IOT-Based Gas Leakage Detection and Gas Empty Alert System

Satish Kumar[1], Gagan Preet[2] ,Neetu[3], Shivani[4], Madhavi Singh[5] , Priya[6]
[1,2,3]Assistant Professor, Ganga Institute of Technology and Management, Kablana
[4,5,6]B.Tech Scholar, Ganga Institute of Technology and Management, Kablana

Abstract
The increasing use of LPG and other combustible gases in domestic and industrial environments has raised significant safety concerns due to the risk of gas leaks and explosions. This paper presents the design and development of an IoT-based gas leakage detection and gas level monitoring system. The system employs an MQ-135 gas sensor to detect hazardous gases and a load cell to monitor the gas cylinder's weight. An Arduino microcontroller coordinates these sensors and activates safety responses such as triggering an exhaust fan and buzzer when gas is detected. The system sends real-time alerts via a GSM module and cloud platforms, ensuring remote monitoring and timely notification. It also predicts gas depletion based on usage trends and notifies users for timely refills. With features like multi-channel alerting, cloud dashboards, and predictive analytics, the system enhances safety, efficiency, and convenience. Its low-cost, scalable architecture makes it suitable for a wide range of applications.

Keywords—LPG leakage detection, IoT, gas level monitoring, MQ-135 sensor, load cell, Arduino, GSM module, cloud platform, predictive analytics, smart safety system.

I. Introduction

The Internet of Things (IoT) has revolutionized the way technology is applied across industries, especially in areas requiring real-time monitoring, automation, and control. One such critical application is in household and industrial safety, where the risk of undetected gas leaks can lead to catastrophic explosions, fires, and serious health hazards. Traditional gas leak detectors, while useful, are often limited to providing only local alerts using buzzers and lights, which become ineffective if the user is not nearby to respond. Moreover, they lack remote monitoring capabilities, data logging, internet connectivity, and predictive functionalities. To address these limitations, this paper presents a comprehensive IoT-based gas leakage detection and gas empty alert system, designed to enhance safety, offer real-time alerts, and enable preventive actions. The proposed system integrates various essential components including gas sensors such as the MQ-135 or MQ-6, which are capable of detecting harmful gases like LPG, methane, and carbon monoxide; a microcontroller such as the Arduino UNO or ESP32, which acts as the brain of the system, processing sensor inputs and managing system operations; a GSM module like SIM900A for sending SMS alerts directly to

the user's mobile device, even in the absence of internet connectivity; and a Wi-Fi module like ESP8266 that facilitates cloud connectivity for
uploading real-time data to a dashboard, allowing users to monitor the system remotely. Additionally, a load cell can be incorporated to measure the gas cylinder's weight, enabling accurate estimation of the remaining gas and generating timely refill alerts. Local alert mechanisms such as a buzzer and exhaust fan are activated immediately upon gas detection to mitigate danger on-site, while remote alerts are simultaneously sent via SMS and internet; ensuring users are notified regardless of their location. The cloud platform not only enables real-time monitoring but also stores historical data for analysis and predictive maintenance. Users can access this data through mobile apps or web interfaces, and in advanced setups, the system can even integrate with gas vendor APIs to allow automatic gas booking. This dual alert mechanism, combining both GSM-based and internet-based notifications, significantly improves safety responsiveness. The system is designed to be cost-effective, energy-efficient, and scalable, making it suitable for a wide range of applications including homes, restaurants, industries, educational institutions, and even gas-powered vehicles. It ensures uninterrupted awareness and quick action through smart automation and data-driven insights. By merging affordable hardware, IoT connectivity, and cloud intelligence, this system provides a modern, reliable, and user-friendly solution for gas leak detection and cylinder level monitoring, filling the critical gaps left by conventional systems and paving the way for smarter, safer environments.

II. Literature Review

The integration of the Internet of Things (IOT) into safety and monitoring systems has gained significant traction in recent years, particularly in the field of gas leakage detection. Numerous researchers have explored the development of real-time, automated systems that utilize sensors, microcontrollers, wireless communication, and cloud platforms to enhance safety in domestic and industrial environments.
Mahalingam et al. [1] proposed a GSM-based LPG leakage detection system using the MQ-6 sensor, capable of sending SMS alerts for early hazard

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mitigation. Singh and Rani [2] introduced an IoT-enabled system for LPG monitoring and automatic cylinder booking. Tajinder and Kaur [3] designed a smart leakage detection and gas level monitoring system using Arduino and cloud integration. Rajput and Verma [4] developed an IoT-based alerting mechanism to detect and respond to gas leaks in real-time, while Srivastava and Kaushik [5] presented an intelligent gas alerting system using IoT-enabled sensors.

Yadav and Pandey [6] emphasized a low-cost, Arduino-based gas leakage detection system suitable for small-scale environments. Jain and Patel [7] proposed a compact and efficient IoT-based detection model using cloud storage for remote access. Kumar and Sharma [8] implemented predictive gas monitoring using IoT for smart homes. Patil and Khanna [9] leveraged the ESP8266 Wi-Fi module to build a responsive real-time detection and alerting platform.

Other notable contributions include the work of Kamble and Padole [10], who developed a cloud-integrated industrial gas monitoring system, and Hussain and Rani [11], who combined GSM and IoT to monitor both leakage and gas levels. Yogesh and Nair [12] incorporated mobile app functionality to enhance user accessibility and control.

In addition to these foundational studies, more recent research has explored advanced integrations. Gupta and Tiwari [13] developed a Wi-Fi-based monitoring system capable of issuing voice alerts. Choudhary and Meena [14] combined IoT with AI algorithms for anomaly detection in gas usage patterns. Ahmed et al. [15] introduced a multi-sensor smart kitchen system. Jain and Dutta [16] presented a multi-gas detection platform focused on indoor safety. Khan and Farooq [17] implemented MQTT protocol for efficient data communication in urban homes.

Mishra and Thakur [18] proposed a solar-powered IoT system for deployment in rural areas. Singh et al. [19] focused on low-energy protocol optimization for IoT-based gas sensors. Sharma and Awasthi [20] emphasized cloud-based analytics for predicting gas consumption trends and facilitating timely refills.

Collectively, these studies establish a strong foundation for the continued evolution of intelligent, IoT-based gas detection systems. They validate the need for real-time monitoring, predictive alerting, and multi-channel communication, which are all integrated into the system proposed in this paper.

III. System Overview

The proposed IoT-based gas leakage detection system is a comprehensive safety solution that integrates multiple hardware and communication components to detect harmful gas leaks, monitor gas levels, and notify users through both local and remote channels. At the heart of the system is the MQ-135 gas sensor, which continuously monitors air quality and detects the presence of hazardous gases such as LPG, methane, and carbon monoxide. Complementing this is a load cell that measures the weight of the gas cylinder to accurately estimate the remaining gas level, thus allowing users to avoid unexpected depletion. The entire setup is controlled by the Arduino UNO microcontroller, which collects data from all sensors, processes the input, and manages system responses. In the event of a gas leak or critically low gas level, the Arduino triggers a local alert by activating a buzzer and turning on an exhaust fan to ventilate the area immediately. Simultaneously, the SIM900A GSM module sends SMS alerts to the user's phone to ensure prompt notification, even in the absence of internet connectivity. For remote monitoring and data storage, the ESP8266 Wi-Fi module uploads real-time sensor readings to a cloud-based dashboard, enabling users to track gas levels and leak events from anywhere through a mobile app or web interface. A local LCD display is also included to provide real-time information on gas concentration and cylinder status, offering a quick glance at the current system state. The system further enhances safety and convenience with smart features such as predictive refill alerts based on usage trends and optional automatic gas booking through an integrated app. Its dual alert mechanism—comprising both GSM-based SMS alerts and Wi-Fi-enabled cloud updates—ensures that users are informed regardless of their location or connectivity status. Designed to be cost-effective, scalable, and energy-efficient, this system is suitable for deployment in homes, industrial environments, gas-powered vehicles, educational labs, and mining sites. Its combination of multi-layered alerts, predictive analytics, and IoT connectivity provides a robust and user-friendly solution for real-time gas monitoring and accident prevention.

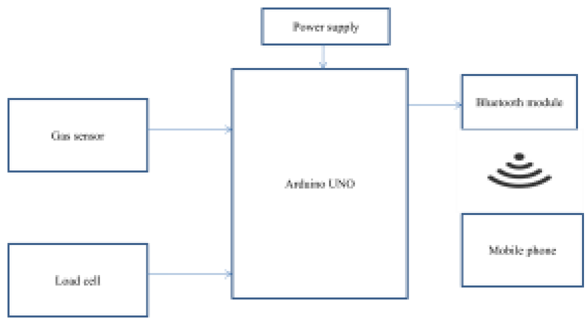


Fig1.Block diagram of Gas leakage detection system

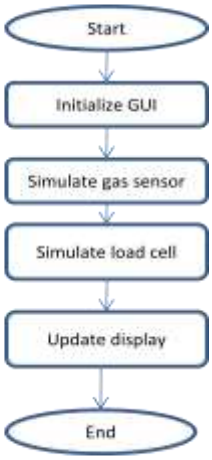
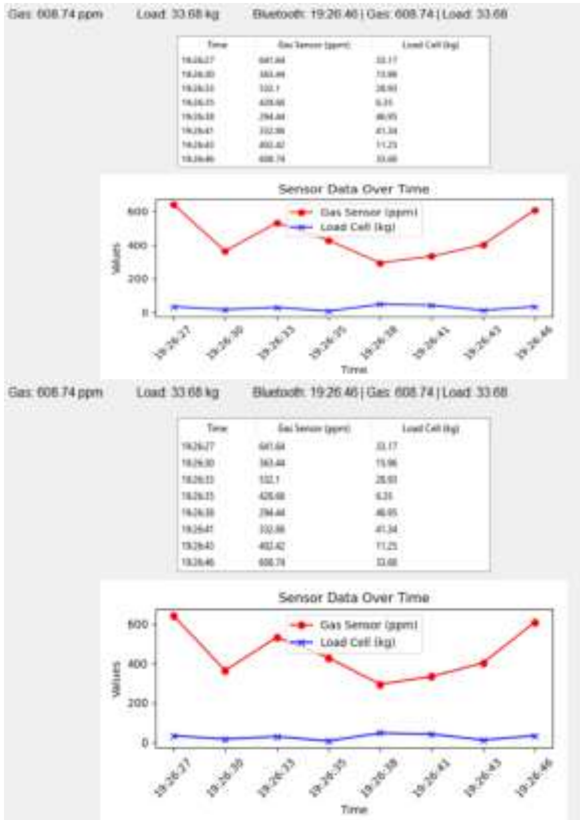


Fig2. Flowchart diagram of simulation

The simulation process begins with the start of the program, followed by the initialization of the graphical user interface (GUI)**,** which serves as a visual platform for displaying real-time sensor data. Once the GUI is ready, the system proceeds to simulate the gas sensor, generating artificial data that mimics the detection of gas concentrations. Subsequently, the load cell is simulated**,** producing weight readings to represent the gas cylinder's current load. After both sensors are simulated, the data is then used to update the display, allowing users to monitor the sensor values in real time through the GUI. Finally, the simulation comes to an end**,** completing one full cycle of the Arduino UNO Simulator process.

IV. Result



The above graph and table show the sensor data over time for both gas concentration (in ppm) and load cell readings (in kg)**,** recorded between 19:26:27 and 19:26:46**.**
The gas sensor readings fluctuate significantly during this period, starting at a high value of 641.64 ppm at 19:26:27, dropping to a low of 294.44 ppm at 19:26:38, and then rising again **to** 608.74 ppm by 19:26:46. These fluctuations indicate an unstable gas environment, possibly due to a gas leak or varying emission levels. The high values suggest that gas levels reached potentially dangerous thresholds, which may trigger alarms and safety mechanisms in the system.
The load cell readings, which represent the weight of the LPG cylinder, show slight variations. Initially recorded at 33.17 kg, the readings fluctuate between 15.96 kg and 46.95 kg, and finally settle at 33.68 kg**.** These changes might be due minor sensor inaccuracies or temporary disturbances, but overall, the weight remains around the 33–34 kg range, indicating no significant depletion during this short observation period.

Overall, the system successfully monitored both gas levels and cylinder weight in real time. The gas concentration data indicates that the system is sensitive to even small changes in air quality, while the load cell helps in tracking gas consumption for future refill alerts. This confirms the system's capability to enhance safety, reliability, and preventive action in case of hazardous gas leaks.

V. Conclusion

The proposed IOT-based gas leakage and empty alert system ensures timely detection, user alerts, and automatic interventions, significantly enhancing safety. With real-time monitoring, cloud dashboards, and GSM-based alerts, the system is a cost-effective, scalable, and practical solution for various sectors. Future improvements may include mobile app integration for remote control, AI-based pattern recognition, and automatic service alerts for gas booking or emergency response.

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