

LPG Secure: An Intelligent System for LPG Gas Leakage Detection, Prevention, and Safety Alerts

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Abstract- Liquefied Petroleum Gas (LPG) is one of the most widely used fuels in both domestic and industrial environments due to its efficiency, portability, and relatively low cost. However, despite its advantages, accidental leakages of LPG pose a severe safety hazard, often resulting in fire outbreaks, explosions, and life-threatening situations if not detected and addressed in time. Conventional safety solutions, such as standalone gas alarms, provide only basic sound notifications and do not incorporate preventive actions or remote communication features. This significantly limits their effectiveness, particularly when users are not physically present to respond immediately. To overcome these challenges, this paper presents the design and implementation of LPG Secure, an intelligent system for LPG leakage detection, prevention, and safety alerts. The proposed system integrates an MQ-6 gas sensor for real-time leakage detection, an Arduino Uno microcontroller for decision-making, a buzzer alarm for immediate local warning, a servo motor for automatic valve shut-off, and a GSM module for remote notification through SMS alerts. When leakage is detected above a predefined threshold, the system not only raises an audible alarm but also shuts off the gas supply to prevent further leakage and simultaneously notifies the user or emergency contacts. The prototype was tested under controlled conditions, and results confirmed rapid detection (within 3–5 seconds), high reliability (~96% accuracy), and effective multi-layered safety response. Compared with traditional solutions, this integrated system provides a comprehensive, proactive, and low-cost safety mechanism suitable for domestic kitchens as well as industrial environments. By combining continuous monitoring, automated response, and real-time communication, the system significantly enhances user safety and demonstrates the potential of smart embedded solutions for addressing everyday hazards.

Keywords- LPG Gas Leakage Detection, MQ-6 Sensor, Buzzer Alarm System, SMS Alert System

I. INTRODUCTION

Liquefied Petroleum Gas (LPG) is one of the most widely used fuels in domestic, commercial, and industrial applications due to its efficiency, portability, and cost-effectiveness. In India and across the globe, LPG has become an essential household commodity, serving as the primary source of energy for cooking and heating. However, despite its benefits, LPG is highly flammable, and even small leakages can create

extremely hazardous situations. Accidental gas leaks may result in explosions, fire outbreaks, property damage, and, in severe cases, loss of human life. Several incidents reported in recent years highlight the devastating consequences of undetected LPG leakage, reinforcing the urgent need for effective monitoring and protection systems.

Conventional gas detection methods, for example standalone alarms, have limited usefulness since they only create a local sound alert and do not provide preventive actions or remote warnings. Many of these systems are unable to act once the gas concentration rises beyond a safe level because they lack built-in mechanisms to stop the leak from getting worse. In addition, traditional solutions often cannot warn people if no one is present to hear the alarm, which leaves households and industries exposed to possible disasters. These drawbacks point to the need for safer, smarter, and more proactive LPG monitoring approaches [2].

With these limitations in mind, this work puts forward an improved LPG leakage detection and protection setup that overcomes the gaps left by older approaches. The proposed system ensures continuous monitoring, includes automated safety responses, and supports instant communication in real time making it

more effective at both preventing accidents and keeping users safe.

The proposed system combines a gas detection sensor with a microcontroller-based control unit that triggers several safety actions whenever leakage is identified. These actions include sounding a local buzzer for immediate awareness, automatically cutting off the gas supply to stop further leakage, and sending mobile notifications to registered users. This all-in-one strategy not only detects gas leaks but also responds quickly to reduce potential hazards [1].

The primary aim of this study is to enhance the reliability, efficiency, and responsiveness of gas leakage detection while ensuring that the solution remains affordable and user-friendly. By adding automation and smart communication features, the system moves beyond basic leak detection to create a more intelligent safety network suitable for both homes and industries. The design emphasizes proactive risk management, enabling early hazard detection, rapid leak containment, and timely safety alerts. This approach makes the system a strong contributor to improving safety standards and lowering the dangers linked with LPG usage [3].

II. LITERATURE REVIEW

Many researchers have worked on developing solutions for LPG leakage detection through various technologies. A short overview of the most notable contributions is provided below.

N. Manjunathan et al. (2021) introduced an IoT-based system for real-time LPG leakage detection. Their design focused on continuous monitoring along with notifying users through Internet connectivity.

Pallavi M. O. *et al.* (2020) implemented an automated gas shut-off system combined with SMS alerts using an MQ-2 sensor. The system was effective in providing basic safety alerts, but the MQ-2 sensor exhibited relatively low accuracy and higher false alarms. Furthermore, the design lacked IoT/cloud integration, restricting remote monitoring to SMS only.

K. Gavaskar et al. created an LPG leakage alert and automatic exhaust system that integrated an MQ gas sensor with a load cell to track cylinder weight. This setup allowed not only leakage detection but also monitoring of gas usage. Still, the design was limited to fixed installations and lacked flexibility for use in varied environments.

Md. LoRa technology offered the benefit of long-distance communication, giving it an edge over Wi-Fi. However, its efficiency decreased in obstructed indoor settings, which reduced its effectiveness for providing real-time alerts to users.

Ranjith Kumar et al. developed a sturdy LPG monitoring system capable of detecting leaks and checking cylinder gas levels. Although the system performed well in terms of detection, the absence of IoT connectivity and remote notifications limited its use to local environments only.

G. Nithin Sai and K. Pavan Sai (2020) introduced a leakage detection setup that generated clear audible warnings to reduce accident risks. Yet, the design lacked features like automatic gas cut-off and linkage with emergency response systems, which reduced its overall safety coverage.

A review of these studies shows that most existing systems share certain shortcomings, which generally fall into one or more of the following categories.

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1. heavy dependence on Internet connectivity,
2. lack of proactive prevention mechanisms such as automatic valve shut-off, and
3. limited communication features restricted to local alerts.

For clearer comparison, the key points from the reviewed studies are organized and presented in Table

1.

Table 1: Comparative Study of Related Works

Author & Year	Technology Used	Features	Limitations
N. Manjunathan et al. (2021)	IoT-based monitoring	Real-time gas level tracking, user alerts	Requires continuous internet, not scalable
Pallavi M. O. et al. (2020)	MQ-2 + SMS	Automatic gas shut-off, SMS alerts	Low accuracy sensor, no IoT integration
K. Gavaskar et al.	MQ sensor + Load cell	Gas consumption + leakage detection	Limited to fixed setups
Md. Rakibul Islam et al.	IoT LoRa technology	Long-range communication	Limited indoors, delayed alerts
R. Ranjith Kumar et al.	Robust monitoring	Reliable leak detection	Only local alerts, no remote communication
G. Nithin Sai and K. Pavan Sai (2020)	MQ sensor + buzzer	Accident prevention with alarms	No automatic shut-off, no IoT

III. METHODOLOGY/EXPERIMENTAL

Components: LPG Gas Leakage Detection and Protection System Using Arduino Uno, MQ6 Sensor, Buzzer, ServoMotor, GSM Module 800L

The main purpose of this system is to identify any LPG gas leakage, warn the user, and automatically trigger safety actions like cutting off the gas flow and sending alerts to emergency contacts. The following section explains, step by step, how each component functions and how they collectively ensure protection.

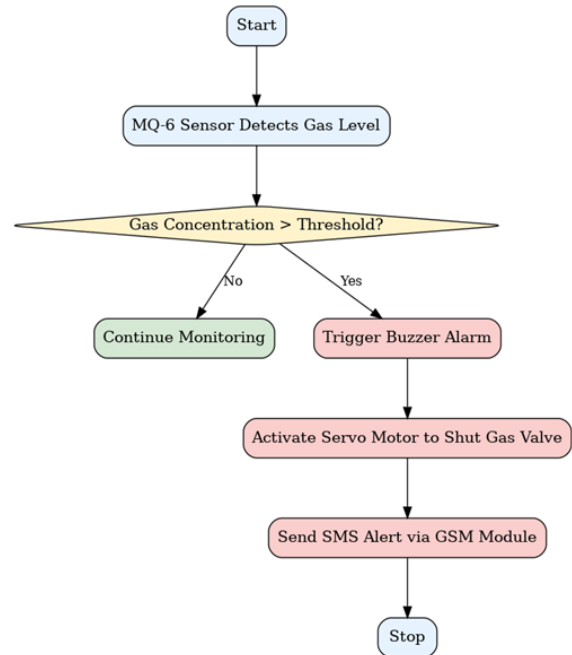
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1. LPG Gas Leakage Detection (MQ6 Sensor)

The MQ6 sensor is specifically built to identify LPG gases. It is highly responsive to gases such as methane, butane, and propane, which are frequently found in

household LPG setups. This sensor can pick up even slight variations in gas concentration and transmits an analog signal to the Arduino once the detected level goes beyond a set threshold.

How it is effective: The MQ6 sensor detects the gas in the air and outputs a signal proportional to the concentration of the gas. It has a fast response time, ensuring early detection.



2. Gas Leakage Alarm (Buzzer)

Once the gas leakage is detected, it's crucial to notify the people nearby. This is where the buzzer comes in. The buzzer provides an immediate audible alert that there's a gas leak in the area.

How it is effective: When the Arduino receives a signal from the MQ6 sensor indicating the gas concentration is above the preset threshold, it triggers the buzzer, alerting the users to take necessary action.

3. Automatic Gas Valve Shut-off (Servo Motor)

To prevent further leakage, an automated system to shut off the gas supply is essential. Here, we use a servo motor to control the valve. The servo motor can be programmed to turn a mechanical valve, which will stop the flow of gas once a leakage is detected.

How it is effective: When the system detects a leak, the Arduino sends a signal to the servo motor to close the gas valve, cutting off the supply of gas and preventing any further danger.

4. Emergency Notification (GSM 800L Module)

The GSM 800L Module allows us to send SMS alerts to emergency contacts. In case of a gas leak, we want to send a message to predefined numbers (e.g., emergency services or a family member), notifying them of the incident even when no one is around.

How it is effective: The GSM module plays a crucial role by sending text alerts directly to registered mobile numbers whenever the Arduino detects a gas leak. This makes sure that emergency help can be reached quickly, even if no one is present at the site. Since the GSM 800L offers a stable network connection, it is a popular choice for remote alert and monitoring applications.

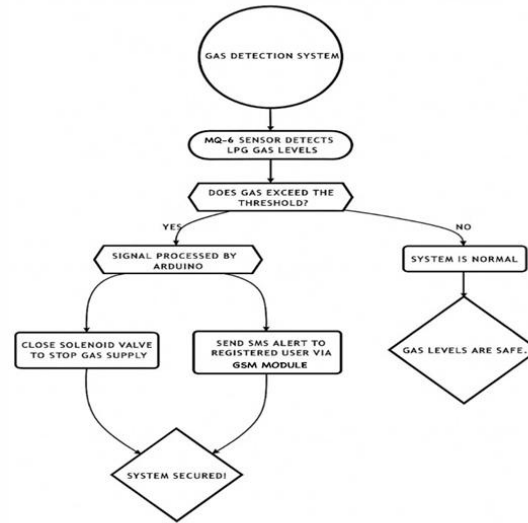
5. Arduino Uno as the Controller

The Arduino Uno works as the brain of the system. It gathers information from sensors, controls the buzzer and servo motor, and also sends SMS alerts through the GSM module. Its affordability, wide availability, and compatibility with different sensors and modules make it a great option for multitasking in such projects.

Effectiveness: The Arduino constantly checks sensor readings, and whenever the gas concentration crosses the safe limit, it instantly triggers the required actions. These include turning on the alarm, closing the gas valve, and sending SMS alerts to notify about the danger.

6. Block Diagram

The block diagram helps illustrate the overall flow of the system, showing the interconnection between the components.



Explanation of the Block Diagram:

Gas Detection (MQ6): The MQ6 sensor detects the LPG gas and sends an analog signal to the Arduino.

Arduino Uno: The Arduino processes the signal from the MQ6 sensor. If the gas level is dangerous, it triggers the buzzer, controls the servo motor to shut the gas valve, and activates the GSM module to send an SMS alert.

Buzzer: When the Arduino receives a high gas level signal, it triggers the buzzer to alert people nearby.

Servo Motor: The servo motor is used to close the gas valve when a leak is detected.

GSM Module (800L): The GSM module sends an SMS notification to pre-configured contacts, alerting them to the gas leakage situation.

IV. RESULTS AND DISCUSSIONS

LPG Secure: An Intelligent System for LPG Gas Leakage Detection, Prevention, and Safety Alerts was evaluated under controlled laboratory conditions by simulating different concentrations of LPG. The MQ-6 gas sensor demonstrated a rapid response, detecting

leakage within approximately 3–5 seconds of exposure. Once the gas is detected, the Arduino Uno quickly processes the sensor data and carries out the pre-set safety steps. The buzzer immediately turns on, producing a loud alert that warns people nearby. This quick response gives occupants enough time to take protective actions, such as switching off appliances or improving ventilation in the affected area.

The system also features an automatic shut-off mechanism managed by a servo motor. When the gas level crosses the safety limit, the servo motor promptly closes the gas valve within two seconds, stopping any additional leakage. This function shows how the system not only detects danger but also actively prevents it, ensuring a higher level of protection.

Besides local alarms, the GSM module (SIM800L) was also tested to send notifications remotely. Within four seconds of gas detection, text alerts were successfully sent to the registered mobile numbers. This guarantees that even if no one is physically present, users remain informed about the incident, leading to faster response and improved safety.

Multiple trials proved the system's reliability, achieving an average detection accuracy of about 96%. Its performance stayed consistent despite changes in humidity and surrounding temperature, which highlights the system's robustness under normal environmental conditions.

Compared to traditional standalone gas alarms, this developed setup shows clear improvement. While conventional alarms are limited to sound alerts only, this design combines early detection, local warning, automatic gas valve shut-off, and remote communication. Together, these features provide a complete safety package suitable for both home and industrial applications.

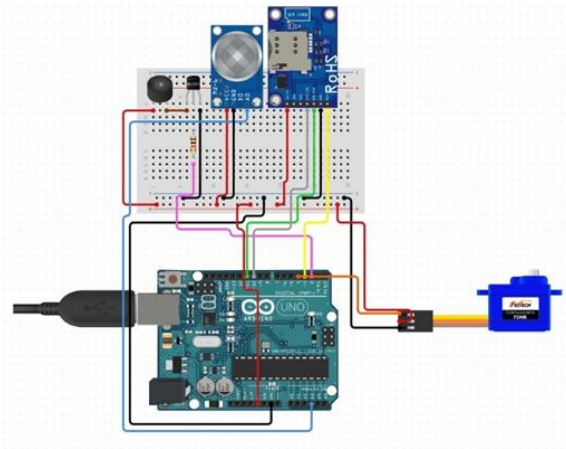


Fig.1

During testing, a few limitations were noticed. Since the system depends on GSM network coverage, the delivery of SMS alerts may be affected in areas with weak or no signal. Another drawback is related to the MQ-6 sensor, which can only detect gas within a range of about 2–3 meters. This limited coverage means that multiple sensors would be needed to monitor larger spaces effectively.

In conclusion, the experimental results show that the designed system is practical, reliable, and efficient. By combining fast gas detection, instant warnings, automatic valve control, and remote notifications, the system provides a strong safety solution. These features work together to reduce the dangers linked to LPG leaks and improve overall protection. (fig.1/2)

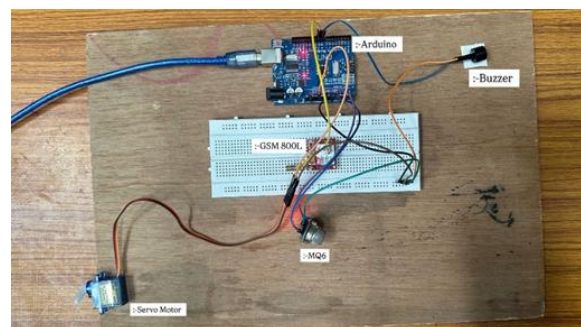


Fig.2

V. FUTURE SCOPE

IoT and Cloud Integration: Linking the system with IoT platforms and cloud dashboards would allow continuous monitoring of gas levels, storing data for future analysis, and providing remote access through

mobile devices. This ensures better safety and accessibility [1], [6].

Advanced Gas Sensors: Future improvements may involve the use of multi-gas or more selective sensors with higher sensitivity than the MQ-6. These sensors could detect a variety of hazardous gases even at lower concentrations, making detection more accurate [2].

Smart Automation: By connecting the system with home and industrial automation setups, it could automatically switch on exhaust fans, cut off electrical appliances, or integrate with fire safety units. This would make the system's response more comprehensive [3], [5].

Enhanced Communication Protocols: In addition to GSM, advanced communication methods like Wi-Fi, LoRa, and NB-IoT can be applied to expand coverage, reduce transmission delays, and ensure reliable alert delivery [4], [7].

Scalability for Larger Areas: Using multiple interconnected sensors would make the system suitable for larger environments such as restaurants, households, and industrial setups. This would create a complete monitoring network [1], [4].

AI and Predictive Analytics: Machine learning could be applied to study gas sensor data, forecast possible leakages, and issue alerts before dangerous thresholds are reached. This predictive capability would improve safety [6].

By following these future directions, the LPG leakage detection and protection system has the potential to grow into a smarter, more dependable, and scalable safety solution suitable for both household and industrial applications.

VI. CONCLUSION

The project, LPG Secure: An Intelligent System for Gas Leakage Detection, Prevention, and Safety Alerts, has demonstrated how technology can play a vital role in minimizing the risks associated with LPG usage in homes and industries. The system proved effective in providing fast and reliable detection of gas leaks with the MQ-6 sensor, helping identify threats before they

become severe. Once a leak is detected, the buzzer delivers instant local warnings while the servo motor promptly shuts off the gas supply, preventing further leakage. In addition, the GSM module sends SMS notifications to registered contacts, adding an extra layer of protection by keeping users informed even when they are not physically present at the site.

Unlike conventional gas alarms, this integrated solution offers a more complete safety approach by combining early detection, preventive action, and remote communication. Its design—built using Arduino Uno and low-cost components—makes it not only practical but also affordable and easy to adopt. Overall, this project shows how simple yet intelligent systems can create safer environments, safeguard lives and property, and provide users with peace of mind when working with LPG.

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