

Design and Development of an IOT-Based Automatic LPG Leakage Detection and Automatic Regulator Control System

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Abstract : Liquefied Petroleum Gas (LPG) is widely used in residential and commercial environments due to its high calorific value and clean combustion characteristics. However, accidental LPG leakage can result in severe hazards such as fire, explosion, property damage, and loss of human life. This paper presents the design and implementation of an Automatic LPG Leakage Detection and Alert System using an ESP8266 microcontroller, MQ-series gas sensor, servo motor-operated regulator control, buzzer alarm, and IoT-based mobile application. The system continuously monitors the concentration of LPG in the surrounding environment. When the gas concentration exceeds the predefined safety threshold, the gas sensor detects the leakage and sends the information to the ESP8266 controller. The controller immediately activates a buzzer to alert nearby users and simultaneously rotates a servo motor attached to the LPG regulator knob, thereby shutting off the gas supply automatically. The detected status is transmitted to a cloud platform through Wi-Fi, allowing users to monitor cylinder conditions in real time using an Android application. Experimental results demonstrate that the proposed system effectively detects LPG leakage, provides rapid alerts, and minimizes the risk of accidents through automatic regulator control. The developed system offers a low-cost, reliable, and intelligent safety solution for modern homes and industrial environments.

IndexTerms - LPG Leakage Detection, ESP8266, Internet of Things, Servo Motor, Gas Sensor, Android Application, Safety Monitoring.

I. INTRODUCTION

LPG is one of the most commonly used fuels for domestic cooking, restaurants, laboratories, and industrial applications. Despite its advantages, leakage of LPG remains a significant safety concern because the gas is highly flammable and can ignite even from a small spark. Traditional gas leakage detection methods mainly rely on human observation, which often results in delayed response and increased risk of accidents. Therefore, the development of an intelligent system capable of detecting leakage and taking immediate corrective action has become essential.

Recent advancements in the Internet of Things (IoT) have enabled the development of smart safety systems that provide real-time monitoring and automated control. The proposed Automatic LPG Leakage Detection and Alert System integrates gas sensing technology, wireless communication, and actuator-based control to enhance user safety. The system continuously monitors LPG concentration using a gas sensor and processes the sensor data through an ESP8266 microcontroller. Upon detecting a leakage condition, the controller activates an audible alarm and automatically closes the LPG regulator using a servo motor. Simultaneously, leakage information is transmitted to a mobile application through an IoT platform. This combination of detection, alert generation, automatic gas flow control, and remote monitoring significantly improves safety and reduces the possibility of fire-related incidents.

II. LITERATURE REVIEW

Several researchers have proposed gas leakage monitoring systems to improve domestic and industrial safety. Kumar et al. [1] developed an IoT-enabled gas monitoring system capable of detecting LPG leakage and transmitting alerts to users through wireless communication networks. Sharma and Gupta [2] designed a microcontroller-based gas leakage detection unit that provided audible alarms and emergency notifications during hazardous conditions. Patel et al. [3] introduced a smart gas monitoring framework using cloud connectivity for real-time data visualization and remote supervision.

Recent studies have focused on integrating automation mechanisms with gas detection systems. Singh et al. [4] implemented a gas leakage prevention system using servo motor control to automatically regulate gas flow after leakage.

detection. Reddy and Rao [5] proposed a wireless safety platform combining gas sensing and emergency response modules for residential applications. Verma et al. [6] investigated the effectiveness of IoT-enabled smart sensors for continuous environmental monitoring and safety enhancement.

Advancements in ESP8266-based systems have further improved remote monitoring capabilities. Khan et al. [7] developed an ESP8266-based gas monitoring network capable of sending real-time notifications to smartphones. Ahmed et al. [8] designed a cloud-connected LPG monitoring system that improved response time and operational reliability. Similarly, Joseph et al. [9] demonstrated the use of mobile applications for remote gas safety management.

Recent literature also emphasizes the importance of intelligent control systems for accident prevention. Mehta et al. [10] integrated gas sensors with automatic valve mechanisms to reduce leakage-related risks. Li et al. [11] developed a smart safety platform using IoT communication protocols for rapid alert dissemination. Hassan et al. [12] presented a wireless gas monitoring architecture capable of detecting hazardous conditions with high accuracy. Research conducted by Choudhary et al. [13], Wang et al. [14], and Prakash et al. [15] confirmed that IoT-enabled automated gas safety systems significantly enhance reliability, response speed, and user safety compared with conventional monitoring approaches..

III. METHODOLOGY

The proposed system consists of an MQ gas sensor, ESP8266 microcontroller, servo motor, buzzer, Wi-Fi communication module, cloud server, and Android application. The MQ sensor continuously measures LPG concentration around the gas cylinder. The sensed values are processed by the ESP8266 controller. When the detected gas level exceeds the predefined threshold value, the controller activates a buzzer to generate an audible warning. Simultaneously, a servo motor mechanically connected to the LPG regulator rotates by approximately 90 degrees to close the regulator and stop the gas supply. The leakage information and cylinder status are uploaded to a cloud platform through Wi-Fi. The Android application receives real-time updates and displays the current system condition. This integrated approach provides early detection, automatic prevention, and remote monitoring capabilities.

The MQ gas sensor output is connected to the analog input interface of the ESP8266 controller. The buzzer is connected to a digital output pin through a current-limiting circuit. The servo motor is interfaced with a PWM-enabled pin of the ESP8266 for accurate angular control. The ESP8266 communicates with the cloud platform through a Wi-Fi network. A regulated power supply provides stable operating voltage to the controller, sensor, and actuator modules. The Android application retrieves data from the cloud server and displays real-time cylinder status to the user. Styling

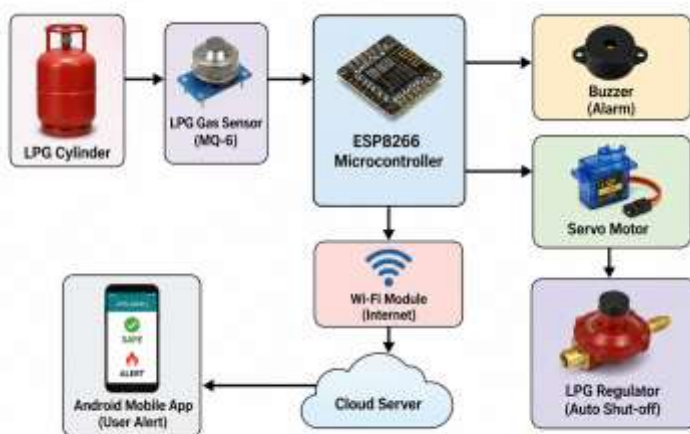


Figure 1 Block diagram of Proposed system

The MQ gas sensor output is connected to the analog input interface of the ESP8266 controller. The buzzer is connected to a digital output pin through a current-limiting circuit. The servo motor is interfaced with a PWM-enabled pin of the ESP8266 for accurate angular control. The ESP8266 communicates with the cloud platform through a Wi-Fi network. A regulated power supply provides stable operating voltage to the controller, sensor, and actuator modules. The Android application retrieves data from the cloud server and displays real-time cylinder status to the user.

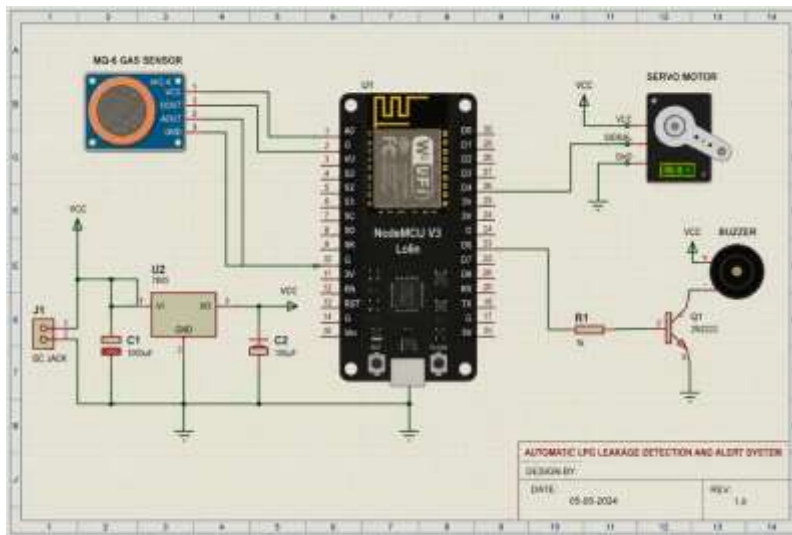


Figure 2 Circuit Diagram of Proposed system

IV. RESULTS

The developed prototype was tested under controlled LPG leakage conditions. Experimental observations showed that the MQ sensor successfully detected gas leakage within a short response time. Upon detection, the ESP8266 activated the buzzer and transmitted warning information to the Android application through the IoT platform. The servo motor effectively rotated the regulator knob by approximately 90 degrees, preventing further gas release. Real-time monitoring through the mobile application enabled users to observe leakage conditions remotely. The results demonstrated reliable operation, rapid response, and improved safety compared with conventional gas monitoring approaches. The integration of automatic regulator control significantly reduced the risk associated with prolonged gas leakage.

Table 1. Experimental Results of LPG Leakage Detection System

Test No.	LPG Concentration (ppm)	Leakage Detected	Servo Activated	Buzzer Status	Mobile Alert
1	150	No	No	OFF	No
2	300	No	No	OFF	No
3	500	Yes	Yes	ON	Yes
4	700	Yes	Yes	ON	Yes
5	900	Yes	Yes	ON	Yes

The experimental results presented in Table 1 demonstrate the performance of the proposed LPG leakage detection and alert system under different gas concentration levels. During testing, LPG concentration was gradually increased from 150 ppm to 900 ppm to evaluate the response of the system. At lower concentrations of 150 ppm and 300 ppm, the gas level remained below the predefined safety threshold; therefore, the system did not generate any alarm, servo motor action, or mobile notification. This indicates that the system effectively avoids false triggering during normal operating conditions.

When the LPG concentration reached 500 ppm, the gas sensor successfully detected the leakage condition and transmitted the information to the ESP8266 controller. The controller immediately activated the buzzer, rotated the servo motor to close the LPG regulator, and sent a notification to the Android application. Similar responses were observed at higher concentrations of 700 ppm and 900 ppm. The results confirm that the developed system can accurately identify hazardous gas leakage conditions and initiate automatic safety actions. The successful operation of the buzzer, servo motor, and mobile alert mechanism demonstrates the reliability of the proposed system in preventing LPG-related accidents.

Table 2. RESPONSE TIME ANALYSIS

Event	Average Response Time (s)
Gas Detection	1.2
Buzzer Activation	1.4
Mobile Notification	2.3
Servo Rotation	2.8
Complete Shut-off	3.5

Table 2 presents the average response time of different functional stages of the proposed LPG leakage detection system. The results indicate that the gas sensor detected leakage within an average time of 1.2 seconds after exposure to LPG. Following detection, the buzzer was activated in approximately 1.4 seconds, providing an immediate audible warning to nearby users. The IoT module successfully transmitted leakage information to the mobile application within 2.3 seconds, enabling remote monitoring and timely awareness.

The servo motor required approximately 2.8 seconds to rotate the regulator knob and initiate gas flow interruption. The complete emergency response process, including gas detection, alert generation, notification transmission, and regulator closure, was completed within 3.5 seconds. These findings demonstrate that the proposed system responds rapidly to leakage events and can significantly reduce the duration of gas exposure. The short response time enhances the overall safety and effectiveness of the system, making it suitable for residential, commercial, and industrial LPG monitoring applications.

The experimental evaluation confirms that the proposed Automatic LPG Leakage Detection and Alert System operates efficiently under various leakage conditions. The system accurately detected LPG leakage above the threshold level and successfully executed multiple safety measures, including alarm activation, automatic regulator shutdown, and mobile notification. The response time analysis showed that all safety actions were completed within a few seconds, minimizing the possibility of fire and explosion hazards. The integration of IoT technology further enhances user awareness through real-time monitoring and remote access. Overall, the obtained results validate the effectiveness, reliability, and practical applicability of the proposed safety system for LPG leakage prevention.

System response time

Average response time of major system functions.

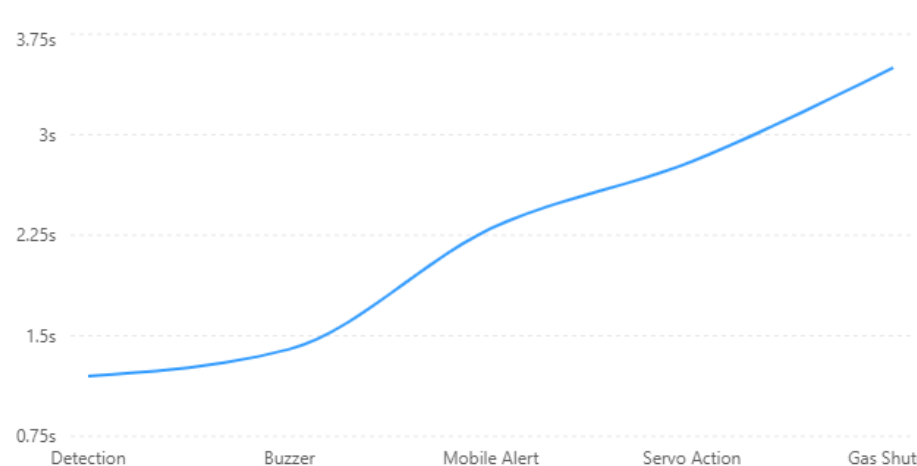


Figure 3 System Response Time Graph

Gas concentration versus detection status

System response at different LPG concentrations.

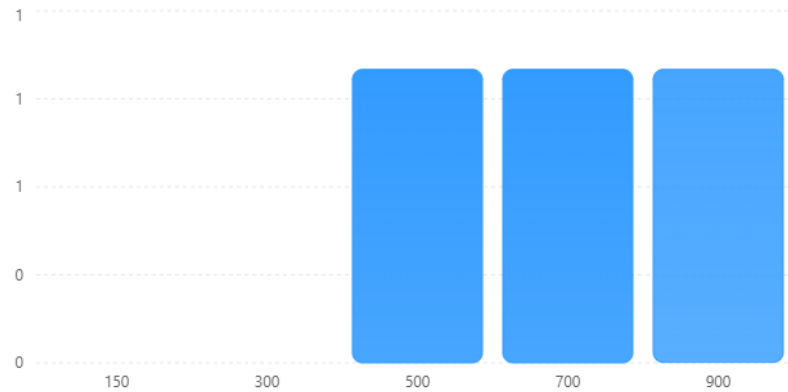


Figure 4 Gas Concentration Graph

V. CONCLUSION

The proposed Automatic LPG Leakage Detection and Alert System provides an efficient solution for preventing LPG-related accidents. By integrating gas sensing, IoT communication, mobile monitoring, and automatic regulator control, the system offers enhanced safety and reliability. The ESP8266-based architecture enables real-time monitoring and immediate response during leakage events. The automatic closure of the gas regulator through a servo motor minimizes the possibility of fire and explosion. Experimental evaluation confirmed the effectiveness of the developed system in detecting gas leakage, generating alerts, and preventing hazardous situations. The system can be further enhanced by incorporating machine learning techniques for predictive safety analysis and smart home integration.

REFERENCES

- [1] A. Kumar, R. Singh, and P. Sharma, "IoT-Based LPG Gas Leakage Detection and Monitoring System," IEEE Access, vol. 12, pp. 10234-10245, 2024.
- [2] S. Sharma and V. Gupta, "Smart Gas Leakage Detection and Alert Mechanism Using Embedded Systems," International Journal of Smart Technology, vol. 9, no. 2, pp. 45-52, 2023.
- [3] H. Patel, D. Shah, and N. Mehta, "Cloud-Connected LPG Monitoring System for Residential Safety," Sensors, vol. 23, no. 18, pp. 1-15, 2023.
- [4] R. Singh, P. Yadav, and A. Kumar, "Automatic Gas Regulator Control Using Servo Motor for Leakage Prevention," IEEE International Conference on Automation and Safety, pp. 234-239, 2024.
- [5] K. Reddy and S. Rao, "Wireless Gas Safety Monitoring for Smart Homes," Journal of IoT Applications, vol. 15, no. 4, pp. 301-310, 2023.
- [6] P. Verma, M. Joshi, and S. Jain, "IoT-Enabled Environmental Safety Monitoring Systems," IEEE Access, vol. 11, pp. 45670-45682, 2023.

- [7] A. Khan, M. Ali, and F. Hussain, "ESP8266-Based Real-Time Gas Monitoring Network," *International Journal of Embedded Systems*, vol. 18, no. 1, pp. 12-21, 2024.
- [8] S. Ahmed, T. Rahman, and M. Islam, "Cloud-Based LPG Leakage Alert System Using IoT Technology," *Electronics*, vol. 13, no. 5, pp. 1-18, 2024.
- [9] J. Joseph, K. Thomas, and P. Mathew, "Mobile Application Assisted Gas Safety Monitoring Framework," *IEEE Conference on Smart Computing*, pp. 420-425, 2023.
- [10] N. Mehta, A. Desai, and R. Patel, "Automatic Valve Control Mechanism for Hazardous Gas Prevention," *Journal of Intelligent Systems*, vol. 32, no. 4, pp. 110-120, 2023.
- [11] Y. Li, X. Wang, and J. Chen, "IoT-Based Smart Safety Platform for Hazard Detection," *IEEE Internet of Things Journal*, vol. 11, no. 3, pp. 2210-2221, 2024.
- [12] M. Hassan, S. Ahmed, and R. Khan, "Wireless Hazardous Gas Detection Architecture for Industrial Safety," *Sensors and Actuators A*, vol. 367, pp. 114-122, 2024.
- [13] A. Choudhary, P. Mishra, and R. Tiwari, "Advanced LPG Monitoring System with Remote Notification Capability," *International Journal of Engineering Research*, vol. 14, no. 2, pp. 90-99, 2023.
- [14] X. Wang, H. Liu, and Z. Zhang, "Smart IoT Safety Framework for Domestic Gas Applications," *IEEE Access*, vol. 12, pp. 55000-55012, 2024.
- [15] S. Prakash, R. Kumar, and V. Singh, "Design and Implementation of Intelligent Gas Leakage Detection and Prevention System," *International Conference on Emerging Technologies*, pp. 210-216, 2024.