Dr. B.C. Roy Engineering College, Durgapur

Project Title:

Smart LPG Gas Leakage Detection and Monitoring System using IoT (ESP-32 & Blynk

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Abstract:

This project aims to design and develop a smart system that detects LPG (Liquefied Petroleum Gas) leakage and initializes appropriate actions to prevent explosions and injuries. The system utilizes sensors to monitor gas concentrations, detects leaks, and triggers alerts and automated responses to ensure safety. Upon detecting a leak, the system will:

1. **Alert Users:** Send notifications via SMS, email, or mobile app.
2. **Automate safety measures**: Shut off the gas supply, activate ventilation systems, or trigger other safety protocols.

The proposed system offers an effective solution for preventing LPG-related accidents in residential, commercial, and industrial settings. By leveraging sensor technology and automation, this project seeks to enhance safety and reduce the risk of explosions and injuries caused by LPG leakage.

Introduction:

Liquefied Petroleum Gas (LPG) is a widely used fuel in residential, commercial, and industrial settings due to its convenience and efficiency. However, LPG leakage can lead to catastrophic consequences, including explosions and fires, resulting in loss of life and property. The importance of detecting LPG leaks and taking prompt action cannot be overstated. This project aims to design and develop an Intelligent LPG Leakage Detection and Safety System that utilizes advanced sensor technology and automation to detect leaks, alert users, and trigger safety measures to prevent accidents. By leveraging cutting-edge technology, this system seeks to enhance safety, reduce risks, and protect lives and property. e Intelligent LPG Leakage Detection and Safety System is crucial because it:

1. **Prevents accidents**: Reduces risk of explosions and injuries.

2. **Enhances safety**: Protects lives and property.

3. **Saves lives**: Timely detection and response can prevent fatalities.

This project addresses a significant safety concern, making it a valuable contribution to residential, commercial, and industrial settings. LPG (Liquefied Petroleum Gas) is widely used for cooking and heating. However, its leakage can lead to disastrous outcomes such as fire hazards and explosions. The Smart LPG Leakage Detection System integrates a gas sensor (here, MQ-6 gas sensor), ESP-32 microcontroller, and Blynk IoT platform to monitor gas levels and alert users via a smartphone in real-time.

Literature Review:

The literature survey on smart gas leakage detection and monitoring systems using IoT reveals several key findings:

- IoT-based monitoring systems: Various studies have proposed IoT-based systems for monitoring LPG levels and detecting gas leakages, enabling real-time monitoring and control.
- Sensor-based detection: Researchers have utilized sensors, such as MQ6, to detect gas levels and trigger alerts when the levels exceed a certain threshold.
- Alert systems: Studies have implemented alert systems using GSM modules, notifications, and alarms to inform users of gas leakages and low gas levels.
- Automation and control: Some projects have integrated automatic booking systems for LPG cylinders, enabling users to order replacements when the gas level falls below a certain threshold.
- Safety and efficiency: The use of IoT technology and sensor-based detection has improved safety and efficiency in LPG usage, reducing the risk of accidents and ensuring timely interventions.

These key findings highlight the potential of IoT-based systems in enhancing safety, efficiency, and user experience in gas leakage detection and monitoring.

Problem Statement and Objectives:

PROBLEM STATEMENT:

LPG leakage can lead to catastrophic consequences, including explosions and fires, due to delayed or ineffective detection methods. There is a need for a smart system that can accurately detect LPG leaks and trigger prompt safety measures.

OBJECTIVES:

- **Design and development:** To design and develop an Intelligent LPG Leakage Detection and Safety System that utilizes advanced sensor technology and automation.
- **Accurate Detection:** Detecting LPG leaks accurately and promptly thereby reducing the risk of explosions and fires.
- **User Alerts:** Alert users through notifications (SMS, email, or mobile app) in case of a leak.
- **Automated Safety:** Triggering safety measures automatically, such as shutting off the gas supply or activating ventilation systems.
- **Enhanced safety:** To enhance safety and reduce risks in residential, commercial, and industrial settings.

Methodology:

1. Component Selection and Research:

All components were carefully chosen based on functionality, compatibility, and affordability. A sensor module for detecting gas leakages (MQ -2) the ESP-32 microcontroller, and IRF540N MOSFET is used in the Intelligent LPG Leakage Detection and Safety System for controlling the gas supply shut-off valve or other high-power devices. Other than these primary components, a relay unit, motor, fan blade, batteries, bread board, jumper wires have been used in this project.

Components and their Purpose:

Component	Specification	Purpose / Role in System
ESP-32 S Node MCU Development Board	Wi-Fi & Bluetooth-enabled MCU	Acts as the main controller enabling Wi-Fi connectivity, Iot integration and gas leak detection.

Component	Specification	Purpose / Role in System
MQ-2 Gas Sensor	Smoke, LPG, Propane detection	Detects gas leaks and can be integrated with safety systems to trigger alarms or automatic shut-off valves.
5V Buzzer	Operating voltage is 5V and sound output >= 85 dB	Used to produce a loud, audible sound to alert users of specific event or condition.
Simple Motor	5V DC operating voltage	Converts electrical energy into machinal energy, providing rotational motion.
Servo Motor	9g by weight, 22.2 x 11.8 x 31 mm approx., operating voltage is 4.8V-5V and operating speed of about 0.1s/60 degrees	Control the cylinder knob and automate safety protocols as required.
Dual H-Bridge Motor Driver IC	Operates from 5V to 35V, maximum current 2A per channel	L298N driver controls a 5V motor/fan to ventilate gas in case of a leak.
Batteries	DC-powered 1.5V AA type battery	Supplies power to fan, sensor, and ESP-32.
Battery case	4 batteries each with a 1.5V voltage, connected in series.	Safeguards batteries from damage, short circuits and also prevents accidental contact or electrical shocks.
Fan Blade	Plastic fan blade	Helps in removing leaked gas and improve air circulation acting as a ventilation system.
Wooden Platform	Platform made up of solid wood	Acts as a base or mounting surface for system's components.
Breadboard & Jumper Wires	Prototyping essentials	Used to connect components during assembly and testing.

Table 1: Component list with their use

2. System Design and Planning:

A block diagram was designed to visualize the interaction between the ESP32, MQ-2 sensor, servo valve, fan, buzzer, and relay. Logical thresholds were defined for gas concentration (in ADC values) to activate responses at increasing severity levels.

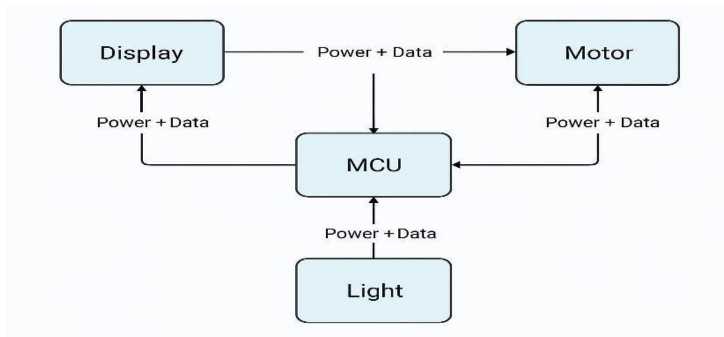


Fig1: Block Diagram of the Circuit

3. Sensor Integration and Calibration:

The MQ-2 sensor was connected to an analog pin on the ESP32-S. It was preheated for several hours before calibration. Multiple readings were taken to determine appropriate gas threshold levels that represent safe, warning, and danger zones.

4. Circuit Assembly:

All components were assembled on a breadboard. The ESP32 controlled the servo for valve closure, the L298N for fan motor control, and the relay for fail-safe operation. Outputs were activated based on real-time sensor readings.

The circuit assembly is designed to demonstrate basic electronics concepts, such as:

1. Series and Parallel Connections: Components are connected in series and parallel to achieve specific circuit behaviors.

2. Voltage and Current Regulation: Resistors are used to regulate voltage and current in the circuit.

3. Input/Output Control: The Arduino Uno is used to control the light bulb and read input from the switch.

- ❖ <u>TinkerCAD Simulation:</u>

The circuit assembly is simulated on TinkerCAD, allowing users to:

1. Design and Test Circuits: Create and test electronic circuits in a virtual environment.

2. Debug and Troubleshoot: Identify and fix errors in the circuit design.

3. Learn Electronics Concepts: Understand basic electronics concepts through interactive.

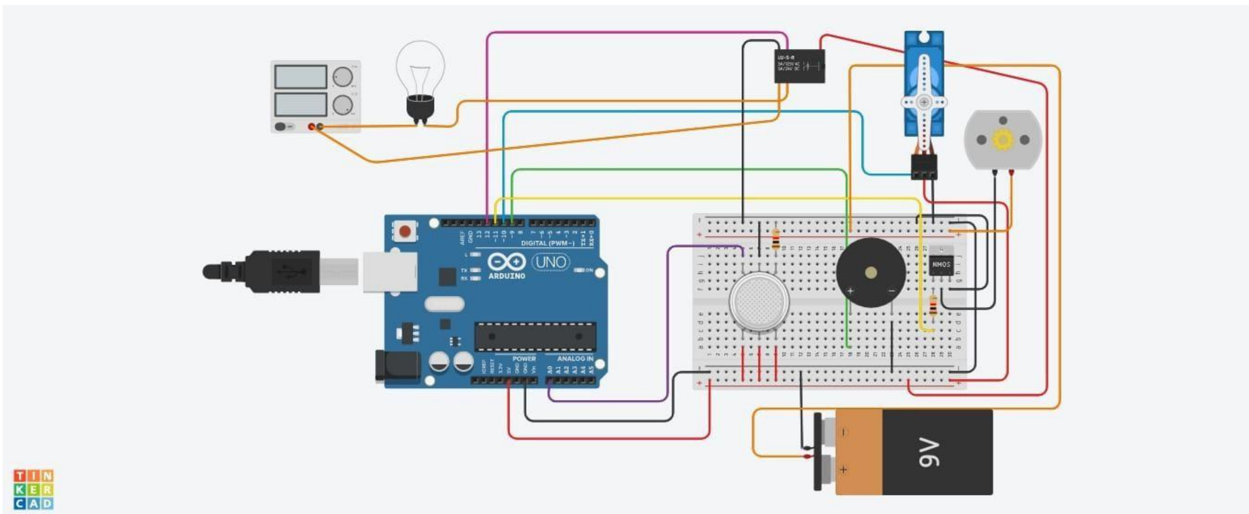


Fig 2: TinkerCAD Simulation Circuit

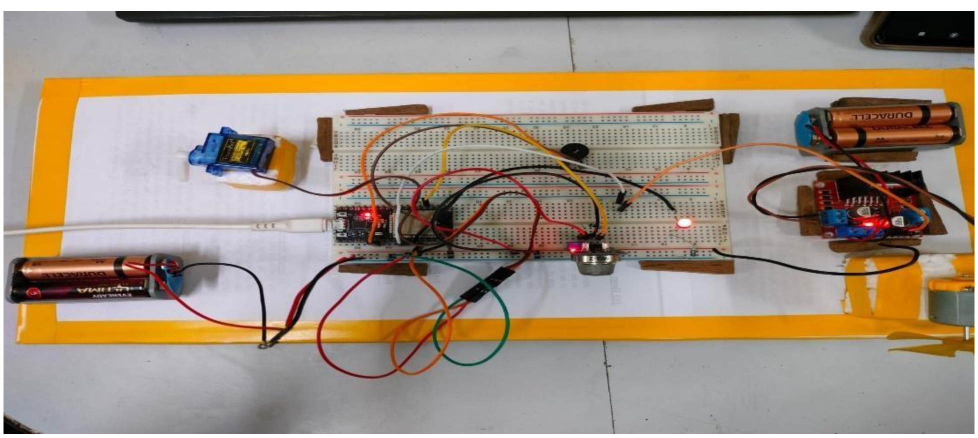


Fig 3: Prototype Circuit

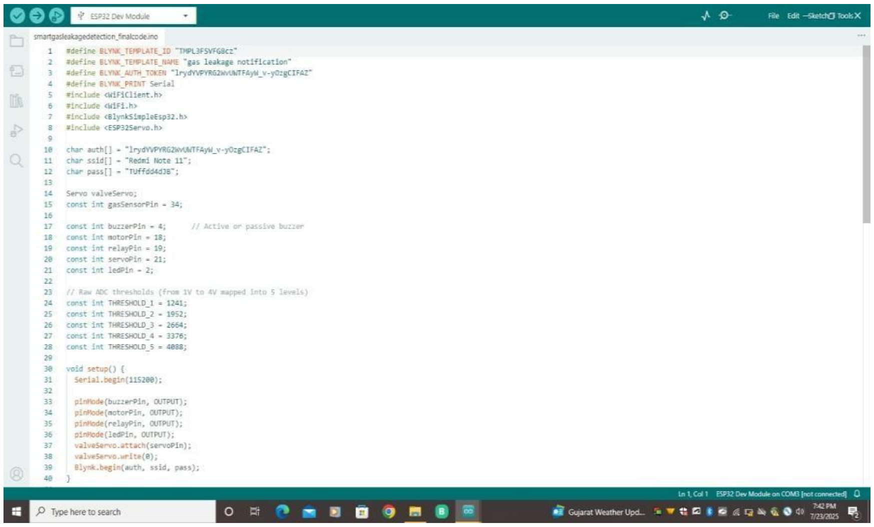
5. Software Development:

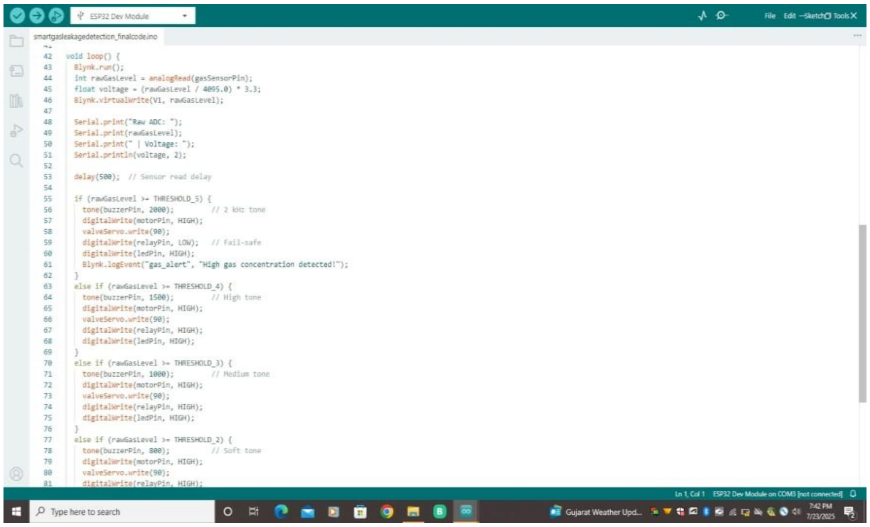
Arduino IDE was used to program the ESP32.

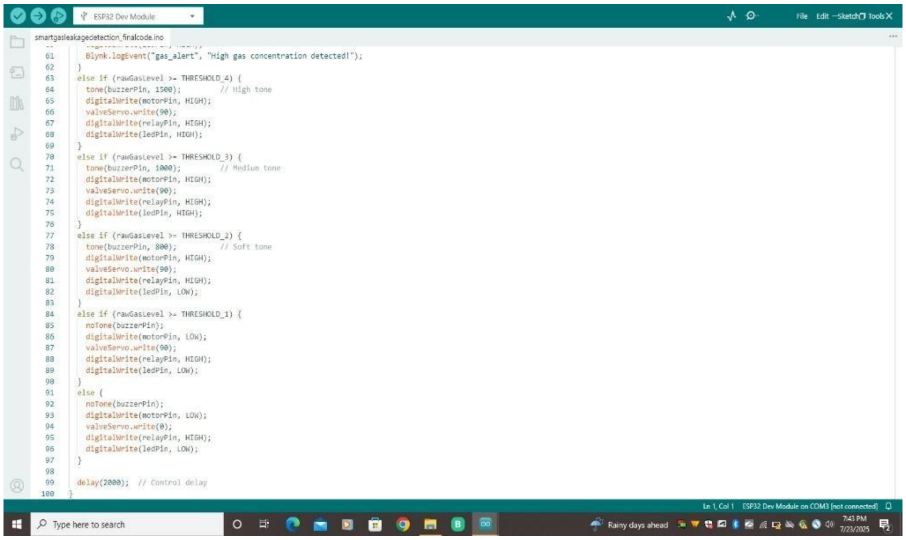
Using the Arduino IDE, the ESP32 was programmed to:

- Read analog values from the MQ-2 gas sensor
- Compare readings to defined thresholds
- Trigger servo, buzzer, fan, and relay outputs
- Connect to Wi-Fi and send gas levels to Blynk IoT (Virtual Pin V0)
- Trigger notifications or logs via the Blynk cloud if high gas levels persist.

Screenshots of the Code:





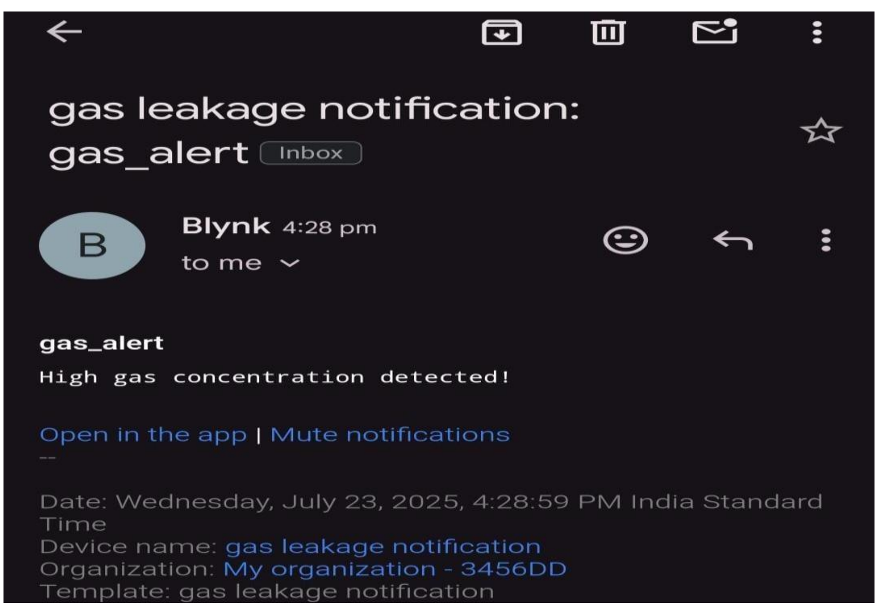


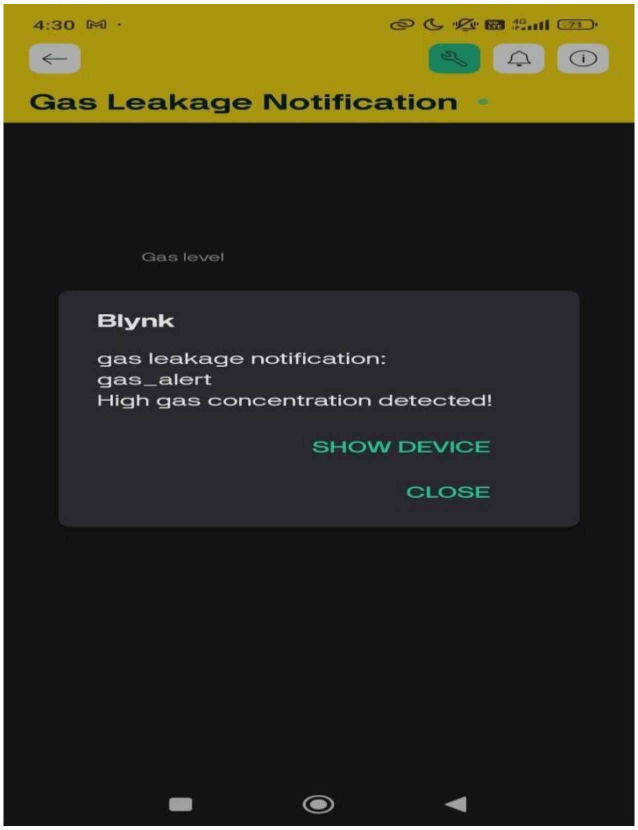
6. IoT Integration with Blynk:

The ESP32 was connected to the Blynk IoT platform using an Auth Token. A virtual dashboard was created with:

Gauge widget to show real-time gas level (V0), and,

Notifications for critical gas levels.





Screenshots of gas leakage notifications or alerts on the phone (via. E-Mail and the Blynk Iot App itself) using the Blynk Iot platform

7. Testing and Optimization:

The system was tested under safe simulated leak conditions (e.g., butane lighter held near sensor). Thresholds were fine-tuned for consistent and quick response. The delay between gas detection and actuator response was minimized to improve safety.

8. Final Integration:

All components were mounted in a compact enclosure for field use. Wiring was routed securely, and insulation precautions were taken to reduce ignition risks. The system is now ready for LPG safety monitoring in small-scale environments such as homes, restaurants, and labs.

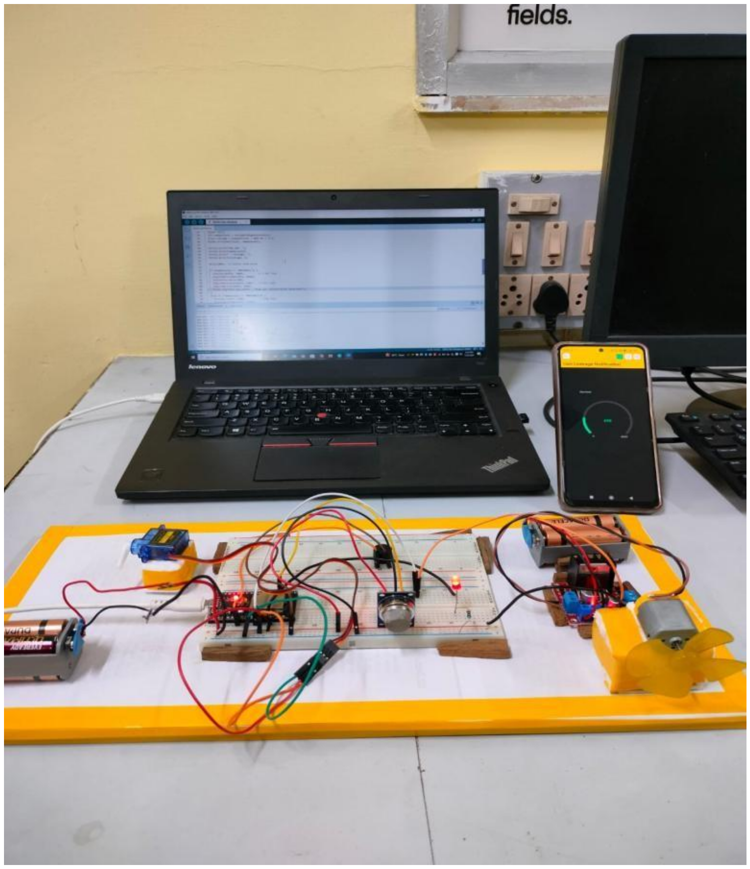


Fig 4: Integration of the prototype with BlynkIoT

Applications:

The smart gas leakage detection and safety system has several key applications:

- **Industrial Settings:**

1. Manufacturing facilities: Detect gas leaks and prevent accidents in industries that use gases like oxygen, nitrogen, or fuel gases.

2. Chemical plants: Monitor gas levels and prevent leaks to ensure a safe working environment.

- **Residential and Commercial Buildings:**

1. Gas stove safety: Detect leaks from gas stoves and alert occupants to prevent accidents.

2. Heating systems: Monitor gas levels and detect leaks in heating systems, such as boilers or furnaces.

- **Other Applications:**

1. Laboratories: Detect gas leaks and prevent accidents in laboratories that use hazardous gases.

2. Oil and gas industry: Monitor gas levels and detect leaks in oil and gas extraction, processing, and transportation facilities.

The system's main goals are to:

1. Prevent accidents: Detect gas leaks and alert occupants to prevent explosions, fires, or other hazards.

2. Ensure safety: Provide early warnings and automated responses to minimize risks and protect people and property.

3. Reduce risks: Mitigate the risks associated with gas leaks, such as explosions, fires, or environmental damage.

Future Scope:

Future Scope of Smart Gas Leakage Detection and Safety System:

- **IoT Integration:** Remote monitoring and control.
- **AI and ML:** Predictive maintenance and improved accuracy.
- **Real-time Monitoring:** Mobile and web-based alerts.
- **Automated Safety Measures:** Shutdown mechanisms and alerts.
- **Multi-Gas Detection:** Expand to detect various gases.
- **Smart City Integration:** Public safety and infrastructure.
- **Industrial Automation:** Improved safety and efficiency.
- **Advanced Sensor Development:** More accurate and reliable sensors.
- **Energy Efficiency:** Reduced power consumption.
- **Enhanced User Interface:** User-friendly interfaces for easier operation and monitoring.

Conclusion:

The smart gas leakage detection and safety system is a crucial development for ensuring safety in various settings, including industrial, residential, and commercial areas. This system provides early detection of gas leaks, alerts occupants, and can automate safety measures to prevent accidents. With its potential for integration with IoT, AI, and ML, this system can be further enhanced to improve accuracy, efficiency, and safety. The project's success can lead to widespread adoption, reducing the risks associated with gas leaks and promoting a safer environment. n line with the United Nations Organization's (UNO) Sustainable Development Goals (SDGs), the smart gas leakage detection and safety system contributes to:

1. SDG 3: Good Health and Well-being: By reducing the risk of gas-related accidents and promoting a safer environment.

2. SDG 9: Industry, Innovation, and Infrastructure: Through the development and implementation of innovative safety technologies.

3. SDG 11: Sustainable Cities and Communities: By enhancing public safety and infrastructure in urban areas.

This project aligns with the UNO's goals of promoting safety, sustainability, and well-being globally.

Overall, this project is a step toward building smarter, healthier, and more sustainable living environments for all.

References:

1. **Development of LPG Gas Leakage Detection using ESP 32** in the Conference of International Conference on Research and Practices in Science, Technology and social sciences (i-crest 2021) at: UITM, Malaysia.

2. **LPG Gas Leakage Detection and Alert System** by the authors: Bhagyashree Dharaskar, Alkesh Gaigawali, Sahil Meshram, Ayush Tembhurne, Abhishek Gautam, Aman Nanhe.

3. **LPG Monitoring System via Blynk Application using ATMega328P** (Publisher: IEEE) by Mary Bettina P. Garcia; Eugene A. Labuac; Darrel Tristan U. Virtusio; Jocelyn F. Villaverde.

4. **IOT-Based Home Automation for LPG Gas and Fire Detection System With Automated Safety Measures**, Publisher: IEEE, Authors: Taritra Panda; Rohit Banerjee; Arnab Pal; Soham Kanti Bishnu; Arindam Chakraborty.

5. **IOT-Enabled LPG Leakage Monitoring with Arduino Uno, Esp32, and Real-Time Mobile Alerts Via Flutter** *Proceedings of the 3rd International Conference on Optimization Techniques in the Field of Engineering (ICOFE-2024)* by M Vijayalakshmi, Krithick Balaji Ramesh and Sivaranjan PG.