



Gas Leakage Detection and Buzzer Alert System

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ABSTRACT: Liquefied Petroleum Gas (LPG) is widely used for domestic and industrial purposes, but leakage of LPG can lead to serious hazards such as fire accidents and explosions. This project presents the design and implementation of an LPG gas detection system that ensures safety by providing early warning in case of gas leakage. The system uses a gas sensor (such as MQ-2 or MQ-6) to continuously monitor the presence of LPG in the environment. When the gas concentration exceeds a predefined threshold, the sensor sends a signal to the microcontroller, which activates an alarm system, such as a buzzer and LED indicator. Additionally, the system can be enhanced with features like automatic exhaust fan activation or SMS alerts using IoT modules for remote monitoring. The proposed system is cost-effective, reliable, and easy to install, making it suitable for homes, kitchens, and small industries. This project aims to minimize risks associated with LPG leakage and improve safety standards through timely detection and alert mechanisms.

KEYWORDS: LPG gas leakage detection, MQ-2 gas sensor, safety alarm system, microcontroller (Arduino/ESP32), hazard prevention.

I. INTRODUCTION

Liquefied Petroleum Gas (LPG) is one of the most commonly used fuels in households, restaurants, and small industries due to its high energy efficiency and ease of use. Despite its advantages, LPG is highly flammable, and even a small leakage can lead to dangerous situations such as fire accidents, explosions, and health hazards. Many accidents occur every year due to unnoticed gas leaks, highlighting the need for an effective and reliable sustainable gas detection system.

To address this issue, an LPG gas detector is designed to sense the presence of leaked gas in the surrounding environment and provide an early warning to users. The system typically uses a gas sensor such as MQ-2 or MQ-6, which can detect combustible gases in the air. When the concentration of gas exceeds a safe limit, the system triggers an alert through a buzzer or visual indicators like LEDs, allowing immediate action to prevent accidents.

This project focuses on developing a low-cost, efficient, and easy-to-use LPG gas detection system using a microcontroller such as Arduino or ESP32. The proposed system can also be enhanced with additional features like automatic ventilation control or remote alert systems using IoT technology. The main objective of this project is to improve safety, reduce risks, and provide a reliable solution for gas leakage detection in everyday environments.

I.1 PROBLEM STATEMENT

Liquefied Petroleum Gas (LPG) leakage is a major safety concern in households and industries, as it can lead to fire accidents, explosions, and serious health hazards. In many cases, gas leaks go undetected due to the absence of proper monitoring systems or human negligence. Traditional methods of detecting gas leakage, such as relying on smell, are unreliable and unsafe, especially in closed environments or during sleep. There is a need for a reliable, cost-effective, and automated system that can continuously monitor LPG levels and provide immediate alerts when leakage occurs. The system should be capable of detecting even small concentrations of gas and responding quickly to prevent



dangerous situations. Therefore, this project aims to design and implement an LPG gas detection system that enhances safety by offering real-time monitoring and timely warning alerts.

1.2 Objectives

To design and develop a reliable LPG gas leakage detection system. To detect the presence of LPG using a suitable gas sensor (MQ-2/MQ-6). To provide an immediate alert using a buzzer and LED when gas leakage is detected. To ensure safety by enabling early warning and preventing accidents such as fire or explosion. To develop a low-cost and easy-to-install system for domestic and small-scale industrial use. To enhance the system with optional features like automatic exhaust fan control or IoT-based remote alerts.

II. RELATED WORK

Several research studies have been carried out to develop efficient LPG gas leakage detection systems using different technologies and approaches. Early systems focused on simple gas detection using semiconductor sensors such as the MQ-2, which is widely used due to its low cost, durability, and sensitivity to combustible gases. A study on smoke and gas detection highlighted that MQ-2 sensors are effective in identifying gas leakage at an early stage, helping to reduce damage and hazards. Recent developments have integrated microcontrollers and IoT technologies to enhance the functionality of gas detection systems. An IoT-based LPG detection system using MQ-2 and NodeMCU enables real-time monitoring and remote alerts through smartphones. Such systems can also automatically shut off gas supply when leakage exceeds a safe threshold, improving safety and efficiency. Another research work proposed a gas leakage detection device using MQ-2 sensors along with a buzzer and LED warning system. This system provides immediate alerts when leakage occurs, making it suitable for household safety applications. Studies have also shown that Arduino-based LPG detection systems are highly accurate and cost-effective. Experimental results indicate that such systems can achieve accuracy levels of around 97%, making them reliable for practical use.

Furthermore, recent research focuses on developing low-cost and compact LPG detectors that balance affordability, sensitivity, and real-time response. These systems aim to provide continuous monitoring and quick alert mechanisms to prevent accidents in domestic and industrial environments.

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Overall, the existing literature demonstrates that LPG gas detection systems have evolved from basic sensor-based alarms to advanced IoT-enabled smart safety systems, offering improved reliability, automation, and user convenience.

III. EXISTING METHODOLOGY

The existing LPG gas detection systems are primarily based on gas sensors that detect the presence of combustible gases in the surrounding environment. Most commonly, semiconductor-based sensors such as MQ-2 or MQ-6 are used due to their high sensitivity, low cost, and ease of integration. These sensors continuously monitor the air and produce an analog or digital output based on the concentration of gas present.

In a typical system, the gas sensor is connected to a microcontroller such as Arduino. The sensor detects LPG leakage and sends signals to the microcontroller when the gas concentration exceeds a predefined threshold level. The microcontroller processes this input and activates output devices such as a buzzer, LED indicators, or alarms to alert the user about the leakage.

Some existing methodologies also include additional safety mechanisms like automatic exhaust fans to disperse the leaked gas or relay-controlled gas valves to stop the gas supply. In advanced systems, IoT modules like ESP8266 or ESP32 are integrated to send real-time notifications to users through mobile applications or SMS alerts. Although these systems are effective, many existing solutions have limitations such as delayed response time, lack of remote monitoring, or higher cost in advanced models. Hence, there is a need to improve these systems by making them more efficient, affordable, and user-friendly while ensuring quick and accurate detection of LPG leakage.



IV. PROPOSED METHODOLOGY

The proposed system is designed to detect LPG gas leakage in real-time and alert users immediately to prevent accidents. The methodology involves sensing, processing, alerting, and safety control mechanisms.

1. System Overview

The LPG gas detection system consists of a gas sensor (MQ-6), a microcontroller (such as Arduino or ESP32), a buzzer, an LED indicator, and optionally a relay module for safety control. The system continuously monitors the concentration of LPG gas in the surrounding environment.

2. Gas Detection Mechanism

The MQ-6 gas sensor is used to detect LPG gases like propane and butane. It operates based on changes in resistance when exposed to gas. The sensor outputs an analog voltage proportional to gas concentration.

3. Data Processing

The analog signal from the sensor is sent to the microcontroller. The microcontroller reads and converts this signal into digital values. A predefined threshold value

4. Alert System

When gas leakage is detected: A buzzer is activated to provide an audible warning. An LED indicator (usually red) turns ON. Optional: Notification can be sent via Wi-Fi (in ESP32-based systems).

5. Safety Control Mechanism

A relay module can be used to: Turn OFF electrical appliances. Activate an exhaust fan to remove gas. This helps reduce explosion risk. Power supply is given to the system. Gas sensor starts sensing the environment. Sensor sends data to microcontroller. Microcontroller compares values with threshold. If leakage detected: Alarm (buzzer) ON. LED ON. Relay activates safety system. If no leakage: System remains in monitoring state.

IV. System Architecture and Operational Analysis of LPG Gas Detector

4.1 System Architecture of LPG Gas Detector

The system architecture of the LPG gas detector defines the interaction between various hardware and software components used to detect LPG gas leakage and provide immediate safety responses. The overall system is designed with three major layers namely the sensing layer, processing layer, and output and safety layer. These layers work together continuously to ensure accurate gas detection and reliable operation. In the sensing layer, the MQ-6 gas sensor continuously monitors the surrounding environment for the presence of LPG gases such as propane and butane. The sensor converts gas concentration into electrical signals based on the change in sensor resistance when exposed to LPG gas. The processing layer consists of a microcontroller such as Arduino or ESP32, which reads the sensor signals, converts them into digital values, and compares them with predefined threshold levels. Based on the comparison, the controller determines whether the environment is safe or if gas leakage has occurred. The output and safety layer includes a buzzer, LED indicators, and a relay module. When the gas concentration exceeds the threshold value, the buzzer generates an audible alert, the LED provides visual indication, and the relay activates external safety devices such as exhaust fans or automatic power cut-off systems. The entire system operates in a continuous loop where gas leakage is detected, processed, and responded to instantly. In advanced systems, ESP32-based IoT integration enables cloud connectivity, mobile notifications, and remote monitoring, thereby improving system intelligence and user safety.

4.2 Working of LPG Gas Detector

The LPG gas detector system is designed to continuously monitor the environment and detect the leakage of LPG gases to prevent accidents and ensure safety. Initially, the system is powered using a regulated power supply, and the MQ-6 gas sensor undergoes a short warm-up period to stabilize its sensing characteristics. The microcontroller initializes all connected components and begins reading sensor values continuously. The MQ-6 sensor operates based on the variation of sensor resistance in the presence of LPG gases. In clean air, the sensor resistance remains high, whereas exposure to LPG gas decreases the resistance significantly. This variation is converted into an analog voltage signal, which is transmitted to the microcontroller for processing. The controller converts the analog signal into digital data and compares it with a predefined threshold value. If the gas concentration remains below the threshold level, the environment is considered safe, and the system continues monitoring. However, when the gas concentration exceeds the threshold value, the system identifies it as LPG leakage and activates emergency response mechanisms. The buzzer produces a loud alarm sound, and the LED indicator glows to provide visual warning. Simultaneously, the relay module activates safety devices such as exhaust fans or electrical shut-off systems to reduce the possibility of fire or explosion. The system continuously repeats the detection and monitoring process even after alert activation. In IoT-enabled systems using ESP32, gas leakage information can also be transmitted to mobile applications or cloud platforms for remote monitoring and real-time notifications.



4.3 Electrical Control Strategies in LPG Gas Detector

Electrical control strategies play a vital role in ensuring the accurate, reliable, and safe operation of the LPG gas detector system. One of the primary control strategies used is threshold-based control, where the microcontroller continuously compares sensor readings with predefined gas concentration limits. If the gas level exceeds the threshold, leakage is detected and emergency actions are initiated. Continuous monitoring control is implemented through a real-time loop that ensures uninterrupted sensing and rapid response to leakage conditions. The system also utilizes ON/OFF control strategies, where output devices such as buzzers, LEDs, and relays operate in binary states depending on the gas concentration level. Relay-based safety control allows the system to isolate low-power control circuits from high-power safety devices such as exhaust fans and electrical appliances. To minimize false alarms caused by sensor noise or fluctuations, filtering and delay strategies are incorporated. Multiple sensor readings are averaged, and small delays are introduced before triggering alerts to improve stability and reliability. Proper sensor calibration is also essential for accurate detection, which involves setting baseline values under clean air conditions and adjusting threshold levels according to environmental factors. Advanced systems implement fail-safe control strategies where alarms are triggered even during sensor or controller failures to ensure maximum safety. IoT-based smart control using ESP32 further enhances system capability by enabling cloud communication, mobile notifications, and remote monitoring. Efficient power management strategies such as low-power components and voltage stabilization techniques are also implemented to ensure uninterrupted operation and energy efficiency.

4.4 Performance Enhancement Techniques in LPG Gas Detector

Performance enhancement techniques are employed in LPG gas detector systems to improve detection accuracy, response speed, reliability, and operational efficiency. One of the most important techniques is proper sensor calibration, which ensures accurate gas sensing by establishing baseline values in clean air and adjusting threshold levels according to the environment. The use of high-sensitivity sensors such as optimized MQ-6 modules further improves LPG detection capability and reduces response time. Sensor signals may contain noise and fluctuations, which can lead to unstable readings and false alarms. To overcome this issue, signal filtering techniques such as averaging methods and low-pass filtering are applied to obtain stable sensor outputs. Fast response mechanisms are achieved by optimizing the microcontroller programming and minimizing processing delays in the control loop. Multi-level gas detection strategies are also implemented, where different gas concentration levels correspond to warning, alert, and emergency conditions, thereby improving safety and early response. Enhanced alert systems using high-decibel buzzers, bright LEDs, and LCD or OLED displays provide better user awareness and monitoring capability. Relay optimization techniques improve switching performance and protect connected devices from voltage spikes. Stable power supply design using voltage regulators and capacitors prevents fluctuations that may affect system operation. IoT integration with ESP32 enables advanced functionalities such as remote monitoring, cloud storage, and instant mobile notifications. Proper PCB design, regular maintenance, backup power systems, and redundant sensor arrangements further improve overall system performance, reliability, and safety.

4.5 Future Trends and Challenges

Future LPG gas detection systems are expected to become smarter, more connected, and highly automated through the integration of advanced technologies. IoT-based smart detection systems using ESP32 and Wi-Fi modules enable real-time monitoring through mobile applications and cloud platforms. These systems can send instant alerts and support remote supervision from any location. Artificial intelligence and machine learning technologies are also emerging in gas detection systems to analyze gas leakage patterns, reduce false alarms, and predict hazardous situations before accidents occur. Wireless sensor networks are being developed for large-scale industrial applications where multiple sensors communicate wirelessly to provide centralized monitoring across factories and smart cities. Smart home integration with platforms developed by Google and Amazon enables voice alerts, automated ventilation control, and intelligent appliance management. Future systems are also expected to become smaller, portable, and energy efficient through miniaturization and low-power design techniques. Advanced sensor technologies such as MEMS-based and infrared gas sensors offer improved sensitivity, faster response, and higher accuracy. Cloud-based monitoring systems further support data analytics, historical trend analysis, and predictive maintenance. Despite these advancements, several challenges remain in LPG gas detection systems. Sensor drift and calibration issues may reduce detection accuracy over time. False alarms caused by smoke, alcohol vapors, or environmental variations remain a major concern. Continuous monitoring systems also consume significant power, particularly in battery-operated devices. Environmental conditions such as humidity and temperature can influence sensor performance. Additionally, advanced IoT and AI-based systems increase overall system cost and depend heavily on reliable internet connectivity. Regular maintenance and sensor replacement are also necessary to ensure long-term reliability and safety.



4.6 Reliability and Fault Tolerance in LPG Gas Detector

Reliability and fault tolerance are essential aspects of LPG gas detector systems because LPG gases are highly flammable and hazardous. Reliability refers to the ability of the system to continuously perform accurate gas detection without failure under different operating conditions. Several factors influence system reliability, including sensor accuracy, stable power supply, proper calibration, and environmental conditions such as temperature and humidity. Reliability can be improved by using high-quality components, implementing filtering techniques, stabilizing the power supply, and incorporating backup batteries. Regular maintenance is also necessary to ensure long-term system performance. Maintenance activities include cleaning the sensor, checking wiring connections, calibrating the sensor periodically, inspecting relays and alarms, and updating software when necessary. Fault detection and handling mechanisms are important for identifying hardware or software failures and ensuring safe operation during abnormal conditions. Common faults include sensor malfunction, power supply failure, loose connections, and microcontroller crashes. To handle such situations, the system incorporates self-checking routines, watchdog timers, and fault monitoring techniques. In fail-safe operation, the system automatically activates alarms during component failure to prevent dangerous situations. Error indications using blinking LEDs or warning messages may also be provided. The implementation of reliable and fault-tolerant design improves user safety, prevents explosions, and ensures continuous monitoring even under fault conditions.

V. INTEGRATION WITH ADVANCED LPG DETECTION SYSTEMS

Modern LPG gas detection systems are increasingly integrated with advanced technologies to improve automation, intelligence, and operational efficiency. IoT-based integration using ESP32 enables the detector to connect with cloud servers and mobile applications for real-time monitoring and remote access. Users can receive instant notifications during gas leakage and monitor gas concentration levels from any location. Smart home integration allows LPG detectors to communicate with intelligent automation platforms, enabling voice alerts, automatic control of exhaust fans, and shutdown of electrical appliances. Automatic gas shut-off systems using solenoid valves provide additional safety by stopping the gas supply immediately after leakage detection. In industrial environments, LPG detection systems are integrated with PLC and SCADA systems for centralized monitoring and automated safety management. Cloud computing and data analytics technologies further support historical data analysis, predictive maintenance, and trend monitoring. Multi-sensor integration combining LPG sensors with smoke and temperature sensors improves overall detection accuracy and reduces false alarms. Mobile application integration enhances user interaction by providing real-time gas level displays, emergency notifications, and device control features. Advanced safety automation systems also integrate fire alarms, ventilation systems, and emergency shutdown mechanisms to provide comprehensive protection during hazardous conditions. Overall, the integration of IoT, automation, and cloud technologies significantly improves the reliability, efficiency, and intelligence of modern LPG gas detection systems. 11. Conclusion Integration with advanced LPG systems transforms a basic gas detector into a smart safety solution. It plays a vital role in modern homes, industries, and smart cities by providing intelligent monitoring and automated protection.

VI. CONCLUSION

The LPG gas detector system is an essential safety solution designed to detect gas leakage and prevent accidents such as fire and explosions. In this project, a reliable and cost-effective system was developed using a gas sensor (MQ-6) and a microcontroller (Arduino/ESP32) to continuously monitor LPG levels in the environment.

The system successfully detects gas leakage in real time and provides immediate alerts through a buzzer and LED indicators. The integration of safety mechanisms such as relay-based control further enhances protection by enabling automatic actions like turning off appliances or activating ventilation systems.

With the addition of advanced technologies such as IoT, cloud monitoring, and smart home integration, the system can be upgraded to provide remote access, real-time notifications, and intelligent decision-making. These features make the system suitable for both domestic and industrial applications.

Overall, the proposed LPG gas detector is efficient, affordable, and easy to implement. It improves safety, reduces risk, and ensures continuous monitoring. Future improvements can further enhance accuracy, reliability, and automation, making it a vital component in modern safety systems.



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