Mini Project Report

on

“Gas Leakage Detection System Using IoT”

Submitted in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

in

INFORMATION TECHNOLOGY

Submitted by

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CERTIFICATE

This is to certify that the project entitled " Gas Leakage Detection System Using IoT" hasbeen carried out by team:

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ACKNOWLEDGEMENT

Apart from individual efforts, the success of any project depends largely on the encouragement and guidelines of many others. We take this opportunity to express our gratitude to the people who have been instrumental throughout the project work.

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We deeply express our sincere thanks to our Head of Department Dr. R. B. Kulkarni for encouraging and allowing us to present the project on the topic "Gas Leakage Detection System using IoT" and providing us with the necessary facilities to enable us to fulfill our project requirements as best as possible. We take this opportunity to thank all faculty members and staff of the Department of Information Technology, who have directly or indirectly helped our project.

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ABSTRACT

Gas leaks pose serious threats to human safety and the environment. A reliable and efficient gas leakage detection system is of paramount importance in various industries, households, and public spaces. This mini project presents the development of a Gas Leakage Detection System, designed to detect and alert users about the presence of hazardous gases, such as LPG gas and carbon monoxide. The system employs a combination of gas sensors, a microcontroller, and a user interface to monitor and provide real-time alerts.The project focuses on designing a cost-effective and easily deployable solution for gas leakage detection. Gas sensors are strategically placed in areas prone to gas leaks, and they continuously monitor the surrounding air for specific gases. When the sensors detect the presence of a hazardous gas, the microcontroller processes the data and triggers an alarm or notification, which can be in the form of visual indicators, audible alarms, or remote notifications via a mobile application.

LIST OF FIGURES

ABBREVIATIONS

Acronym	Definition
GSM	Global System for Mobile Communication
LED	Light Emitting Diode
IoT	Internet of things
LCD	Liquid Crystal Display
IDE	Integrated development environment

TABLE OF CONTENTS

Chapter 1
INTRODUCTION

1.1 Background:

Gas leakage is a significant safety concern in various settings, including residential, commercial, and industrial environments. The presence of hazardous gases, such as natural gas, propane, or carbon monoxide, poses serious risks to human health and property. Accidental gas leaks can lead to fires, explosions, and even fatalities. Therefore, the development of efficient and reliable gas leakage detection systems is of paramount importance.

In recent years, the emergence of the Internet of Things (IoT) has revolutionized the way we interact with and monitor our surroundings. IoT technology allows for the interconnection of physical devices, sensors, and systems through the internet, enabling real-time data collection, analysis, and remote control. This technology has been leveraged in various applications, from smart home devices to industrial automation and environmental monitoring.

1.2 Motivation:

Our motivation for the "Gas Leakage Detector System using IoT" project is rooted in the need for enhanced safety, environmental protection, and overcoming the limitations of existing gas detectors. We leverage IoT technology to provide real-time monitoring, remote alerts, and cost-effective gas leak detection. Our system's early detection capabilities can prevent disasters, and it aligns with the broader trend of IoT applications. Additionally, the project fosters research and innovation in the field by integrating cutting-edge technology components.
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1.3 Scope:

The scope of the "Gas Leakage Detector System using IoT" project report encompasses the design, development, and implementation of an IoT-based gas detection system. This system focuses on the real-time monitoring and early detection of gas leaks, including both flammable and toxic gases. The project includes the integration of gas sensors (such as MQ sensors), an Arduino microcontroller, a relay module for control, a GSM module for remote alerts, and an exhaust fan for safety measures. The report will detail the working principles, hardware components, software development, and system testing, highlighting the project's significance in improving safety, environmental protection, and the potential for applications in various settings.

1.4 Expected Outcome:

The expected outcomes of the "Gas Leakage Detector System using IoT" project include a reliable and efficient gas detection system capable of accurately identifying and monitoring various gases. The system should provide real-time data collection, analysis, and alert notifications via IoT technology. This project aims to enhance safety by preventing gas-related accidents, reduce response times during emergencies, and offer users the convenience of remote monitoring through a user-friendly interface. Additionally, the project's expected outcome is to contribute to the advancement of IoT applications in gas detection and safety, offering a scalable solution for both domestic and industrial settings.

Chapter 2
LITERATURE SURVEY

TITLE	DESCRIPTION	ADVANTAGES	DISADVANTAGES
Smart Gas Level Monitoring, Booking &Gas Leakage Detector over IoT	They explain the gas cylinder monitoring system using IoT2.	1)Efficient Gas Management 2)Real-time Alerts	1)Focus on monitoring only 2)Doesn't Detect
Arduino Based LPG gas Monitoring & Automatic Cylinder booking with Alert System	They make an automatic booking system of gas cylinder when it come to an end. Alarm system for gas leakage	1)Enhanced Safety 2)Real-time Alerts	1)Technical Complexity 2)Maintenance

LPG Monitoring and Leakage Detection	They Monitor the LPG cylinder with the leakage and alarm system.	1)Reduced Health Risks 2)Smart Home Integration	1)Dependency on Power 2)Calibration and Sensor Drift
A Security alert system using GSM for Gas Leakage.	The aim of this project is to monitor for liquid petroleum gas (LPG)leakage to avoid fire accidents providing house safety feature where security has been an important issue, and to provide an alert by sending SMS.	1)Remote Monitoring 2)Real-Time Alerts 3)No Dependence on Wi-Fi 4)24/7 Monitoring	1)Technical Complexity 2)SIM Card and Subscription Costs 3)Maintenance

Chapter 3
RELATED THEORY AND PROBLEM DEFINITION

3.1 Problem Statement:

IoT Based Gas Leakage Detection System with Alarming and Prevention Method.

3.2 Related Theory

- What is IoT?

The Internet of Things (IoT) describes the network of physical objects— "things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinaryhousehold objects to sophisticated industrial tools. With more than 7 billion connected IoT devices today, experts are expecting this number to grow to 10 billion by 2020 and 22 billion by 2025. Oraclehas a network of device partners.

- Why is Internet of Things (IoT) so important?

Over the past few years, IoT has become one of the most important technologies of the 21st century. Now thatwe can connect everyday objects—kitchen appliances, cars, thermostats, baby monitors—to the internet via embedded devices, seamless communication is possible between people, processes, and things.

By means of low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention. In this hyperconnected world, digital systems can record, monitor, and adjust each interaction between connected things. The physical world meetsthe digital world—and they cooperate.

- What technologies have made IoT possible?

While the idea of IoT has been in existence for a long time, a collection of recent advances in a number of different technologies has made it practical.

- Access to low-cost, low-power sensor technology. Affordable and reliable sensors are making IoT technology possible for more manufacturers.
- Machine learning and analytics. With advances in machine learning and analytics, along with access to varied and vast amounts of data stored in the cloud, businesses can gather insights faster and more easily. The emergence of these allied technologies continues to push the boundaries of IoT and the data produced by IoT also feeds these technologies.
- Conversational artificial intelligence (AI). Advances in neural networks have brought natural-languageprocessing (NLP) to IoT devices (such as digital personal assistants Alexa, Cortana, and Siri) and madethem appealing, affordable, and viable for home use.

Chapter 4
DESIGN METHODOLOGY

4.1 Proposed System Architecture:

- Flow Chart

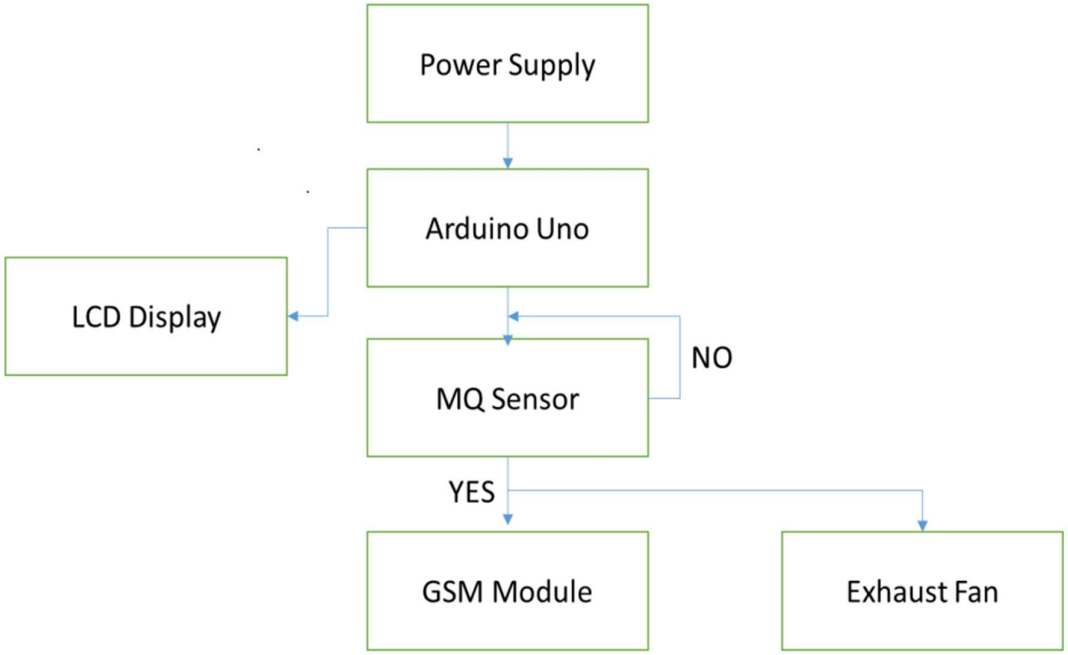

Fig. 1 Flow Chart

- Firstly, Power supply is provided to Arduino Uno. Arduino Uno is interfaced with 16 x 2 LED display, MQ2 Sensor, GSM Module and Exhaust fan.
- MQ2 Sensor is gas detector sensor used to detect leaked gas. It detect the gas and sends analog data to Arduino Uno.
- LED Display is Interfaced with Arduino. It displays the data of current gas level.
- GSM Module us also interfaced with Arduino Uno. When leaked gas is detected Arduino sends a signal to GSM Module, then Module sends a alert call to mobile number which is set in the program.
- Exhaust fan is connected through Relay Module. Whenever gas is leaked Arduino will start the exhaust fan automatically.

4.2 Technical Specifications:

Software Requirements:

- Arduino Software (IDE)

Languages used for Front-end:

- C
- C++

Hardware:

- Arduino UNO
- MQ2 Sensor
- GSM Module
- Relay Module
- I2C Module
- LCD Display
- Exhaust Fan

Chapter 5

IMPLEMENTATION

5.1 Arduino UNO:

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered a powerful board used in various projects. Arduino.cc developed the Arduino UNO board.

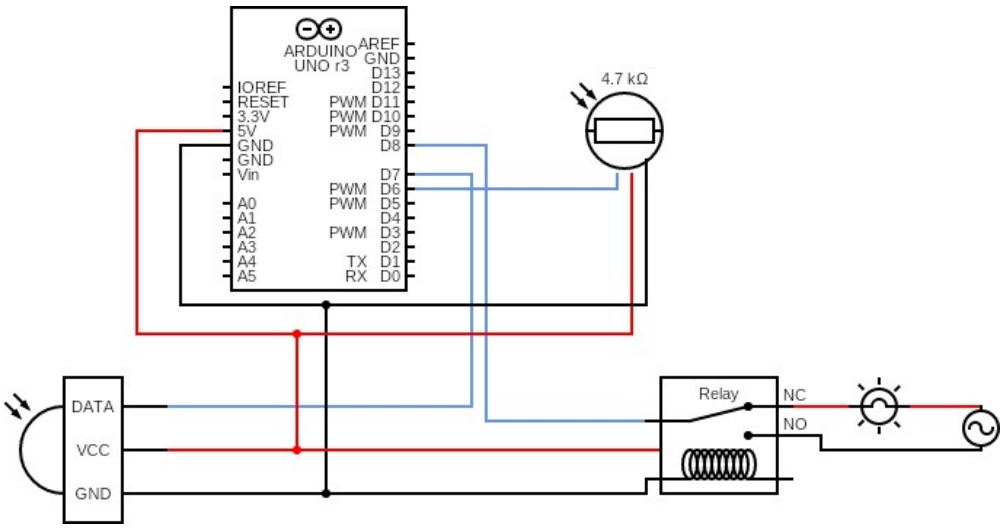

Fig 2. Circuit diagram

The Arduino UNO includes 6 analog pin inputs, 14 digital pins [1] , a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

- ATmega328 Microcontroller- It is a single-chip Microcontroller of the ATmel family. The processor code inside it is 8-bit. It combines Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timers, external and internal interrupts, and an oscillator.

ICSP pin - The In-Circuit Serial Programming pin allows the user to program using the firmware of the Arduino board[1] . Power LED Indicator- The ON status of LED shows the power is activated. When the power is OFF, the LED will not light up.

- Digital I/O pins- The digital pins have the value HIGH or LOW. The pins numbered from D0 to D13 are digital pins.
- TX and RX LEDs- The successful flow of data is represented by the lighting of these LEDs
- AREF- The Analog Reference (AREF) pin is used to feed a reference voltage to the Arduino UNO board from the external power supply.
- Reset button- It is used to add a Reset button to the connection.
- USB- It allows the board to connect to the computer. It is essential for the programming of the Arduino UNO board
- Crystal Oscillator- The Crystal oscillator has a frequency of 16MHz, which makes the Arduino UNO a powerful board.
- Voltage Regulator- The voltage regulator converts the input voltage to 5V.
- GND- Ground pins. The ground pin acts as a pin with zero voltage.
- Vin- It is the input voltage.
- Analog Pins- The pins numbered from A0 to A5 are analog pins[1] . The function of Analog pins is to read the analog sensor used in the connection. It can also act as GPIO (General Purpose Input Output) pins.

5.2 LED Display:

A 16x4 LED display is a visual output device consisting of 16 columns and 4 rows of light-emitting diodes (LEDs), allowing for the presentation of alphanumeric characters and simple graphics. Each LED corresponds to a pixel, creating a 16-character wide and 4-line tall matrix. These displays are commonly used for showcasing information in applications like digital clocks, temperature displays, or any scenario requiring a compact, multi-line visual output. They interface with microcontrollers or other electronic devices, and their versatility makes them suitable for various projects where concise, multiline information presentation is essential.

Table 1. Interface Pin Function

Pin No.	Symbol	Description
1	V_{SS}	Ground
2	V_{DD}	Power supply for logic
3	V_O	Contrast Adjustment
4	RS	Data/ Instruction select signal
5	R/W	Read/Write select signal
6	E	Enable signal
7~14	DB0~DB7	Data bus line
15	A	Power supply for B/L +
16	K	Power supply for B/L -

5.3 MQ Sensor:

MQ (Mikroelektronika) gas sensors are a series of semiconductor sensors widely used for detecting various gases in the atmosphere. These sensors are popular in electronic projects, especially those related to air quality monitoring, gas leak detection, and industrial safety applications. The MQ series consists of multiple models, each designed to detect a specific gas. Here is some general information about MQ sensors:

MQ2 gas sensors are versatile semiconductor devices commonly used for detecting various gases in air. Designed for easy integration into electronic systems, MQ2 sensors are sensitive to gases such as methane, propane, butane, alcohol, smoke, and carbon monoxide. The sensor's resistance changes in presence of these gases, and this variation is converted into an analog voltage signal.

Typically used in gas leakage detection systems and air quality monitoring devices, MQ2 sensors are affordable and widely available. They feature a built-in heating element to ensure stable performance and require a preheat time before accurate readings can be obtained. The analog output allows interfacing with microcontrollers like Arduino and Raspberry Pi.

The MQ2 sensor's compact size and ease of use make it popular for DIY projects and applications requiring real-time gas detection. However, users should be aware that calibration might be necessary for accurate readings, and environmental conditions, such as temperature and humidity, can impact sensor performance. Proper handling, calibration, and adherence to datasheet guidelines are essential for optimal results in gas detection applications.

Fig 3. MQ sensor image

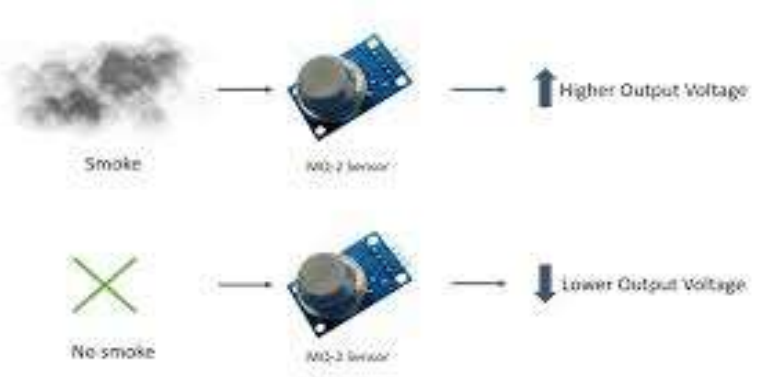

Fig. 4. MQ sensor working

5.3.1 Types of MQ sensors and working mechanisms

1. MQ-2: Methane, Butane, LPG, Smoke:
Working Mechanism: MQ-2 is sensitive to a variety of gases including methane, butane, LPG, and smoke. The sensor contains a tin dioxide (SnO2) semiconductor that changes resistance when exposed to the target gases. The change in resistance is converted to an analog signal.

2. MQ-3: Alcohol, Ethanol, Smoke:
Working Mechanism: MQ-3 is sensitive to alcohol, ethanol, and smoke. Similar to MQ-2, it uses a tin dioxide semiconductor. When these gases are present, the sensor's resistance changes, leading to an analog output signal.

3. MQ-7: Carbon Monoxide, Methane, LPG:
Working Mechanism: MQ-7 is designed for the detection of carbon monoxide, methane, and LPG. It contains a carbon monoxide (CO) sensor based on tin dioxide. The presence of CO changes the sensor's resistance, resulting in an analog voltage signal.

4. MQ-135: Ammonia, Sulphide, Benzene Vapor, Smoke:
Working Mechanism: MQ-135 is sensitive to a range of gases including ammonia, sulfur dioxide, benzene vapor, and smoke. It employs a tin dioxide semiconductor and a heater. The sensor's resistance changes in the presence of the target gases.

5. MQ-9: Carbon Monoxide, Methane, LPG:
Working Mechanism:MQ-9 is similar to MQ-7 but is optimized for detecting carbon monoxide, methane, and LPG. It uses a tin dioxide semiconductor for gas sensing, and the change in resistance is converted to an analog signal.

6. MQ-4: Methane, Butane, LPG, Smoke:
Working Mechanism: MQ-4 is designed for the detection of methane, butane, LPG, and smoke. It utilizes a tin dioxide semiconductor, and its resistance changes with the concentration of the target gases.

5.3.2 Sensitivity

The sensitivity of an MQ-2 gas sensor, or any MQ series gas sensor, refers to its responsiveness to a particular gas. It essentially measures how much the sensor's resistance changes in response to a given concentration of a specific gas. The sensitivity is a crucial parameter as it determines the sensor's ability to detect and quantify the presence of a gas accurately.

The sensitivity of MQ-2 sensors is typically defined in terms of the ratio of the change in resistance (ΔR) to the concentration of the gas. This ratio can be expressed as:

$$Sensitivity = \Delta R / Gas\ Concentration$$

5.4 GSM Module:

GSM (Global System for Mobile Communications) modules are essential communication components that enable devices to connect to mobile networks for data transfer and messaging. Operating on 2G, 3G, or 4G/LTE networks, these modules require a Subscriber Identity Module (SIM) card for authentication. Typically interfaced through AT (Attention) commands over a serial interface like UART, GSM modules facilitate SMS messaging, voice calls, and data transfer. They operate within a power supply range of 3.4V to 4.5V and often support external antennas to enhance signal reception. Some advanced modules integrate GPS functionality for location tracking. Widely used in IoT (Internet of Things) applications, security systems, and remote monitoring setups, GSM modules find roles in vehicle tracking, smart agriculture, and industrial automation. Considerations for deployment include network compatibility, power consumption, antenna placement, and adherence to regulatory standards. By providing cellular connectivity, GSM modules empower diverse applications, bridging the gap where Wi-Fi or wired connections are impractical or unavailable.

The GSM SIM900A is a compact and widely used GSM/GPRS module for wireless communication. Operating on 2G networks, it integrates seamlessly with microcontrollers through AT commands. Featuring a SIM card slot for authentication, the module supports SMS, voice call, and GPRS data transfer functionalities. With a voltage range of 3.4V to 4.5V, it is suitable for diverse applications, including IoT projects, remote monitoring, and security systems. Equipped with an external antenna connector, the SIM900A ensures reliable cellular connectivity, making it a popular choice for projects requiring mobile communication in areas without Wi-Fi access or wired networks.

The GSM SIM900A module typically has the following pins:

1. VCC: Power supply (4.4V to 5.5V).
2. GND: Ground.
3. RXD: Receive Data (Serial input).
4. TXD: Transmit Data (Serial output).
5. RESET: Reset the module.
6. RI (Ring Indicator): Indicates an incoming call or SMS.

7. DTR (Data Terminal Ready): Ready for data transfer.
8. CTS (Clear To Send): Indicates module is ready to receive data.
9. RTS (Request To Send): Request to send data.
10. Antenna Connector: External antenna connection.
11. SIM Card Slot: Insert Subscriber Identity Module (SIM) card here.

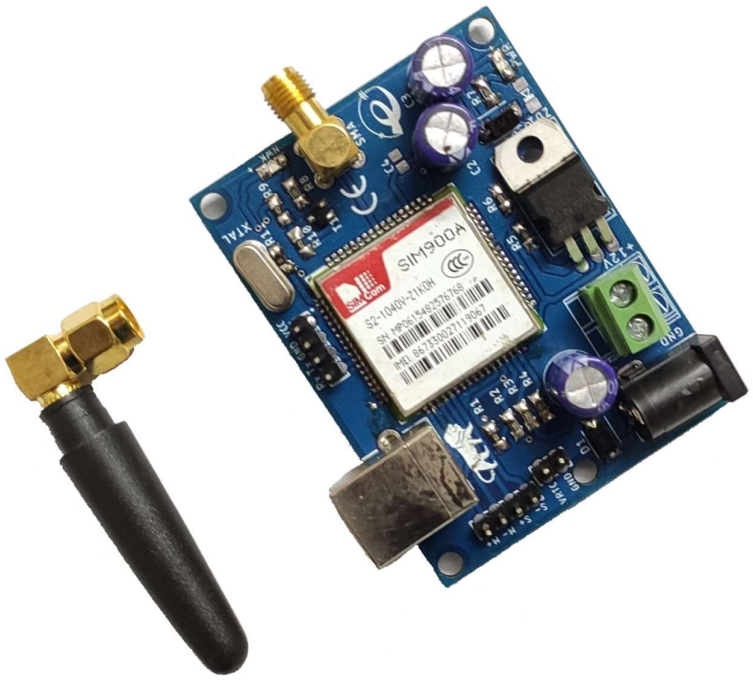

Fig.5 GSM SIM900A Module

5.4 Relay:

A relay is an electromechanical device that uses an electric current to open or close the contacts of a switch. The single-channel relay module is much more than just a plain relay, it comprises components that make switching and connection easier and act as indicators to show if the module ispowered and if the relay is active or not.

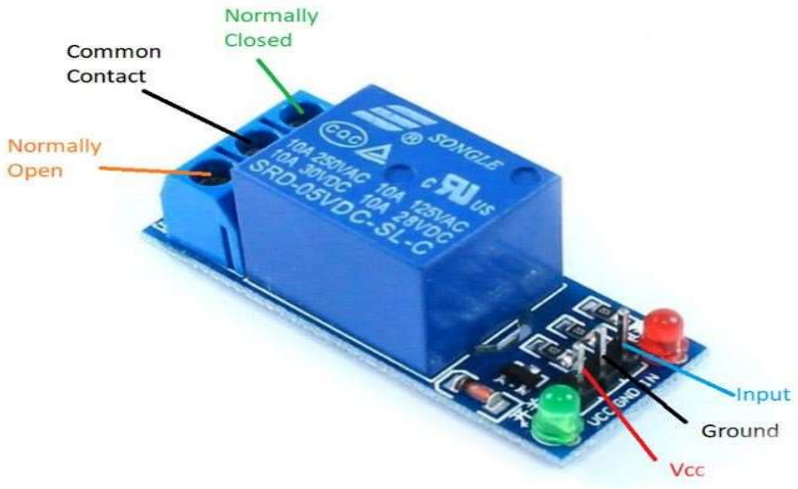

Fig 6. Single channel Relay module

Table. 2 pin of single channel relay

Pin number	Pin name	Description
1	Relay Trigger	Input to activate the relay
2	Ground	0V reference
3	VCC	Supply input for powering the relay coil
4	Normally Open	Normally open terminal of the relay
5	Common	Common terminal of therelay
6	Normally Closed	Normally closed contact of the relay

Single-Channel Relay Module Specifications

- Supply voltage – 3.75V to 6V
- Quiescent current: 2mA
- Current when the relay is active: ~70mA
- Relay maximum contact voltage – 250VAC or 30VDC
- Relay maximum current – 10A

5.5 Exhaust Fan:

An Exhaust Brushless Motor Fan is a crucial component in ventilation systems, commonly employed in industries, automobiles, and electronic devices. Unlike traditional brushed motors, brushless motors offer enhanced efficiency, reduced maintenance, and longer operational life. This fan is specifically designed for exhausting air, heat, or fumes from enclosed spaces, contributing to temperature control and air quality improvement.

The brushless motor technology eliminates the need for brushes, resulting in lower friction, reduced wear and tear, and minimal electromagnetic interference. This translates to a quieter operation and increased reliability. The fan's brushless motor also allows for precise speed control and improved energy efficiency, making it an environmentally friendly option.

Exhaust Brushless Motor Fans find applications in automotive exhaust systems, computer cooling, and industrial ventilation setups. Their ability to maintain consistent performance over extended periods, coupled with the advantages of brushless motor technology, makes them an ideal choice for environments where reliable and efficient exhaust capabilities are paramount. As technology advances, these fans continue to play a vital role in optimizing air circulation and maintaining optimal operating conditions.

Fig.7 Brushless Exhaust Fan

5.6 Implementation of Project:

1. Connect the MQ2 sensor to an analog pin on the Arduino Uno.
   Connect A0 pin of MQ2 Sensor to A0 pin od Arduino
   Connect Vcc pin of Sensor to 5V pin on Arduino
   Connect GND pin of Sensor to GND pin on Arduino
2. Connect the LED display to the appropriate digital pins on the Arduino Uno.
   GND and Vcc Pins of 16x2 Display to GND and 5V pins of Arduino respectively
   Connect SCL and SDA pins of Display to Arduino
   Data will be shown on Display
3. Connect the GSM SIM900A module to the Arduino Uno using the appropriate serial connections.
   Connect RX and TX pins of Module to pin 2 and pin 3 of Arduino
   Connect GND to GND on Breadboard and Power Supply of 5v – 2A
   If Leaked Gas is Detected using Sensor GSM will call to given Mobile Number
4. Connect the Relay Module to a digital pin on the Arduino Uno, controlling the exhaust fan.
   GND and Vcc Pins of Relay Module to GND and 5V pins of Arduino respectively
   Whenever Gas is Detected Exhaust Fan will be Turned On.

Arduino Code :

```
#include <LiquidCrystal_I2C.h>
#include <Wire.h>
#include <SoftwareSerial.h>
#include<Servo.h>
#define sensorDigital A0
#define relay 8
#define buzzer 7
#define sensorAnalog A0

LiquidCrystal_I2C lcd(0x27, 16, 2);
SoftwareSerial GSM(3, 2);
Servo s1;
char phone_no[]="91+8669022407";

int data = 0;

int Red = 6;
int Green = 7;

void setup() {
  s1.attach(9);
  randomSeed(analogRead(0));
  pinMode(sensorDigital, INPUT);

    pinMode(relay, OUTPUT);

      pinMode(buzzer, OUTPUT);

  GSM.begin(9600);
  Serial.begin(9600);
  lcd.init();
  lcd.backlight();

   data=analogRead(sensorDigital);

```

```
  lcd.print(" Gas Leakage Detector");
  Serial.println("Init...");
  initModule("AT","OK",1000);
  delay(3000);
  lcd.clear();
}

void loop() {
bool digital = digitalRead(sensorDigital);

          int analog = analogRead(sensorAnalog);

          if (digital == 0)
          {

   lcd.setCursor(0, 0);
   lcd.print("Gas Level Normal");

    digitalWrite(relay, LOW);

    digitalWrite(buzzer, HIGH);

     delay(5000);

     digitalWrite(buzzer, LOW);

          }
   else {

   lcd.setCursor(0, 0);
   lcd.print("Gas Level high");
   lcd.setCursor(0, 1);
```

```
    lcd.print(" Calling..");
    delay(1000);
          lcd.clear();
             digitalWrite(relay, HIGH);
                digitalWrite(buzzer, LOW);

      }
  lcd.clear();
}

void callUp(char *number){
  GSM.print("ATD+"); GSM.print(number); GSM.println(";");
  delay(15000);
  GSM.println("ATH");
  delay(100);
}

void initModule(String cmd,char* res,int t){
  while(1){
    Serial.println(cmd);
    GSM.println(cmd);
    delay(1000);
    while(GSM.available()>0){
      if(GSM.find(res)){
        Serial.println((res));
        delay(t);
        return;
      }
      else{
        Serial.println("Error");
      }
    }
    delay(t);
      }
}
```

Chapter 6
RESULT

6.1 Arduino UNO interfacing with MQ2 Sensor and LCD Display

Here the whole circuit is in its rest state in the light. The LCD here won't show any danger as there is the no presence of gas in the environment. Firstly, it checks gas in surrounding if the gas is not leaked then it shows normal and if gas is present then it shows high level on LCD display.

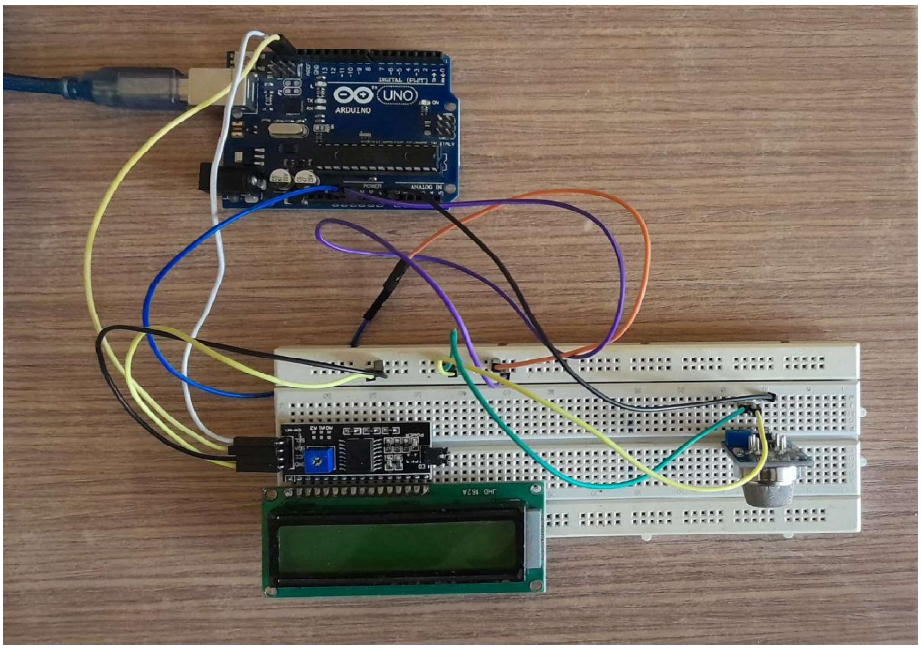

Fig 8. Arduino UNO interfacing with Display

6.2 LCD Display at normal condition

Here as the resting condition is shown when we have just started the model by giving it power supply. Then at normal state it shows the output as follows:

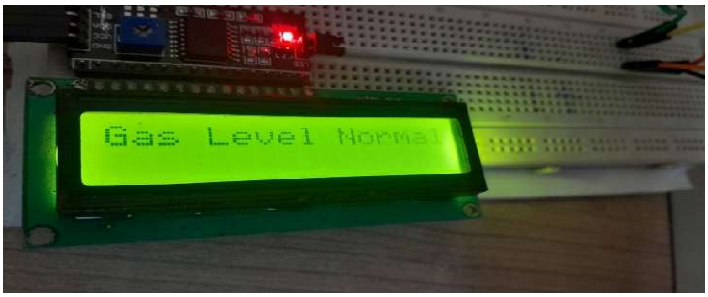

Fig 9. Result of LCD when there is no gas present

6.3 Power supply to the circuit

When the power is supplied to Arduino UNO then it starts displaying the gas level.

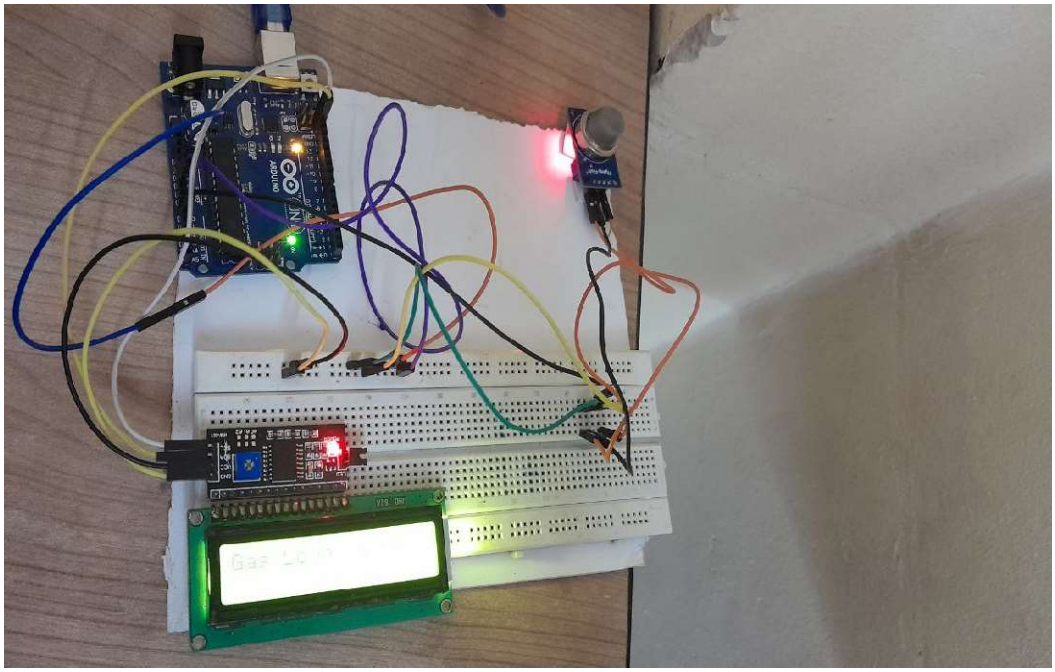

Fig 10. Result of when the gas Sensor Working

6.3 Ready to detect gas and start alarm call

Here the whole circuit is in its rest state as due to leaked gas is not detected yet. Whenever gas is get detected the MQ sensor will sense the gas and data will be displayed on LED display. Then Arduino will send signal to GSM SIM900A Module. GSM will give a alert call to provided contact number in program. Exhaust fan will be turned on to throw out the leaked gas.

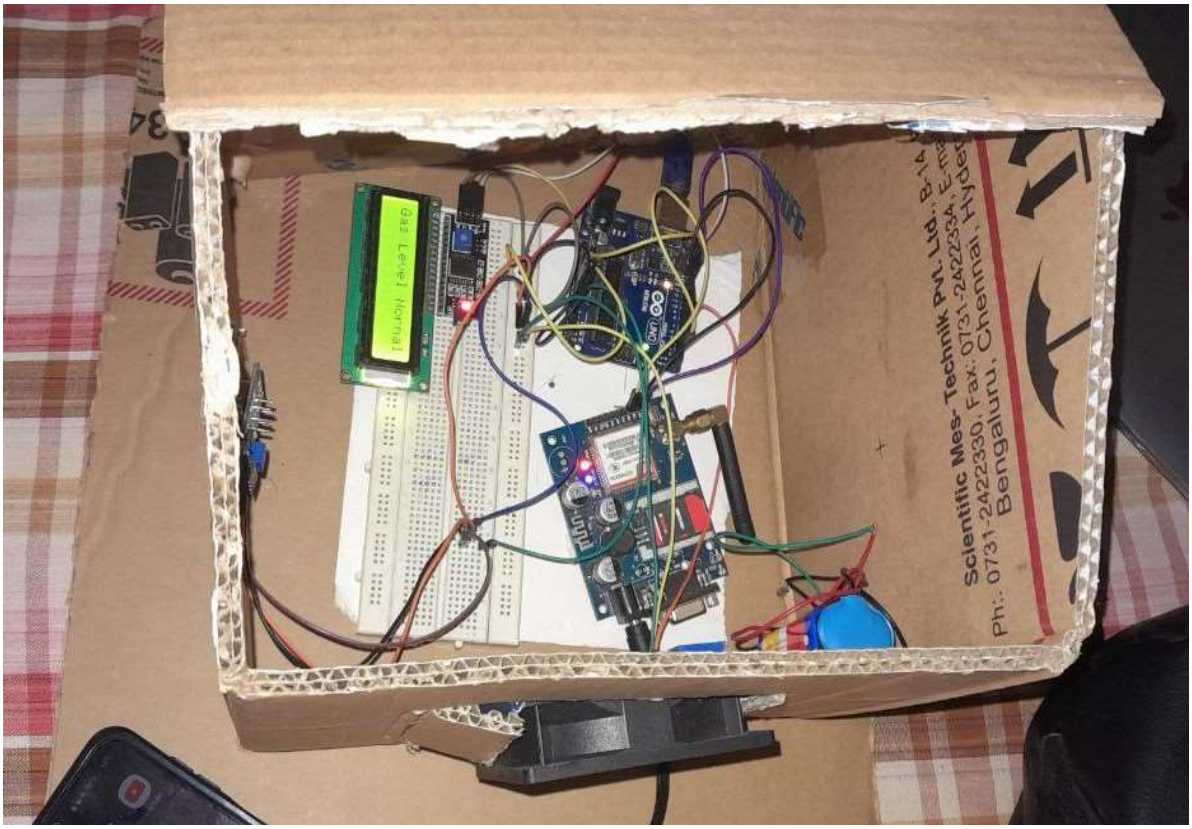

Fig 11. Result of sensing condition and Interfaced with GSM module

6.4 Gas detection and prevention

This system detects the leaked gas and starts alarming system so proper precaution will taken. And also prevents fire accident.

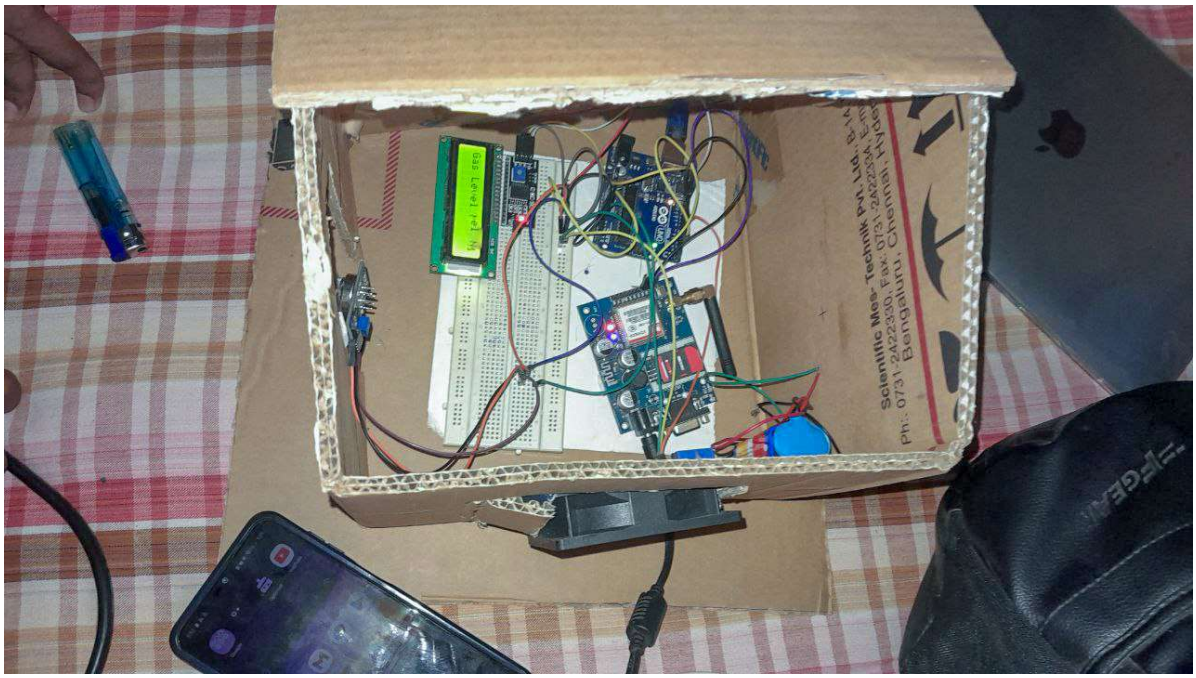

Fig 12. Result of Sensing Gas and Alert Call

Conclusion

In conclusion, the development and implementation of the Gas Leakage Detector System using IoT represent a significant step towards enhancing safety and efficiency in various environments. This project has successfully harnessed IoT technology to create a reliable, real-time gas detection and alert system. The system's ability to monitor gas levels continuously, provide immediate alerts, and facilitate remote control offers substantial benefits for safety, cost savings, and environmental preservation. By addressing the critical need for proactive gas leak detection, this project contributes to the advancement of IoT applications in the realm of security and environmental monitoring. It underscores the potential of technology to mitigate hazards and protect lives, making it a valuable addition to the field of gas detection and IoT-based solutions.

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