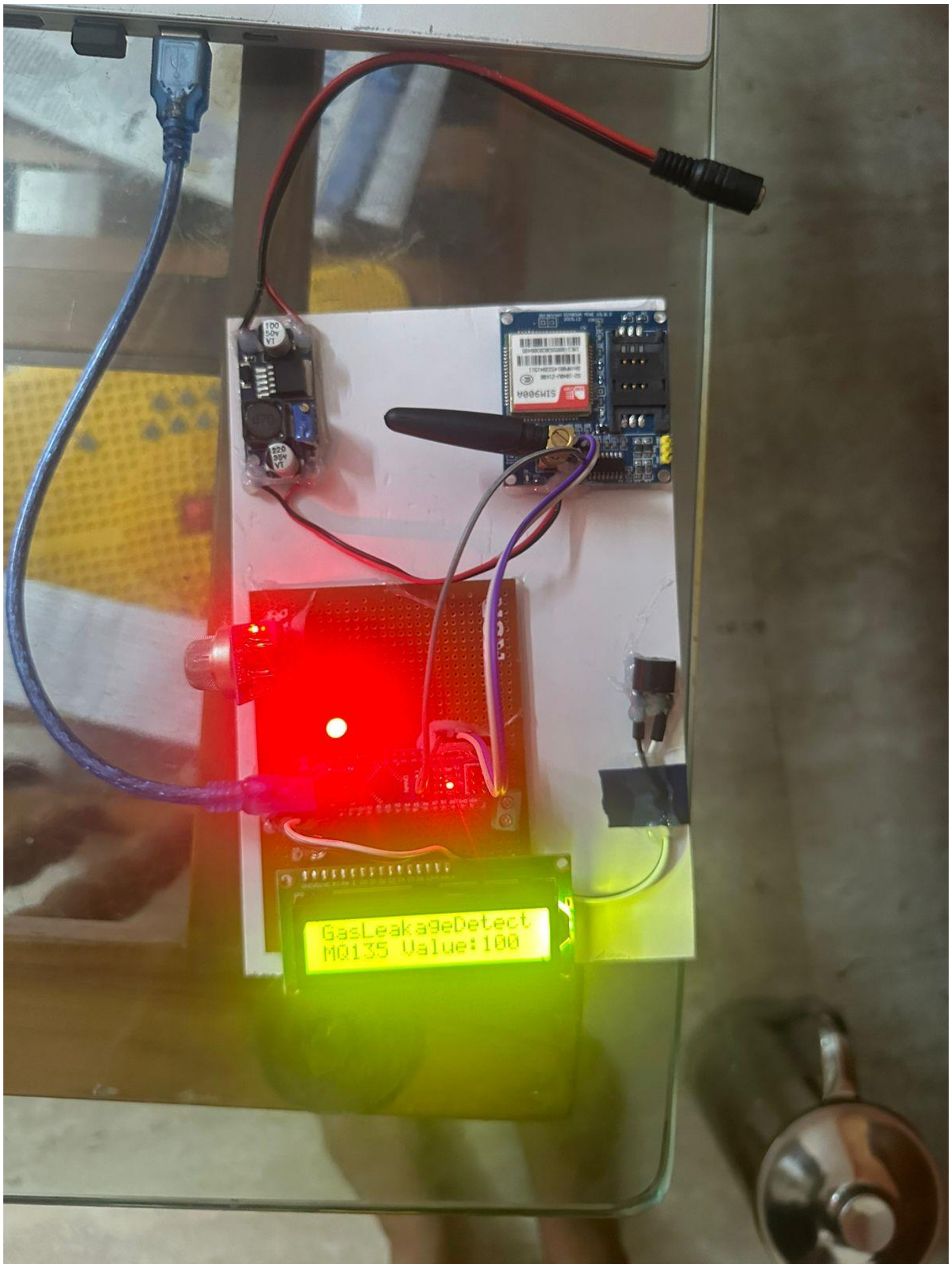


Figure 5.1 Connections in the board

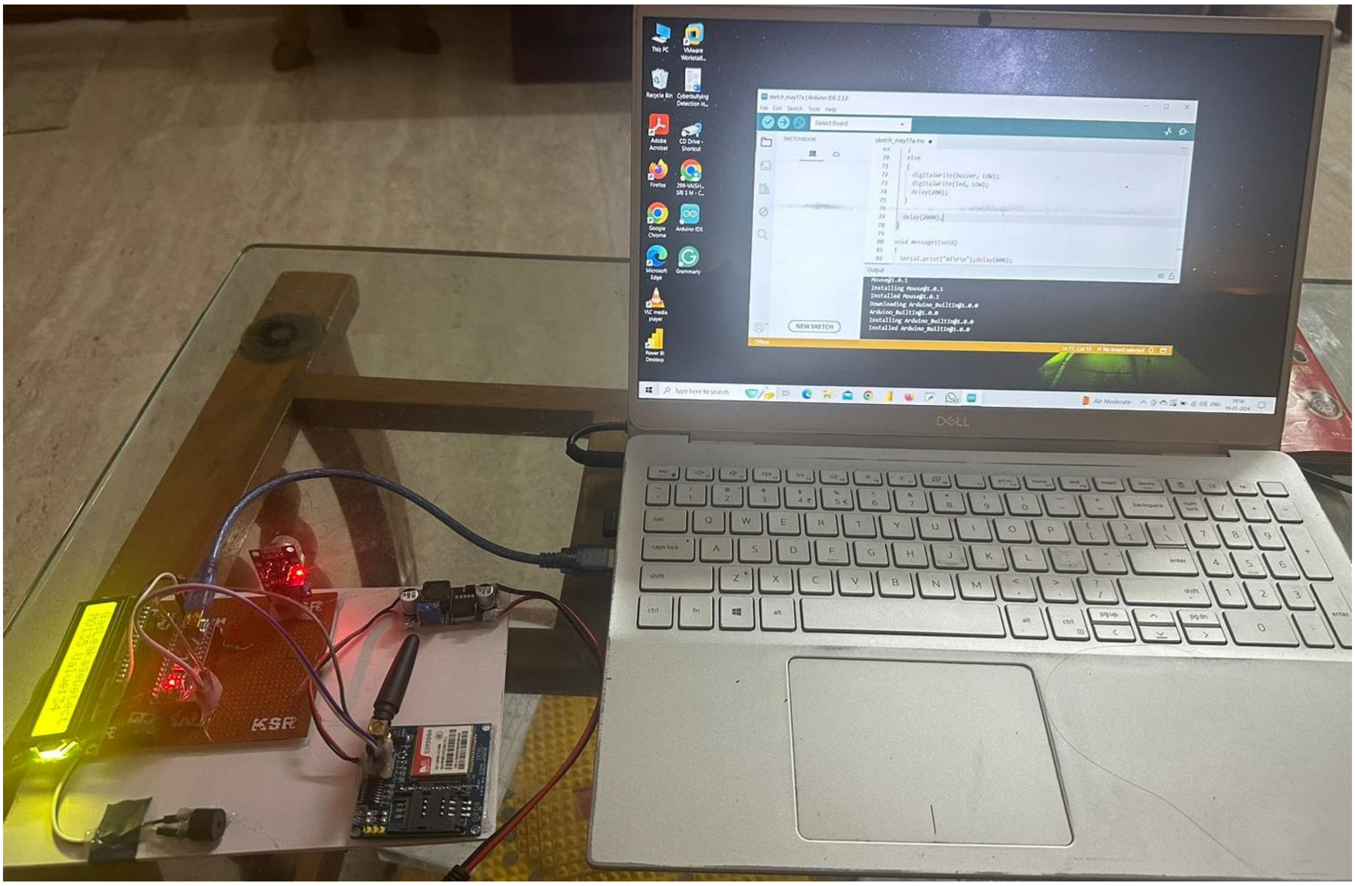


Figure 5.2 Working Model connected with Arduino IDE

Alert Message from the sensor:

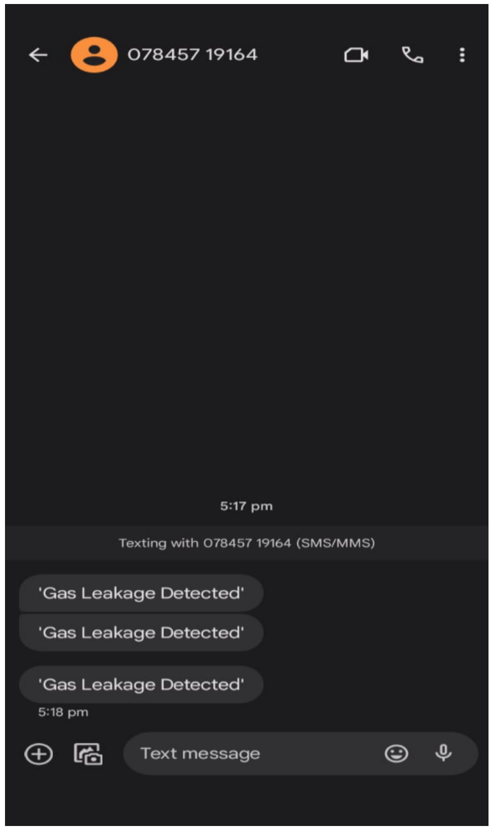


Figure 5.3 Alert Message

5.1 RESULT

The primary results of this project encompass the development and testing of a functional IoT-based gas explosion detection and alerting system. The system successfully utilizes the MQ-135 gas sensor module to detect the presence of combustible gases like methane. The Arduino code effectively interprets sensor readings and compares them to a pre-defined threshold. Upon exceeding the threshold, the system triggers an appropriate alerting sequence.

The system generates a loud and noticeable audible alert through the buzzer or alarm, prompting immediate action from occupants in the vicinity. The LED provides a clear visual confirmation of a potential gas leak, even in dimly lit environments. The GSM shield and SIM card combination facilitates the transmission of SMS alerts to designated phone numbers, ensuring notification of relevant authorities or individuals.

The project serves as a valuable educational tool, highlighting the importance of gas leak detection and safety protocols. It encourages users to Install the system in a well-ventilated location to prevent sensor saturation, regularly inspect and maintain gas lines and appliances, have a clear evacuation plan in place for the event of a gas leak, contact a qualified gas service provider to address any detected leaks safely and effectively.

CHAPTER 6

CONCLUSION AND FUTURE ENHANCEMENT

6.1 CONCLUSION

This project has presented a cost-effective gas explosion detection and alerting system leveraging the power of the Internet of Things (IoT). By utilizing readily available components and a multi-layered approach, the system offers a proactive solution for safeguarding homes, businesses, and industrial facilities from the dangers of gas leaks.

The system effectively addresses the limitations of traditional gas leak detection methods, which often rely on human senses and infrequent inspections. The continuous monitoring capabilities of the MQ-135 sensor, coupled with the Arduino's processing power and the GSM shield's communication features, create a robust system for early detection and timely notification. The multi-faceted alerting system, encompassing a loud buzzer or alarm, a bright LED, and SMS notifications, ensures that occupants and authorities are alerted promptly, allowing for swift evacuation and corrective action.

FUTURE ENHANCEMENT

- **Sensor Integration:** Explore the integration of additional sensors for a more comprehensive approach. Sensors for detecting smoke, carbon monoxide (CO), or temperature fluctuations could provide a more holistic picture of potential hazards.
- **Cloud Connectivity**: Consider incorporating cloud connectivity. This would enable remote monitoring of gas concentration levels, allowing for real-time data analysis and potentially triggering automated responses, such as shutting off gas valves remotely.
- **Machine Learning and AI:** Implement machine learning algorithms to analyze sensor data over time and learn patterns. This could help the system distinguish between normal gas fluctuations and actual leaks, further reducing false alarms.
- **Mobile App Integration:** Develop a mobile application that allows users to monitor gas concentration levels remotely, receive alerts, and potentially control the system settings.
- **Self-Diagnostics and Auto-Calibration:** Incorporate self-diagnostic features to detect sensor malfunctions and automate calibration processes, ensuring optimal system performance.

APPENDIX

SOURCE CODE:

```
#include <LiquidCrystal.h>

const int rs = A0, en = A1, d4 = A2, d5 = A3, d6 = A4, d7 = A5;

LiquidCrystal lcd(rs, en, d4, d5, d6, d7);


#define MQ135Pin A6

const int DOUTpin3 = 2;

int limit3;

int value3;


int buzzer = 11;

int led = 12;


#define serial


void message1(void);


void setup()

{

Serial.begin(9600);//sets the baud rate
```

```
 pinMode(buzzer, OUTPUT);
pinMode(led, OUTPUT);
digitalWrite(buzzer, LOW);
 digitalWrite(led, LOW);

 lcd.begin(16, 2);

lcd.setCursor(0, 0);
lcd.print("GasLeakageDetect");
  delay(2000);
}

void loop()
                                    {
  /*..........GAS (MQ135)..........*/
value3 = analogRead(MQ135Pin);
  limit3 = digitalRead(DOUTpin3);

  #ifdef serial
 Serial.print("MQ135 value: ");
  Serial.print(value3);//prints the alcohol value
  Serial.print("  Limit: ");
 Serial.println(limit3);/*prints the limit reached as either LOW or HIGH (above or
```

```
underneath) */
  #endif

  lcd.setCursor(0, 1);
  lcd.print("MQ135 Value:");
  lcd.print(value3);
  lcd.print(" ");

  delay (500);

  #ifdef serial
 Serial.println("*******************************************************");
  Serial.println("         ");
  #endif

  if (limit3 == 0)
  {
    digitalWrite(buzzer, HIGH);
    digitalWrite(led, HIGH);

    delay (200);
    message1();
    Serial.println();
```

```
    delay (200);


    delay (1000);
  }
  else
  {
    digitalWrite(buzzer, LOW);
    digitalWrite(led, LOW);
    delay (200);
  }


  delay (2000);
}


void message1(void)
{
Serial.print("AT\r\n"); delay (800);
  Serial.print("AT+CMGF=1\r\n"); delay (800);
  Serial.print("AT+CMGS="); delay (500);
  Serial.write(""); delay (500);
  Serial.print("9xxxxxxxxx"); delay (500);
  Serial.write("");
  Serial.print("\r\n"); delay(500);
```

```
 Serial.print("'Gas Leakage Detected'\r\n"); delay (500) ;//17
delay (500);
 Serial.write(26);
}
```

REFERENCES

[1] **“Energy-Efficient routing protocol for reliable low-latency internet of Things in oil and gas pipeline monitoring”** proposed by karam S N, Bila K, Year:2024

[2] **“Evaluating a novel gas sensor for ambient monitoring in automated life science laboratories”** by MFR, Roddelkopf T, Year:2022.

[3] “**Modeling and implementation of a low-cost IoT-smart weather monitoring station and air quality assessment based on fuzzy inference model and MQTT protocol”** by Fahim M,El Mhouti, Year:2023

[4] **“Enhancing data transmission in duct air quality monitoring using mesh network strategy for LoRa”** by Mulick A, Abd Rahman AH, Year:2023

[5] **“Quantifying non-steady state natural gas leakage from the pipelines using an innovative sensor network and model for subsurface emissions – InSENSE”** by Lo JH, Smits KM, Year: 2024

[6] **“High-resolution geoelectrical characterization and monitoring of natural fluids emission systems to understand possible gas leakages from geological carbon storage reservoirs”** by Salone R, De Paola, Year:2023

[7] **“A novel benzo hemi cyanine-based fluorescent probe for susceptible visualizing detection of phosgene”** by Shao S, Bao C, Year: 2023

[8] **“Characterization of H_2S QEPAS detection in methane-based gas leaks dispersed into environment”** by Olivieri M,Menduni G, Year: 2023

[9] **“Evaluating of IAQ-Index and TVOC Parameter-Based Sensors for Hazardous Gases Detection and Alarming Systems”** by Al-okby , Neubert S, Year:2021

[10] **“Mobile Detection and Alarming Systems for Hazardous Gases and Volatile Chemicals in Laboratories and Industrial Locations”** by Al-okby, Neubert S, Year:2021