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A PROJECT PHASE I REPORT

On

GAS LEAKAGE DETECTION SYSTEM

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ABSTRACT

Liquefied Petroleum Gas (LPG) is a main source of fuel, especially in urban areas because it is clean compared to firewood and charcoal. Gas leakage is a major problem in the industrial sector, residential premises, etc. Nowadays, home security has become a major issue because of increasing gas leakage. Gas leakage is a source of great anxiety with ateliers, residential areas and vehicles like Compressed Natural Gas (CNG), buses, and cars which are run on gas power. One of the preventive methods to stop accidents associated with the gas leakage is to install a gas leakage detection kit at vulnerable places. The aim of this paper is to propose and discuss a design of a gas leakage detection system that can automatically detect, alert and control gas leakage. This proposed system also includes an alerting system for the users. The system is based on a sensor that easily detects a gas leakage.

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LIST OF ABBREVIATIONS

LPG	**-**	**LIQUEFIED PETROLEUM GAS**
IOT	**-**	**INTERNET OF THINGS**
PPM	**-**	**PARTS PER MILLION (mg/L)**
ASCII	**-**	**AMERICAN STANDARD CODE FOR INTERCHANGE**
I/O	**-**	**LINES INPUT OUTPUT LINES**
VCC	**-**	**COMMON COLLECTOR VOLTAGE**
VEE	**-**	**VOLTAGE AT EMITTER**

CHAPTER 1

INTRODUCTION

1.1 SCOPE AND OBJECTIVE

The Gas Level Detection and Gas Leakage Identification System (GLDG-LIS) is designed to monitor hazardous gas concentrations in real-time, detect gas leaks, and ensure safety in environments like industrial plants, homes, or public spaces. Its primary objectives are to provide early detection of gas leaks, trigger automated alerts, and initiate appropriate safety measures to prevent accidents, explosions, or harmful exposure. The system aims to enhance safety, improve operational efficiency, and support regulatory compliance by offering remote monitoring, data logging, and trend analysis. Additionally, it ensures predictive maintenance, reduces risks, and minimises operational costs through proactive leak identification and response mechanisms.

1.2 PROBLEM DEFINITION

Gas leakage is a serious problem and nowadays it is observed in many places like residences, industries, and vehicles like Compressed Natural Gas (CNG), buses, cars, etc. It is noticed that due to gas leakage, dangerous accidents occur. The Liquefied petroleum gas (LPG), or propane, is a flammable mixture of hydrocarbon gases used as fuel in many applications like homes, hostels, industries, automobiles, and vehicles because of its desirable properties which include high calorific value, less smoke, less soot, and meagre harm to the environment. Liquid petroleum gas (LPG) is highly inflammable and can burn even at some distance from the source of leakage. This energy source is primarily composed of propane and butane which are highly flammable chemical compounds. These gases can catch fire easily. In homes, LPG is used mainly for cooking purposes. When a leak occurs, the leaked gases may lead to an explosion.

Gas leakage leads to various accidents resulting in both material loss and human injuries. Home fires have been occurring frequently and the threat to human lives and properties has been growing in recent years. The risks of explosion, fire, suffocation are based on their physical properties such as toxicity, flammability, etc. The number of deaths due to the explosion of gas cylinders has been increasing in recent years.

The Bhopal gas tragedy is an example of accidents due to gas leakage. The reason for such explosions is due to substandard cylinders, old valves, no regular checking of gas cylinders, worn out regulators and a lack of awareness of handling gas cylinders. Therefore, the gas leakage should be detected and controlled to protect people from danger. An odorant such as ethane thiol is added to LPG, so that leaks can be detected easily by most people. However, some people who have a reduced sense of smell may not be able to rely upon this inherent safety mechanism. A gas leakage detector becomes vital and helps to protect people from the dangers of gas leakage There are different gas detection techniques used. In this paper a low-cost advanced sensor-based gas leakage detector, alert and control system is proposed and discussed. The system is very efficient, user friendly, portable, small in size and cost effective.

1.3 MOTIVATION

A LPG gas leakage detector is a crucial tool for ensuring the safety and well-being of your home or workplace. By swiftly detecting gas leaks, it helps prevent potential hazards such as fires or explosions, offering peace of mind. Prioritising the installation of a gas leakage detector not only protects your loved ones but also contributes to a safer environment, reducing the risk of accidents and saving lives.

1.4 DOMAIN INTRODUCTION

A gas leakage detection system using Arduino and sensors is an innovative and affordable solution to ensure safety in environments where the risk of gas leaks can lead to hazardous situations, such as in kitchens, factories, industrial plants, laboratories, and residential areas. This mini-project leverages the power of the Arduino microcontroller, a versatile open-source platform, combined with gas sensors like the MQ series (MQ-2, MQ-5, MQ-7, etc.), which are specifically designed to detect gases such as methane, carbon monoxide, liquefied petroleum gas (LPG), smoke, and other potentially harmful or explosive substances. The core idea of the system is to continuously monitor the air quality by measuring the concentration of these gases. The sensors detect the presence of the gases and send real-time data to the Arduino, which processes the information and compares it against pre-set safety thresholds.

The integration of Arduino makes this project both customizable and easy to implement, offering an accessible solution for learning about sensor interfacing, circuit design, and programming. Furthermore, this gas leakage detection system provides a practical, low-cost method to enhance safety and prevent dangerous situations caused by gas leaks, which are often undetected until it's too late. As it operates in real-time, the system helps in early identification of potentially harmful gas accumulations, reducing the risk of explosions, fires, or poisoning, thereby safeguarding both lives and property. This project also has immense potential for expansion, such as adding additional features like real-time data logging, remote monitoring, or even integrating with home automation systems. Overall, this Arduino-based gas leakage detection system not only serves as a functional safety device but also demonstrates the practical application of electronics and programming in addressing real-world problems, making it a valuable educational tool and highly applicable.

CHAPTER 2

LITERATURE SURVEY

2.1 Nagib Mafuz, Shaw Smart Gas Level Monitoring, Booking & Gas Leakage Detector over Karmokar , Md. Ismail Hossain Rana , IoT "IEEE 7th International Advance Computing Conference" issue-1-3 2017

• This paper approaches a smart technique for monitoring the leakage of LPG Gas

using IOT. This system can trigger an alarm if the gas leaks.

• It has good performance, Accurate output measured from LPG sensor.

• Low maintenance and low operating costs.

• The sensor has excellent sensitivity combined with a quick fast response time.

• Due to GSM cost of product will increase and using Arduino does not contain wifi module.

2.2 M.Anitha , A. Reethika Shree, R. Manjula Devi Smart LPG Gas Monitoring and Automatic Cylinder Reservation System "International Journal of Recent Technology and Engineering (IJRTE)" ISSN:2277-3878,Volume-9 Issue-1 May 2020

• Proposed methodology performed by this technology is detecting LPG leakage, displaying the weight of the cylinder through which we can determine in how many days it will be out of gas.

• LPG weight measurement and display the level of Gas Remaining and leakage detection has 90% accuracy.

• Due to GSM the cost of the product will be increased and also the maintenance charge will increase and we have to provide two batteries which will increase the cost.

2.3 Ajay Kumar, Mukesh Kumar, Design and Implementation of smart LPG Trolley With Home Safety "2016 2nd International Conference on Next Generation Computing Technology (NGCT-2016)" Issued on 16 October 2016.

• Weight measuring and displaying weight along with automatic booking. The desired outputs and results are displayed and notified to the user through this mobile application.

• Weight Measurement and Display of value is accurate with no delay.

• Automatic booking and display the remaining gas status in the LPG cylinder.

• No leakage detection, Due to Bluetooth range being short.

2.4 Jayesh Gupta, Abhijit Patil, Smart LPG Monitoring and Automatic Booking System using IOT " International Journal of Engineering Research & Technology (IJERT)" ISSN: 2278-0181 Vol. 9 Issue 04, April-2020

• Proposed methodology will perform certain actions simultaneously on detection of gas leakage and also help customer to lessen the burden of booking the cylinder to Distributor Company

• Accurate weight measurement, leakage detection and system are reliable.

• Gas detection Fire alarm SMS sent to the agency if gas finished before.

• No cloud data based will stored Due to raspberry pi and GSM cost of product will increase so it is not efficient for normal customers as well as agencies.

• Maintenance cost also will increase and this is not affordable.

CHAPTER 3

PROPOSED SYSTEM

3.1 FUNCTIONAL DIAGRAM

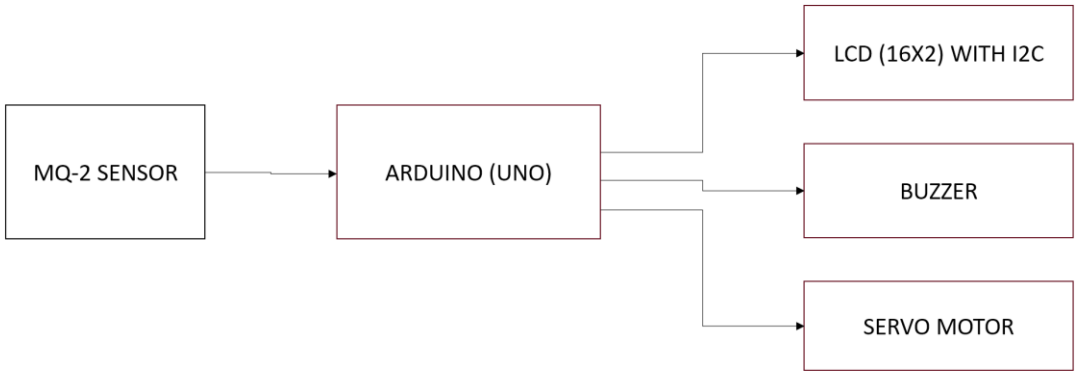


Fig 3.1 Functional Diagram

In this semiconductor sensors are used to detect LPG gas. An MQ2, a semiconductor sensor is used. Sensitive material of the MQ-2 gas the sensor is SnO2, which has lower conductivity in clean air. When the target combustible gas exists, the sensor conductivity increases along with the rising gas concentration. The MQ-2 gas sensor has a high sensitivity to Propane, Butane and LPG, and response to Natural gas. The sensor could be used to detect different combustible gases, especially Methane; it has a low cost and is suitable for different applications. The MQ-2 can detect gas concentrations anywhere from 200 to 10,000 ppm. The sensor's output is analog resistance. Figure above shows the block diagram of the gas leakage detection and alert system.

This system is based on the Arduino UNO R3 and MQ-6 gas sensor. When the sensor detects gas in the atmosphere, it will give digital output 1 and if gas is not detected the sensor will give digital output 0. Arduino will receive the sensor output as digital input. If the sensor output is high, then the buzzer will start tuning along with the LCD that will show that “Gas detected: Yes”. If the sensor output is low then the buzzer will not be tuning, and the LCD will show that “Gas detected: No”. The buzzer most commonly consists of a number of switches or sensors connected to control unit that determines which button was pushed or whether a preset time has lapsed, and usually illuminates a light on the appreciate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound.

3.2 APPLICATIONS OF USING GAS SENSOR

1) Harmful Gas Detection

The sensing of toxic gases such as H2S, Methane, and CO is of great importance in any industry to avoid unwanted leakage and consequences like poisoning or explosions. The presence of these gases can be easily detected in the industrial facilities and commercial buildings with the help of IoT-powered gas monitoring solutions. Moreover, a gas detector or sensor device is a crucial part to carry out safe industrial operations. The sensor-enabled solution helps prevent the high risk of gas explosions and affecting any casualties within and outside the premises.

2) Fire Hazard Prevention

The gas sensors help detect the concentration of gases present in the atmosphere to avoid hazardous consequences like fire breakouts. Also, it is an imperative solution to keep the plant workers and equipment safe from fire hazards. It effectively detects the presence of hazardous gases like propane and methane and alerts the plant authorities, preventing the premises from unexpected ignition. Moreover, a gas monitoring solution uses gas analyser to generate alerts regarding the temperature increase. This allows the management to take immediate actions to curb harmful fire explosions.

3) Oxygen Level Measurement

Sensing the presence of gases is a necessity to conduct industrial operations as several pitmen had lost their lives due to lack of oxygen in the process of mining explorations. A sudden decrease in the oxygen levels can result in dizziness, brain damage, or even death among the workers working in mines or close-packed industrial premises. A gas monitoring system significantly benefits the industries by maintaining proper oxygen levels that reflect the optimal performance of your workers. This system also creates alerts in real-time about the decreasing oxygen levels, which gives enough time to take necessary measures to evacuate the facilities much before the health gets affected.

3.3 COMPONENTS

TABLE 3.1 - LIST OF COMPONENTS

SI.NO	COMPONENTS NAME	QUANTITY
1.	Arduino UNO	1
2.	MQ-2 LPG Gas Sensor	1
3.	Buzzer	1
4.	Servo Motor	1
5.	IRF540N MOSFET	1
6.	10K ohm Resistor	1
7.	LPG Gas Regulator	1
8.	LCD Display	1
9.	Male to Male/Female Jumper Wires	30

3.3.1 ARDUINO UNO

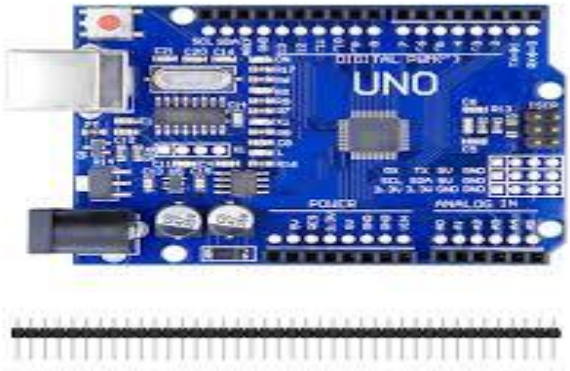


Fig 3.2 Arduino UNO

The Arduino Uno acts as the central processing unit that reads input from a gas sensor, typically an MQ-2, which is designed to detect the presence of combustible gases like LPG (Liquefied Petroleum Gas). When the sensor detects a concentration of gas above a certain threshold, it sends a signal to the Arduino, which then processes the information and triggers an alarm, such as a buzzer or an LED light, to alert users of a potential leak. The Arduino Uno's digital and analog input/output pins make it easy to interface with sensors and other components like alarms, relays for controlling gas shut-off valves, or communication modules for remote notifications. The simplicity of the Arduino Uno and its open-source nature allow for easy customization and expansion of the project, making it a perfect choice for creating affordable and reliable gas leakage detection systems for home or industrial safety applications.

3.3.2 MQ-2 LPG GAS SENSOR

Fig 3.3 MQ-2 Gas Sensor

The MQ-2 gas sensor is a widely used sensor for detecting a variety of gases, including LPG (Liquefied Petroleum Gas), methane, carbon monoxide, and smoke. It consists of a sensitive metal oxide semiconductor (MOS) material that changes its resistance in the presence of gases. When the sensor detects the target gas, such as LPG, the resistance of the material decreases, which can be measured and processed by a microcontroller, like an Arduino. The MQ-2 sensor typically has both analog and digital output, allowing it to provide a continuous measurement of gas concentration or a simple binary output for triggering an alarm when the gas level exceeds a certain threshold. It is highly effective in applications like gas leak detection, air quality monitoring, and fire detection systems. With its relatively low cost and ease of use, the MQ-2 sensor is ideal for hobbyist and industrial applications, making it a popular choice for projects that require gas detection capabilities.

3.3.3 BUZZER

Fig 3.4 Buzzer

A buzzer is a critical component in an LPG leakage detector system, serving as an audible alarm to alert users of a potential gas leak. When an LPG gas sensor, such as the MQ-2 or MQ-6, detects a gas concentration above a certain threshold, it sends a signal to the microcontroller (like an Arduino Uno), which then activates the buzzer. The buzzer produces a loud sound, which helps to draw attention and signal the presence of a danger in environments where LPG is used, such as kitchens or industrial settings. The buzzer can be a simple passive or active type, with active buzzers producing a continuous sound when powered, and passive buzzers requiring a specific frequency signal to generate sound. In an LPG leakage detector, the buzzer plays a crucial role in providing immediate feedback, allowing users to take prompt action, such as ventilating the area or shutting off the gas supply, to prevent accidents.

3.3.4 SERVO MOTOR

Fig 3.5 Servo Motor

A servo motor can be an essential component in an advanced LPG leakage detector system, particularly when the project includes an automated safety feature, such as shutting off the gas supply in the event of a leak. In such a setup, the servo motor is typically used to control a valve or mechanism that can physically stop the flow of gas when a leak is detected. When the gas sensor, like the MQ-2 or MQ-6, detects an abnormal concentration of LPG in the air, the microcontroller (Arduino Uno) processes the signal and triggers the servo motor to rotate. This motion can be used to turn a valve to the "off" position, halting the gas flow and reducing the risk of a hazardous situation. The precision and reliability of servo motors make them ideal for this type of application, where controlled and accurate movement is crucial for safety. Integrating a servo motor into an LPG leakage detector adds an extra layer of automation, helping to enhance the overall safety and functionality of the system.

3.3.5 IRF540N MOSFET

Fig 3.6 IRF540N MOSFET

The IRF540N MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor) is a powerful electronic switch that can be used in an LPG leakage detector to control high-power components, such as solenoid valves or other actuators, for automatic safety actions. In an LPG leakage detection system, when a gas sensor (like the MQ-2 or MQ-6) detects an LPG leak, the microcontroller (e.g., Arduino Uno) processes the sensor input and sends a signal to the IRF540N MOSFET. The MOSFET then acts as a switch to control the flow of current to an external component, such as a servo motor or gas valve. Using the IRF540N MOSFET in the circuit is beneficial because it can handle higher voltages and currents than standard transistors, making it suitable for driving power-hungry components in safety-critical applications. The MOSFET operates efficiently, with minimal heat dissipation and low on-resistance, which is important for ensuring the system remains reliable and responsive. In an LPG leakage detector, the IRF540N enables quick and safe actuation of systems like gas shut-off valves or relays, contributing to the overall safety of the environment by preventing gas-related accidents.

3.3.6 LCD DISPLAY

Fig 3.7 LCD Display

An LCD I2C display is an essential component for an LPG (Liquefied Petroleum Gas) gas leakage detector system. The display provides a clear and easy-to-read interface for users, showcasing critical information such as gas concentration levels, system status, and alert notifications. By utilising the I2C communication protocol, the LCD can efficiently display data while minimising the number of microcontroller pins required, making it ideal for space-constrained projects. In a gas leakage detection system, the display can show real-time gas levels, warnings when gas is detected, and visual indicators like colour-coded text or symbols to alert users of potential hazards. Additionally, the low power consumption of I2C displays ensures that the overall system remains energy-efficient and suitable for continuous operation in safety-critical environments.

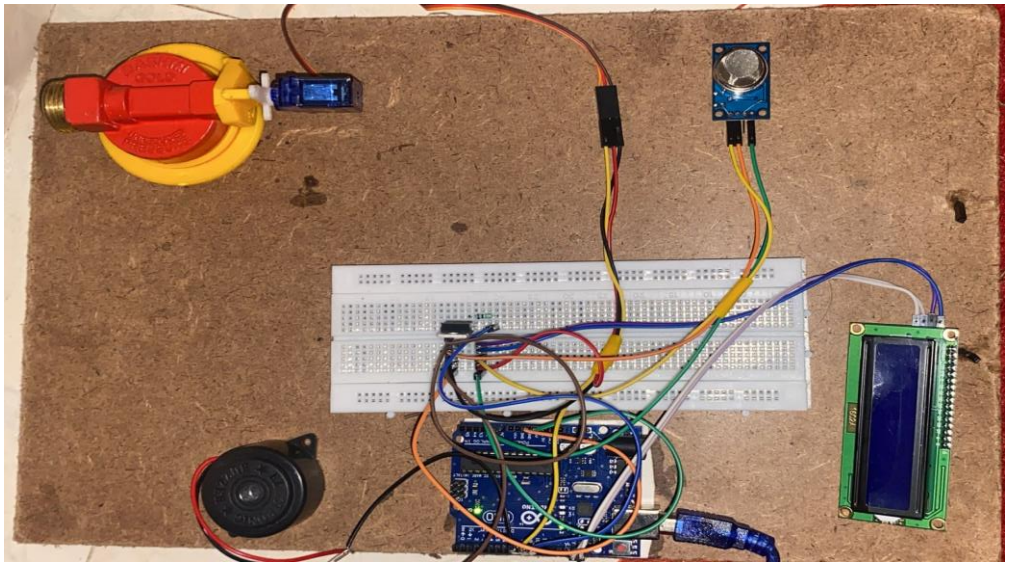
TABLE 3.2 -LCD PINS DESCRIPTION

PIN NO	FUNCTION	NAME
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	VCC
3	Contrast adjustment; through a variable resistor	VEE
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight VCC (5V)	Led+
16	Backlight Ground (0V)	Led-

CHAPTER 4

HARDWARE

4.1 HARDWARE OUTPUT



- The gas sensor MQ-2 is connected to the Arduino's analog input pins to detect the concentration of gas. The LCD display is connected to the Arduino via the I2C interface for easy data visualisation of gas levels and system status.
- A servo motor is linked to a digital pin of the Arduino to trigger a mechanical response, such as closing a valve or activating a safety mechanism when gas levels exceed a safe threshold.
- The buzzer is connected to another digital pin to sound an alarm when the sensor detects a gas leak. All components are connected using jumper wires to the appropriate pins on the Arduino. This setup creates a simple yet effective gas leakage detection system, with visual and auditory alerts for safety.

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

The design of a sensor-based automatic gas leakage detector with an alert and control system has been proposed and discussed in this paper. This is a low-cost, low power, lightweight, portable, safe, user friendly, efficient, multi featured and simple system device for detecting gas. Gas leakage detection will not only provide us with significance in the health department but it will also lead to a rise in our economy, because when gas leaks it not only contaminates the atmosphere but also wastage of gases will hurt our economy. The proposed system will cost only USD 20 which is easily affordable even for poor people. In the open literature it is noticed that much work has not been done for a smart gas detection system. In future, more advanced features will be integrated with this system which will provide users with more safety and relaxation. The proliferation of handheld devices has led to developments in the field of smart gas sensors, which has considerably widened their scope of application. The need for ensuring safety in workplaces is expected to be the key driving force for the market over the coming years.

5.2 FUTURE SCOPE

The future scope of the LPG Gas Leakage Detector can be significantly enhanced by integrating more advanced technologies. One key development would be the incorporation of machine learning algorithms to analyse sensor data over time, allowing the system to predict potential gas leaks based on patterns and environmental conditions. This predictive capability could help in early detection, reducing the risk of accidents. Additionally, using multi-sensor arrays (e.g., combining gas sensors with temperature, humidity, and pressure sensors) would enable more accurate and reliable gas leak detection, compensating for environmental fluctuations that may affect sensor readings.

Edge computing could also be integrated to process sensor data locally on the device, reducing latency and dependency on cloud-based systems while ensuring faster response times. Furthermore, low-power wide-area network (LPWAN) technologies, like LoRaWAN or NB-IoT, could be utilised to enable long-range, low-power communication for remote monitoring and real-time alerts in large industrial setups or remote locations. The addition of cloud-based data analytics platforms would allow for real-time tracking, analysis, and reporting of gas leakage trends across multiple devices, providing users with actionable insights. Finally, smart gas shutoff systems could be further enhanced by integrating solenoid valves controlled via mobile apps or IoT platforms, enabling automatic or remote shutdown of gas supplies in case of leaks, adding an additional layer of safety.

APPENDIX SOURCE CODE

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <Servo.h>

// Pin Definitions
#define MQ2_SENSOR_PIN A0
#define BUZZER_PIN 8
#define SERVO_PIN 9

// Create LCD object (address 0x27, 16 columns, 2 rows)
LiquidCrystal_I2C lcd(0x27, 16, 2);

// Create Servo object
Servo myServo;

// Threshold values for LPG detection
int gasThreshold = 110; // Set based on your calibration of the MQ-2 sensor

void setup() {
  // Initialize the LCD
  lcd.begin(16, 2);
  lcd.print("LPG Detection");
  delay(2000);
```

```
 // Initialize Buzzer
  pinMode(BUZZER_PIN, OUTPUT);

  // Initialize Servo
  myServo.attach(SERVO_PIN);
  myServo.write(0);  // Initial position of the servo (closed/normal)

  // Start Serial Monitor
  Serial.begin(9600);
}

void loop() {
  // Read sensor value
  int sensorValue = analogRead(MQ2_SENSOR_PIN);
  Serial.print("Sensor Value: ");
  Serial.println(sensorValue);

  // Display gas sensor value on LCD
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Gas Level: ");
  lcd.print(sensorValue);

  // Check if gas level exceeds threshold
  if (sensorValue > gasThreshold) {
    lcd.setCursor(0, 1);
    lcd.print("Gas Detected!");
```

```
// Turn on the buzzer
    digitalWrite(BUZZER_PIN, HIGH);

    // Rotate servo to simulate action (open valve or trigger alarm)
    myServo.write(140); // Rotate servo to 90 degrees (open position)

    // Sound the buzzer for a warning
    delay(5000); // Wait for 1 second before stopping the buzzer
    digitalWrite(BUZZER_PIN, LOW);

    // Keep the servo in the triggered position
    delay(2000); // Wait for 2 seconds before rechecking gas level
  } else {
    lcd.setCursor(0, 1);
    lcd.print("No Gas Detected");

    // Reset servo to closed position if no gas is detected
    myServo.write(0);  // Servo back to initial position (closed)
  }

  delay(500);  // Delay before the next reading
}
```

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