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CS5068NI– Cloud Computing & IoT

LPG Gas Leakage Detection System

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I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

Acknowledgement

I want to thank Sugat sir, Jaganath sir for the help. It would have been difficult for us to understand cloud integration with real world IOT works without their help. We learnt a lot about team management and real-world imprecation of cloud and IOT to make our lives more convenience. Helping us in crucial steps and giving room for growth that’s something I really liked about our teachers. So, thank you for the opportunities provided by teachers to help us grow and to make this project successful.

ABSTRACT

Due to risks associated with LPG gas leakage, most households and industries face the threat of potential accidents and safety hazards. Detecting the gas leakage in time and shutting off the gas supply manually is both unreliable and difficult. Often, the leakage is not notice until it has already created a hazardous situation, increasing the risk of fires, explosions or health issues.

To resolve these issues associated with LPG gas leakage, an LPG gas leakage system can be utilized. This system monitors the presence of gas in the environment with the help of an LPG gas sensor. The sensor sends data to an Arduino controller when the concentration of gas surpasses a certain limit. A mechanism is automatically deployed to the shut off the gas regulator with the help of the Arduino, preventing further leakage and ensuring safety.

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1. Introduction

The Internet of Things is an integrated system of interconnected components that makes it easier for devices to communicate with each other and with the cloud. IoT, a thing that we use in our daily life, is made up of a network of connected objects that sends and receives information (valuable info) throughout real time without human intervention. These sensors, software, and connectivity-enabled devices provide automated monitoring, control, and data analytics across a variety of applications.

IoT technology has altered safety systems by delivering real-time data, predictive analytics, and timely alerts. IoT technology is critical in improving reliability and security when detecting LPG leaking. IoT-enabled devices can continuously monitor gas levels, detect leaks, and inform users via mobile apps or alarms. Furthermore, these systems can initiate automated measures, such as turning off gas valves or informing emergency services, ensuring a prompt reaction to possible threats. The use of IoT in gas leak detection systems indicates.

1.1. Current Scenario

Because of the effectiveness and clear combustion properties, liquefied petroleum gas, also known as LPG, now is one of the more popular forms of energy on Earth. It is crucial for homes, companies, and travel, and demand is predicted to increase by over 4.4% a year. However, because of its great ignite ability, Gas presents an important threat to safety. More than 18k (18000) gas leaks are reported in India every year. In places with little airflow, where traditional leak detection methods, such as relying on our sight or smell, probably usually fails, this risk rises significantly. This approach enables automated replies, real-time monitoring, and timely notifications.

1.2. Problem statement and Project as a solution

The increase of use of our daily life Liquefied Petroleum Gas also known as LPG (in short terms) in homes and enterprises has prompted important safety issues because of its extreme combustible nature and leaks in frequent more than 18K (18000) per year in India alone. Traditional detection approaches, such as relying on smell, are unreliable, and improved technologies remain too expensive for broad usage. To solve this, we offer a cheap IoT-based LPG detection system that detects leaks in real time, sends automated notifications via SMS or mobile apps, and allows for remote monitoring. To avoid any mistakes, the system will also initiate some emergency procedures as such turning off the gas supplies. Designed in the way to be effective in costing and kind of scalable, this solution increases safety and accessibility, particularly in low-income and rural areas like for us common people, while also catering to bigger setups such as restaurants and various businesses.

1.3. Aim and Objectives

Aim

- Our main aim for this project is to develop a sensor based IOT system capable of detecting LPG gas leakage to prevent accidents by giving alerts and taking safety actions automatically

Objectives

- To build a system that detects a daily life using LPG gas leakage using an LPG gas sensor and Arduino Uno.
- To alert users of gas leakage through a buzzer alarm.
- To use a cooling fan to reduce the spread of leaked gas.
- To connect all the components, including IRF540N MOSFET, mini board, and jumper wires, to ensure smooth operation.
- To make system affordable, easy to use, and suitable for homes and industries.

2. Background

LPG (Liquefied Petroleum Gas) is highly used, especially in kitchens for domestic use and also for industries. However, the flammable nature of LPG poses numerous risks, such as explosions and fire outbreaks. The gas, if inhaled, can lead to suffocation and also death. The most common causes of gas leaks in domestic households and industries are because of incorrect installation of the LPG.

We are developing a system that detects gas leakages and alerts the people. The LPG gas leakage detection system focuses on early detection and prevention of gas leaks. This system is helpful in preventing injuries and even loss of life. The system is a combination of gas sensors, actuators, and control systems that is designed to enhance safety measures and prevent hazards.

2.1. System Overview

The gas leakage detection system is designed to detect and monitor gas leaks and also to provide a smart reaction for the safety. Four Arduino Uno boards serve as the system's main controllers, handles output and sensor data analysis.

It constantly finds gas leaks in the surroundings areas. Six LPG gas sensors are used. Seven buzzers set up by the Arduino when a leak is detected. Servo motors are included as well into the system. Jumper wires connect the complete system ensuring complete interaction between components.

2.2. Expected Outcomes and Deliveries

The LPG gas leakage detection system will detect the gas in the environment using the sensor. It ensures immediate alerts through a buzzer sound to make the users take action on the leakage area. The deliverables include components such as an Arduino Uno, LPG gas sensor, servo motor, buzzer, CPU cooling fan, IRF540N MOSFET, breadboard, and wires. The system will be adaptable for households as it has easy integration and is affordable.

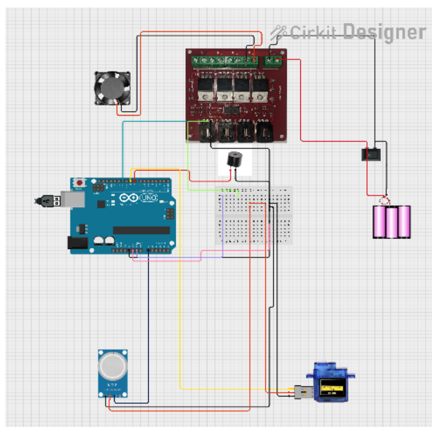

Figure 1:Working process of the system

The figure above indicates how the system works. The LP Gas sensor monitors the environment for the presence of LP Gas. The Arduino Uno reads the sensor output. Then the buzzer is activated to produce an alert. The CPU cooling fan is activated via the IRF540N MOSFET.

2.3. Design Diagrams

- **Hardware Architecture**

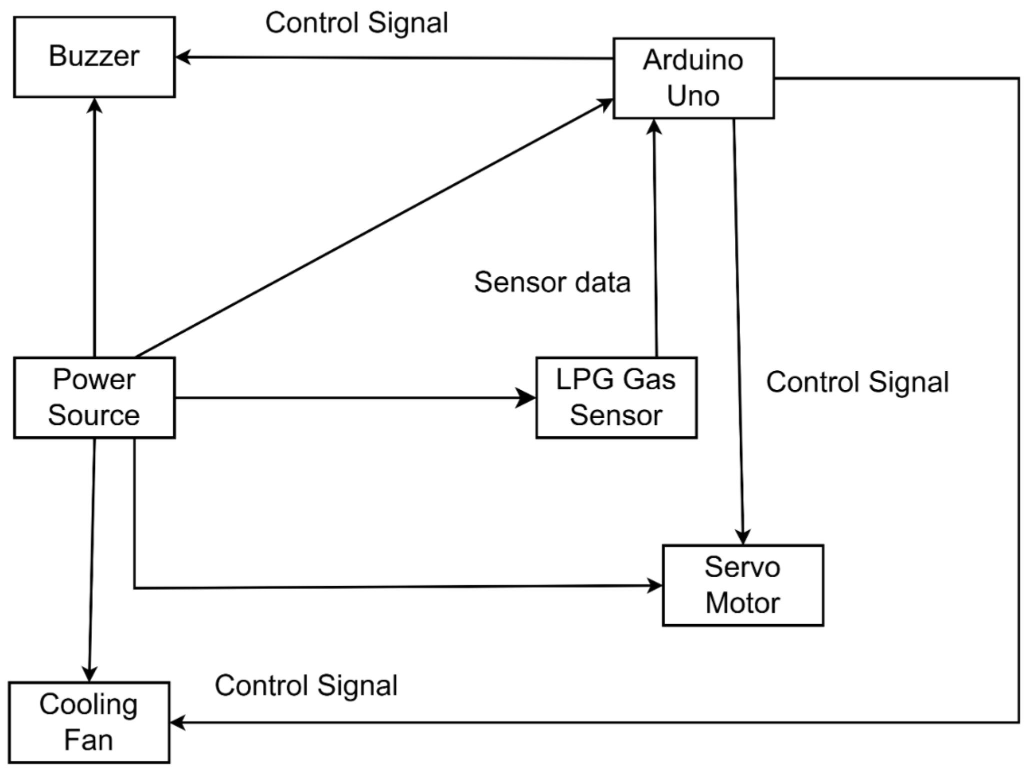

Figure 2: Hardware Architecture

- **Flowchart**

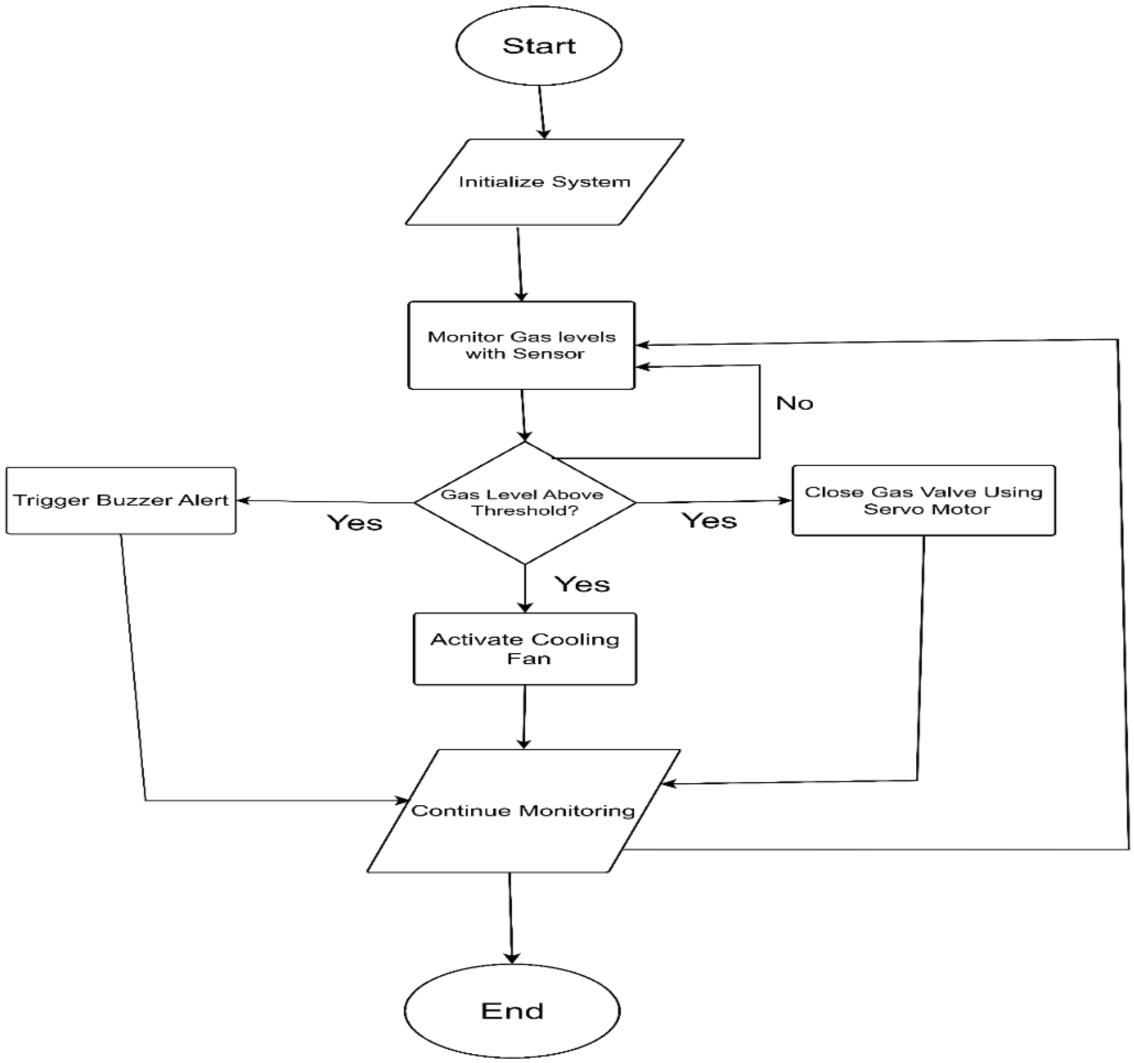

Figure 3: Flowchart

- **Circuit Diagram**

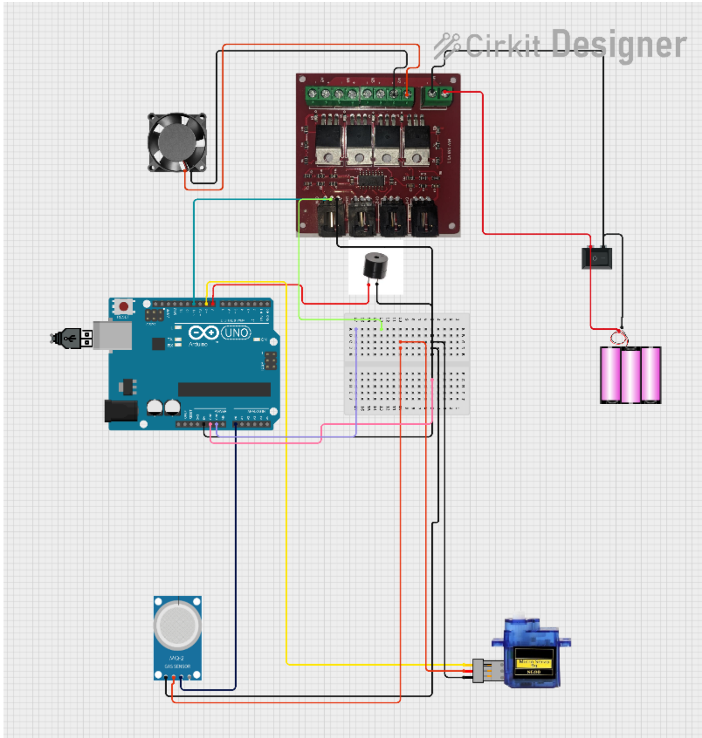

Figure 4: Circuit Diagram

- **Block Diagram**

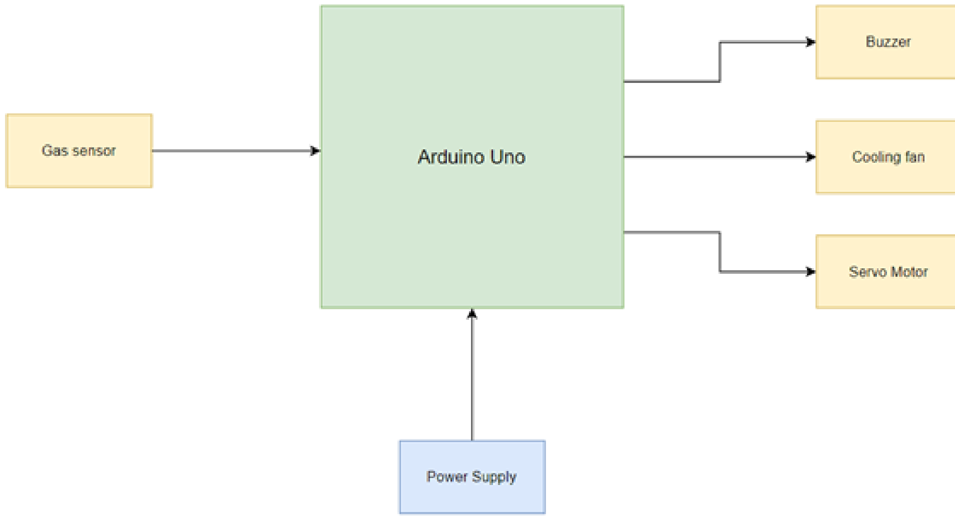

Figure 5: Block Diagram

The hardware architecture of the device is displayed in the image above. The Arduino Uno (microcontroller) is the primary component. The data is received from the left side from the gas sensor. The components (Buzzer, Cooling fan, Servo motor) on the right side of the image receive instructions from the Arduino after it processes the data. Power is provided to the Arduino (microcontroller) from the laptop through a USB cable.

2.4. Requirement Analysis

- **Hardware**

Arduino Uno:

Arduino UNO was the company's first USB board which is recognized as a durable surface than can be used in many different tasks. Compared to other boards, like the Arduino Mega Board, etc., it is simpler for us to separate. It is also compatible with both offline and internet platforms. (Anon., 2024)

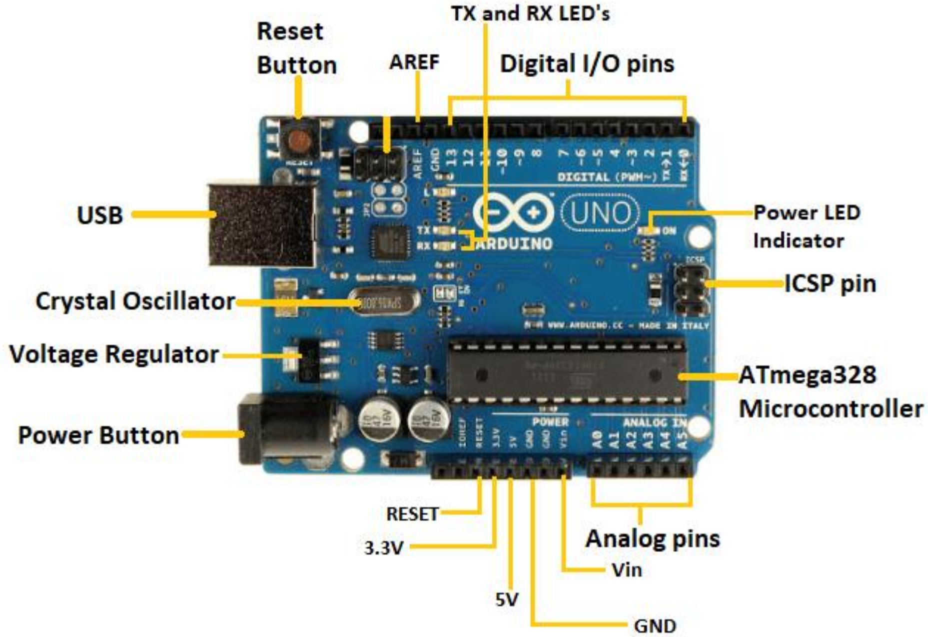

Figure 6: Arduino Uno

Servo Motor:

The type of motor than can rotate with extreme accuracy is a serve motor. This particular type of motor usually includes a circuit for control that provides feedback on the motor shaft's existing location. This type of feedback enables the servo motors to rotate extremely accurately. A servo motor is used if you desire to rotate something at an appropriate angle or distance. It is made up simply of a fundamental motor which operates by a servo mechanism. (Anon., 2023)

Figure 7: Servo motor

LPG gas sensor:

A specific kind of device used to detect the possibility of a hazardous LPG gas leakage in houses, automobiles, pipelines, and petrol pump is an LPG gas sensor. For the purpose of warn, the operators of the gas leak in the nearby areas, this sensor is connected to an emergency circuit and generates an alarm sound.

Figure 8: LPG gas sensor

Buzzer:

A buzzer is an electronic device that transfers electrical impulses that generate sound. It typically operates between 5 and 12 volts and is mainly used to generate a hearing alarm or alert. These models offer a number of forms, with each having unique functions, operating theories, and techniques to generate sounds. (Anon., 2024)

Figure 9: Buzzer

Jumper wires:

Jumper wires are wires which consists of connector pins on both of its end. The pins allow them to connect it's both point with each other without welding. Jumper wires are mostly used with breadboards and other prototyping tools to make it simple to replace circuit as required. (Anon., 2016).

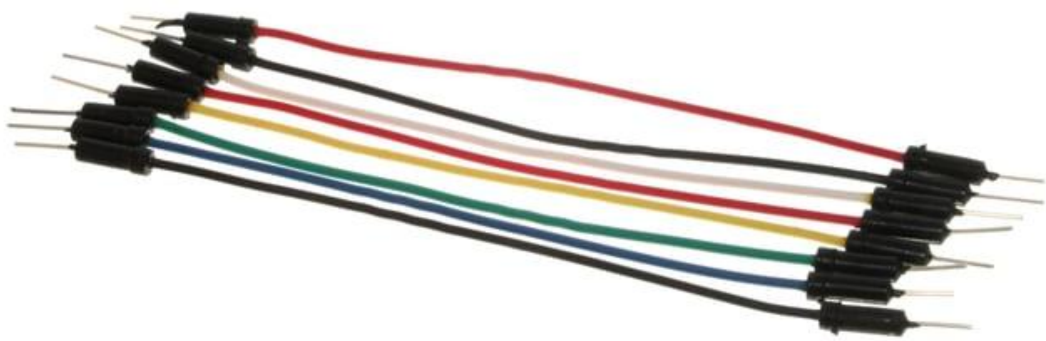

Figure 10: Jumping wires

- **Software**

Arduino IDE:

Code is written and uploaded to Arduino boards using the open-source Arduino IDE software. It is suitable with different operating systems like Windows, Mac OS X, and Linux.

Draw.io:

It makes the system architecture and several other block diagrams.

Ms Word:

Ms Word is used in creating the report for the overall proposal of the project.

Cirkit Designer:

Cirkit Designer IDE is an all-in-one circuit design tool that helps you create and share electronic circuits with ease.

3. Development

The development of the LPG Gas Leakage Detection System followed the structured way to make sure project is done without much errors and below is the stepwise description of the process:

3.1. Step 1: Planning and Design

This phase of plan included understanding the scope, system requirements and the objectives mentioned in the project. Our project aims to develop an IoT-based system that can detect LPG gas leaks, while going through safety measures like turning off the regulator.

During this phase:

- A few system designs were created, including diagrams like Hardware Architecture, Circuit Diagram, Flowchart, and Block Diagram of the system.
- Key components are as Arduino Uno, LPG Gas Sensor, Servo Motor, Buzzer, and Jumper Wires were used.

3.2. Step 2: Resource Collection

All required hardware and software resources were collected and prepared. These included:

- Hardware: Arduino Uno, LPG gas sensor, buzzer, servo motor, IRF540 Isolation Power Module Electronic Block 4 Channel MOSFET, mini breadboard, jumper wires, and CPU cooling fan, Three 4v batteries, switch, regulator.
- Software: Arduino IDE (for coding and uploading programs), Cirkit Designer (for circuit simulation), and MS Word (for documentation).
- Working with team members ensured our efficient resource management, with some components being sourced locally while others were obtained from college resource department.

3.3. System Development

Our system is an IOT based LPG gas detector with auto cut off feature which helps in the reduction of various accidents related to daily households in kitchen regarding LPG. At the start the Arduino was connected to the laptop for power supply and also for us to upload and execute the code.

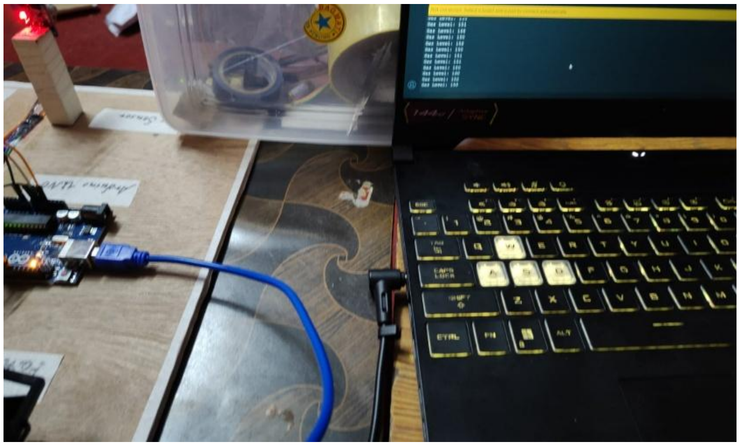

Figure 11: Powering up and executing code for arduino

The above figure, the first step was conducted by providing power supply to the Arduino then the servo motor gets powered up and when the gas is detected the servo motor turns off the regulator automatically.

After that the breadboard and Arduino were connected with the mosfet IRF540N mosfet and we used IRF540 4 channel mosfet for controlling our cooling fan's speed and as it also provides protection to Arduino as well.

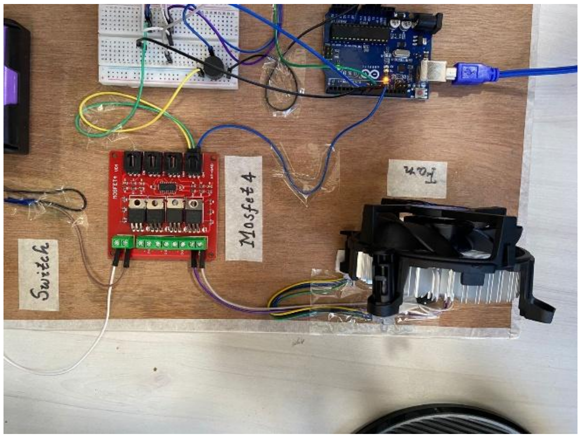

Figure 13: Connecting mosfet for efficiency and control

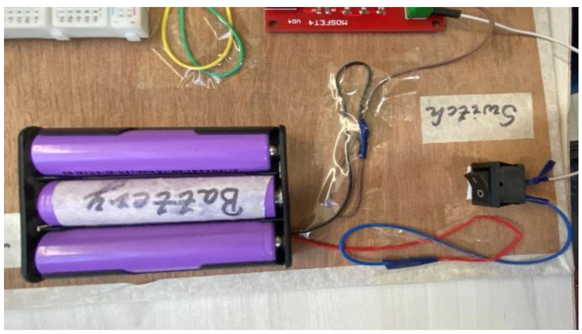

Figure 12: connecting battery with switch to mosfet

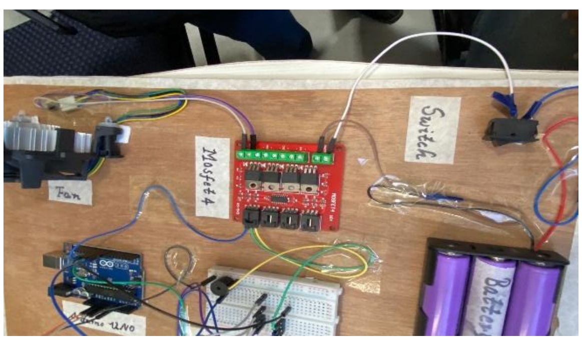

Figure 14: Connection among switch, battery, mosfet and fan

The above figures show the Mosfet connection to Arduino and mini breadboard as we need to control the 12v fan, so power supply for the fan we used extra power supply three 4v batteries and connected them through a switch and connected the fan with it.

Then we come to the step of adding the servo motor to the mini breadboard and Arduino, since it is needed to turn off the LPG regulator when gas leakage is detected and with the help of code done in Arduino IDE it automatically starts as a safety mechanism.

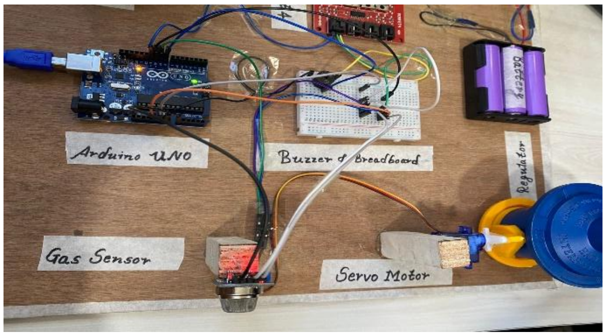

Figure 15: Connecting for servo motor

In this step, we connected the servo motor to the mini breadboard and attached it to the LPG regulator turn on/off knob as the code works when the leakage is detected the servo motor will automatically start and then it will turn the knob off.

Here, we connected the MQ2 gas sensor with mini breadboard and Arduino. This sensor helps to detect and then start the next phase for the safety protocol and the servo motor starts after it detects the leakage as the code goes.

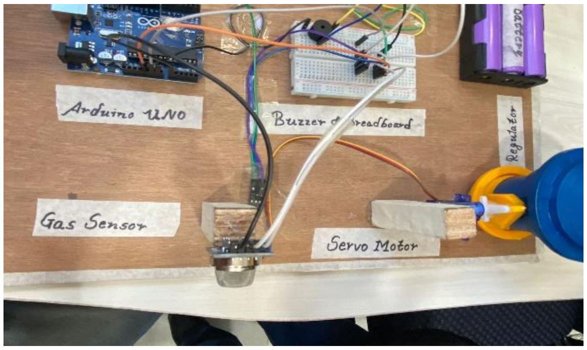

Figure 16: Connecting gas sensor for detection

After this step, we connected the fan for after leakage safety protocol as it circulates the air and helps dilute the leaked LPG leakage in the environment, reducing the risk of it reaching a dangerous level that could ignite and with this a regulator was connected with the servo motor as to showcase it works when the gas is leaked.

4. Results and Findings

- **Results**

The efficient use of IoT in safety applications was highlighted by the gas leak detection system's successful demonstration of its ability to detect gas leaks and respond immediately. LPG gas sensors were included to enable accurate and fast leak detection, and the Arduino Uno effectively processed sensor data to turn on servo motors and buzzers. Users were instantly notified to any dangers by the buzzers' quick audio signals. The servo motors performed as planned, imitating the automated regulation of ducts or valves to minimize the impact of gas leakage. The importance of exact component coordination for smooth operation and the importance of sensor testing to prevent false alarms are two important takeaways from the project. Because of its modular design, the system may be adjusted to fit larger spaces. All things looked at the study proved the viability and reliability of Internet of Things-based gas detection devices, highlighting their potential to improve safety in both home and commercial environments.

- **Findings**

For this section, we will be testing various cases as to prove that our project went on without any errors. The test cases are as follows:

(a) Test 1

Test No:	1
Objective:	To show the execution of the code for the project
Action:	Code was verified and uploaded in Arduino IDE.
Expected Result:	Compiling of the code to be successful.
Actual Result:	Execution was successful.
Conclusion:	The test was successful.

Table 1: Test Case 1

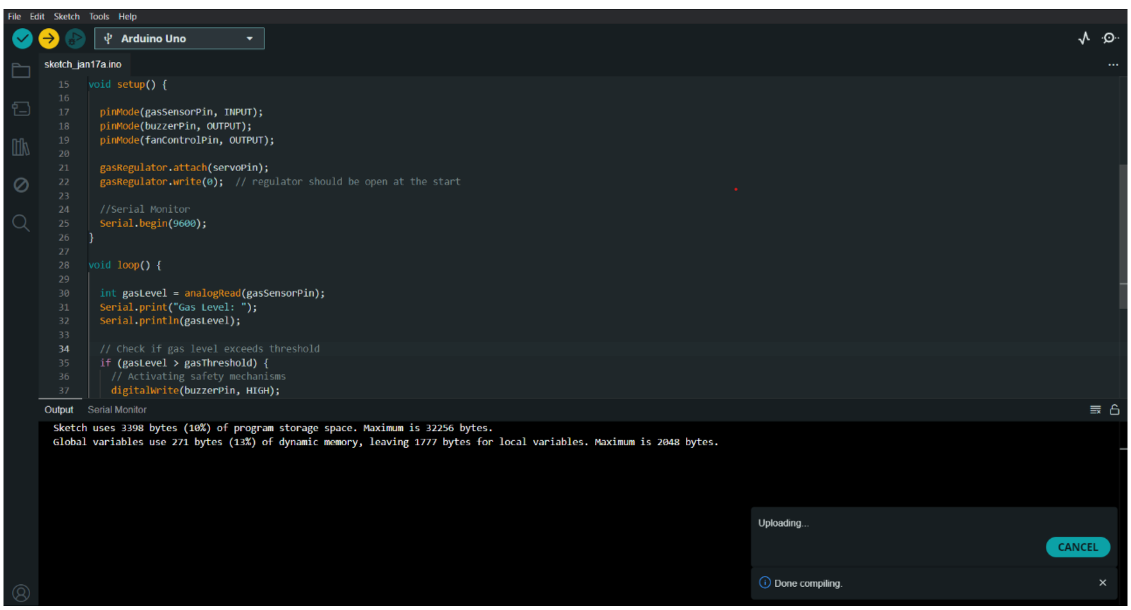

Figure 17: Execution of Code

(b) Test 2

Test No:	2-
Objective:	To check if the led turns on signalling in gas leak with the buzzer alarming when gas leakage is detected.
Action:	Lighter was used near the sensor.
Expected Result:	The green LED on gas sensor would turn from on and the buzzer will start pinging.
Actual Result:	The green LED was turned on and the buzzer was pinging signalling gas leakage.
Conclusion:	The test was successful.

Table 2: Test Case 2

Figure 18: Warning of gas leakage

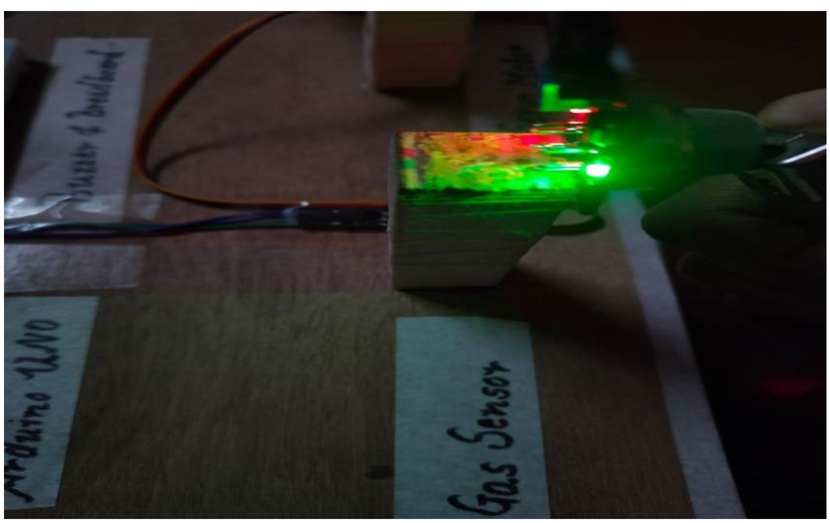

Figure 19: Sensor reacting to gas leakage

(c) Test 3

Test No:	3
Objective:	To check if the switch is off whether the fan works or not.
Action:	Switch was turned off and lighter was used to increase gas level.
Expected Result:	Fan wouldn't run without the power supply provided from battery turned on by switch.
Actual Result:	Fan didn't run.
Conclusion:	The test was successful.

Table 3: Test Case 3

Figure 20: Turning switch off

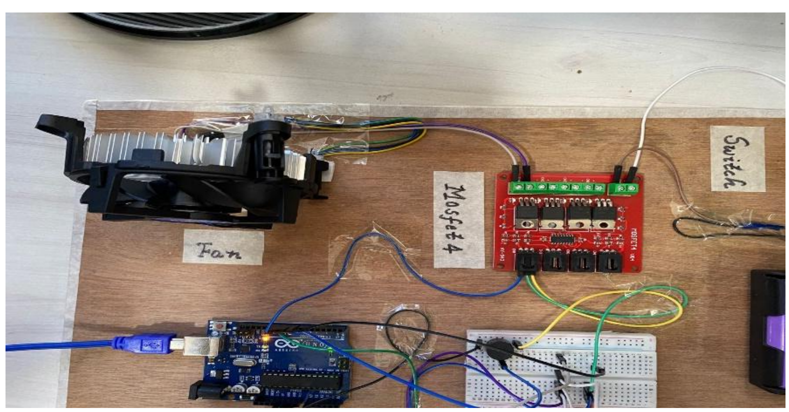

Figure 21: Fan was not running

(d) Test 4

Test No:	4
Objective:	To check if the knob turns itself automatically off after gas leakage is detected.
Action:	Lighter was used for leakage.
Expected Result:	Servo motor should turn the regulator knob off after gas leakage detection.
Actual Result:	Servo motor turned the regulator knob off after detecting gas leakage.
Conclusion:	The test was successful.

Table 4: Test Case 4

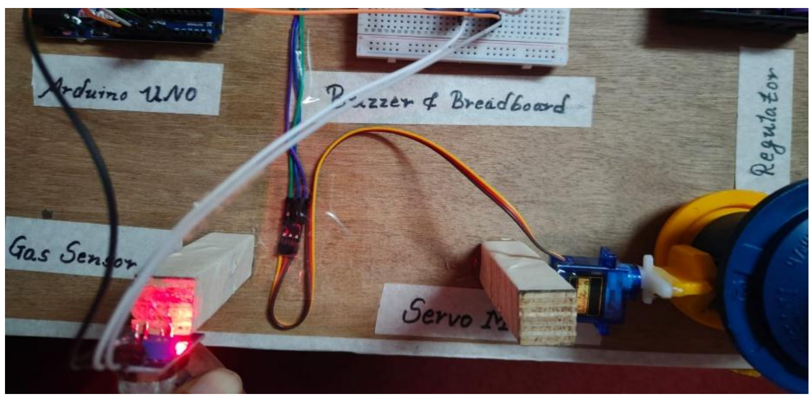

Figure 22: Regulator knob before gas leakage

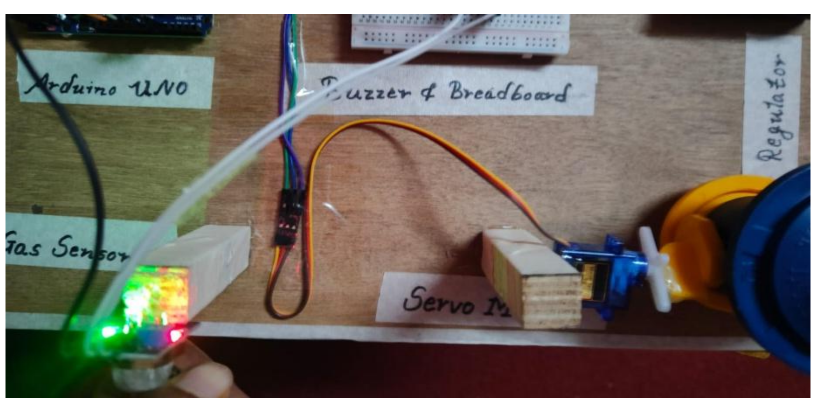

Figure 23: Regulator knob after gas leakage

5. Future Works

In the future, this LPG Gas Leakage Detection System can be improved to work even better. One idea is to add a mobile app or a web dashboard so that users can monitor the gas levels and get alerts if there’s a leak. This way, they can respond quickly even when they are not at home. The system could also be upgraded to detect other gases, not just LPG, to provide more safety. It could even connect to smart home systems to automatically turn off appliances or open windows when a gas leak is detected. The gas sensor can be improved for more accurate readings, and the system could also use smart technology like machine learning to predict possible leaks based on patterns. This would make the system even more automatic and helpful. For the system to be used more widely, it will need support from safety organizations and local authorities. Over time, the system can be used in places like restaurants and factories to keep everyone safe.

6. Conclusion

This project creates a smart system to detect LPG gas leaks and take action to keep people safe. The system alerts users with a buzzer and automatically turns off the gas supply using a servo motor if a leak is detected. By usings simple components like the Arduino Uno, gas sensor, and buzzer, this system helps prevent dangerous accidents caused by gas leaks. In the future, the system could be upgraded with more features like real-time monitoring through an app, and even smarter sensors. This project is an important step toward making homes and workplaces safer from gas leaks, and it can be expanded in the future to improve safety even more.

7. References

Elsevier, 1997. *Science Direct.* [Online] Available at: https://www.sciencedirect.com/science/article/abs/pii/S2214785322070225 [Accessed 17 December 2024].

Sraker, D. M., 2013. *IJRASET.* [Online] Available at: https://www.ijraset.com/research-paper/lpg-gas-leakage-detection-and-alert-system [Accessed 13 December 2024].

8. Appendix

8.1. Individual Contribution Plan

The individual contribution of each member of the group to completer the project is mentioned below:

Name	Tasks
Aayush Gupta	Introduction, Current Scenario, Problem statement and Project as a solution, Development, Acknowledgement, Findings (Testing), Coding.
Mission Aryal	Future works, Aim, Objectives and Conclusion, Flowchart, Design Diagrams (Circuit Diagram).
Suprim Adhikari	Background, System Overview and Results.
Prapti Adhikari	Design Diagrams (Hardware Architecture), and Requirement Analysis, Background Expected Outcomes and Deliverables.
Riwaj Neupane	Design diagrams (Block diagram), Reference, Abstract, Assembling and Wiring.

Table 5: Contribution Table

8.2. Code

```
#include <Servo.h>

// Pins
const int gasSensorPin = A0;
const int buzzerPin = 8;
const int servoPin = 9;
const int fanControlPin = 11;

// Threshold Gas Level
const int gasThreshold = 500;


Servo gasRegulator;

void setup() {

  pinMode(gasSensorPin, INPUT);
  pinMode(buzzerPin, OUTPUT);
  pinMode(fanControlPin, OUTPUT);

  gasRegulator.attach(servoPin);
  gasRegulator.write(0);  // regulator should be open at the start

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

```
void loop() {

  int gasLevel = analogRead(gasSensorPin);
  Serial.print("Gas Level: ");
  Serial.println(gasLevel);

  // Check if gas level exceeds threshold
  if (gasLevel > gasThreshold) {
    // Activating safety mechanisms
    digitalWrite(buzzerPin, HIGH);
    analogWrite(fanControlPin, 255);
    gasRegulator.write(90);
    Serial.println("Warning: Gas Leakage Detected!");
  } else {
    //reset
    digitalWrite(buzzerPin, LOW);
    analogWrite(fanControlPin, 0);
    gasRegulator.write(0);
  }

  // Small delay for stability
  delay(500);
}
```