iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: https://doi.org/10.22214/ijraset.2026.79922

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

Automatic Gas Booking and Leakage Detection System

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Abstract: ***Liquefied Petroleum Gas (LPG) is widely utilized in households and industries because of its efficiency and clean nature. However, problems like gas leakage and misjudgment of remaining gas are among some of the major hazards involved in using LPG. Traditional methods of detecting leaks and measuring fuel amount involve manual operations, which are inefficient and prone to errors.***

This project introduces an intelligent monitoring system that detects any LPG leakages and measures the available gas volume within the cylinder. For detecting leaks, MQ-6 gas sensor is used to monitor the ambient air for any increase in gas concentration. Meanwhile, to measure the available gas volume, the load cell sensor is used along with the HX711 IC module to measure the weight of the cylinder. The ESP32 microcontroller analyzes all these signals and performs required functions.

Upon gas leakage detection, the system triggers the required safety measures such as shutting off the gas by turning the valve closed, activating the exhaust fan and triggering the buzzer for alerting the person nearby about the leakage. In addition to the above, the GSM module also sends real-time messages to the user informing about any leakage. Furthermore, in case of low gas level in the cylinder, notifications are sent along with refill requests.

Keywords: LPG Monitoring System, Gas Leakage Detection, MQ-6 Gas Sensor, Load Cell, HX711 Amplifier Module, ESP32 Microcontroller, GSM Communication Module, Solenoid Valve Control, Exhaust Ventilation System, Automatic Gas Booking System, Embedded Safety Automation.

I. INTRODUCTION

Liquefied Petroleum Gas (LPG) has become one of the most widely used fuels in domestic, commercial, and small-scale industrial sectors due to its high calorific value, clean combustion, and ease of storage and transportation. Despite these advantages, LPG poses significant safety risks because of its highly flammable nature. Even a minor leakage can lead to hazardous situations such as fire accidents, explosions, and serious health issues. Therefore, ensuring safe handling and continuous monitoring of LPG systems is of critical importance.

In conventional setups, LPG monitoring primarily relies on manual observation methods, such as estimating the remaining gas by lifting the cylinder or detecting leakage through smell. These approaches are not only inaccurate but also unreliable, particularly in situations where users are unaware, asleep, or away from the location. The absence of real-time monitoring and automated safety mechanisms increases the probability of accidents and inconvenience due to unexpected gas depletion.

With the advancement of embedded systems and sensor technologies, there is a growing opportunity to develop intelligent solutions that enhance both safety and efficiency in LPG usage. This project proposes an integrated LPG Gas Level Monitoring and Leakage Detection System that combines real-time sensing, automated control, and communication features. The system utilizes a gas sensor to detect leakage and a load cell to continuously measure the cylinder weight for accurate estimation of remaining gas.

A microcontroller-based control unit processes sensor data and initiates appropriate actions when abnormal conditions are detected. In the event of gas leakage, the system automatically shuts off the gas supply, activates ventilation, and generates an alert to notify the user. Additionally, when the gas level falls below a predefined threshold, the system provides a low-level warning and facilitates timely refill notification. This integrated approach minimizes human intervention while significantly improving safety and reliability.

The proposed system offers a cost-effective and efficient solution suitable for domestic and small commercial environments. By combining monitoring, alerting, and automatic safety control into a single platform, it contributes toward the development of safer and smarter LPG management systems.

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II. LITERATURE SURVEY

With the increased usage of LPG in various sectors ranging from domestic to industrial usage, the need for monitoring systems and safety systems to detect any possible problem has become more important than ever before. Many scientific studies have tried to enhance monitoring and safety systems. In this chapter, we critically evaluate existing approaches and identify some problems that led us to propose our integrated system.

The conventional ways for monitoring LPG mainly depend on estimation techniques that require the user to make decisions based on their estimations. For instance, the traditional way to monitor the amount of gas left in the tank would be through manually estimating by comparing the cylinder weight to previous experience or observing the properties of the burner flame. As far as leakage detection is concerned, people heavily rely on their sense of smell since odorants are added to LPG. Such methods are extremely unreliable and potentially unsafe especially when no one can supervise them as in the cases of sleeping times.

On the other hand, researchers tried to develop some automatic detection devices that depend on sensor technology. Specifically, gas sensors (MQ-series sensors) have been used successfully in many studies. For example, in [1], [2], gas sensors are used to detect any leak in the LPG cylinder and automatically alert the user about the problem through sound waves or buzzers. Nevertheless, in most studies, the proposed systems only focused on detecting leakage and sending alerts without initiating appropriate action.

Another aspect studied to develop better LPG monitoring system is level monitoring systems. Many load cells were used to detect changes in weight and thus determine the gas level. Signal conditioning circuits like HX711 were used in several studies (see [3], [4]) to measure the weight of LPG cylinders. Nevertheless, these studies were independent of leakage detection studies. Therefore, both functionalities were separately studied in the literature.

Moreover, wireless communication systems were studied to enhance monitoring systems as well by allowing remote notification to the user. GSM modules were used in numerous studies. For instance, in [5], [6], researchers designed an alert system to send SMS notifications to the user's phone regarding any leakage or shortage of gas. Similar to previous studies, none of them included some action mechanism to stop leakage.

Recent studies have developed a semi-integrated approach to LPG monitoring. Such works integrate many components including gas sensors, load cells, microcontrollers, and communication.

III. PROPOSED METHODOLOGY

The proposed system is an intelligent system which integrates a set of real-time monitoring devices and systems for detection of gas leakage and cylinder level to ensure greater safety in operations.

System Architecture

The proposed system is built with an embedded technology architecture comprising four major units – Sensing unit, Processing unit, Communication unit and Safety and Control unit. In this architecture, multiple sensing and control modules are controlled by one single processor through multiple connections to the microcontroller.

Gas Leakage Detection Mechanism

For detecting gas leakage in the atmosphere, a semiconductor-based gas sensor will be used in the architecture. The output resistance value of the gas sensor is affected by any increase in combustible gas concentration. The gas concentration level is detected by continuous comparison of the sensor output with predefined threshold values.

If the output value exceeds the predetermined safety value, then gas leakage will be detected.

Gas Level Measurement Approach For measuring the amount of gas left inside the cylinder, a load cell based technique is considered in the system architecture. Load cells detect the weight of gas cylinders continuously and the output value, in millivolt, is passed through a signal conditioning module for amplification

IV. SYSTEM FLOWCHART

The flowchart describes the whole procedure of operation of the LPG gas level monitoring and leakage detection system. First of all, the initialization process is performed. As a result, the ESP32, gas sensor, load cell with the amplifier module, and GSM module are initialized. After that, the system starts working. Two types of information are constantly collected by the system during monitoring – the gas content information gathered from the gas sensor and cylinder weight information gathered from the load cell.

In addition, there is a need to make a decision about whether there is a gas leakage or not. If yes, then there should be performed several actions to prevent further damage. In particular, the system triggers the relay module and, as a result, closes the solenoid valve. In addition, the exhaust fan should be switched on. A buzzer will be active during the whole process as well. Besides, the system sends a notification message and refill request message to the user. As soon as everything is done, monitoring continues.

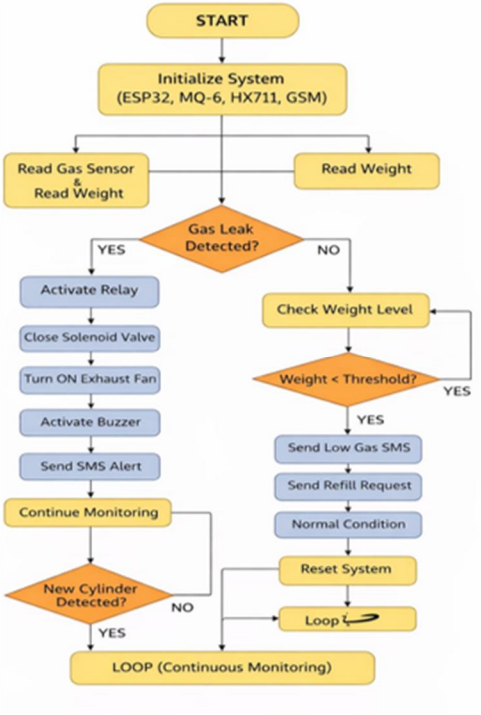

Fig 4.1: Overall Working Flowchart of LPG Gas Monitoring and Leakage Detection System

V. RESULT

The developed system has been tested in various operational conditions in order to verify the performance of the suggested solution. The obtained test results reveal that the developed system is capable of performing effective LPG leakage detection and gas level monitoring.

The sensor used to detect gas leakage has shown an observable change in signal in the case where the gas concentration exceeded the predefined threshold value. Thus, the activation of alert devices took place without any delays, which provided better user experience.

The load cell sensor proved its reliability as it continuously detected the gas level in the cylinder due to the measurement of its weight. It became possible to determine whether there is a lack of gas when measuring the cylinder weight.

The GSM modem has reliably performed communication with the user. It is obvious from the test results that alerting messages have been transferred to the smartphone without any delay.

In addition, the performance of the developed system has been confirmed by multiple trials. The stable work of all parts of the system has been observed.

Thus, the developed system proves its efficiency and reliability due to the simultaneous leakage detection, gas level monitoring, and user notifications.

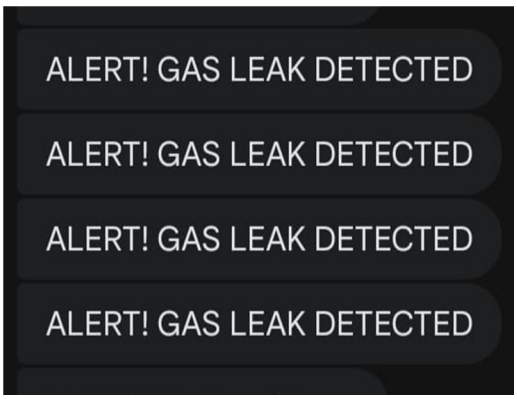

Fig 5.1 : Gas leakage detection alert sent to user

Fig 5.2: Low Gas Alert SMS with Remaining Gas Value Low Gas Alert SMS with Remaining Gas Value

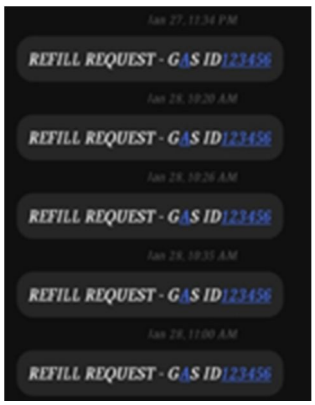

Fig 5.3: Automatic Refill Request SMS Sent to Gas Agency

VI. CONCLUSION

In this report, a system for leak detection of LPG gas and monitoring of the level of cylinder has been designed. This system can detect the leakage of gas at the initial stages and alerts the person about it to avoid any possible risks in the domestic environment. This mechanism operates effectively as it can alert the users whenever there is any leakage.

Not only does it provide security from accidents, but also provides convenience to the users because the level of gas in the cylinder is monitored on an ongoing basis. If the gas level gets down to a particular point, the process of booking gas will get initiated automatically, making life easier for the user.

These facilities make the proposed system a perfect solution to be applied in modern houses.

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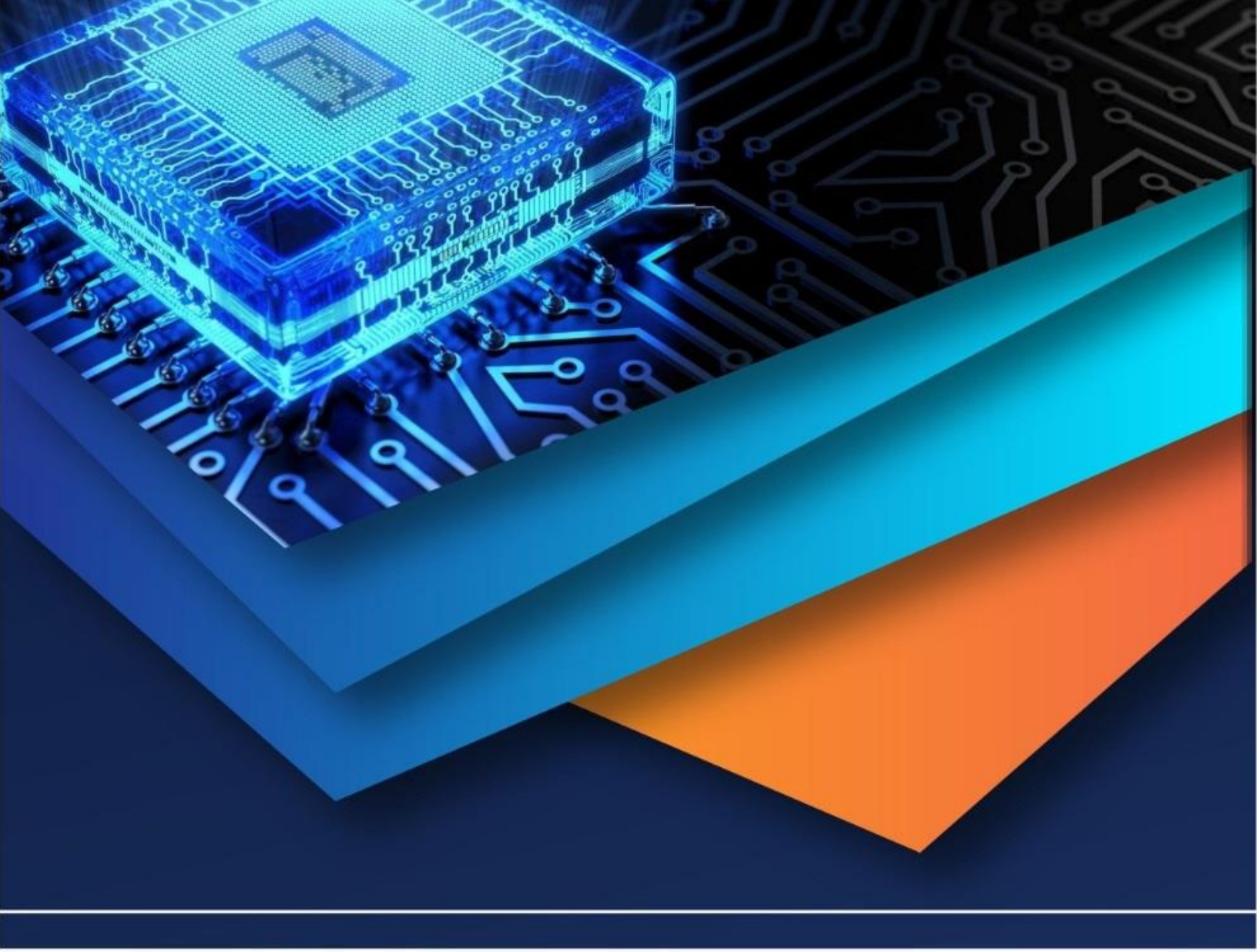

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