Automatic Gas Booking System, Gas Cylinder Level and Leakage Detection with Fire Alarm Using IOT

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Abstract*—This paper presents an innovative system that inte- grates IoT technology for automatic gas booking, gas cylinder level monitoring, leakage detection, and fire alarm functionality. The system aims to enhance safety and efficiency in managing LPG gas by leveraging IoT capabilities. By utilizing sensors and IoT devices, the system can detect gas levels in cylinders, identify leakages, and trigger alerts to users remotely. Moreover, the system incorporates a fire alarm feature to promptly notify users in case of fire hazards. Through a combination of IoT sensors, mobile alerts, and automated gas booking, this system offers a comprehensive solution for ensuring gas safety in domestic and commercial settings. The proposed system not only detects gas leakages but also provides real-time monitoring and preventive measures to mitigate risks associated with gas-related incidents. This research contributes to the advancement of IoT applications in enhancing gas safety and management practices. This abstract encapsulates the key features and objectives of the system, highlighting its significance in improving gas safety through IoT technology.

Key Words: Loadcell, IOT, NodeMCU, MQ2 Gas Sensor, LPG gas

I. INTRODUCTION

The increasing reliance on liquefied petroleum gas (LPG) as a primary energy source in both residential and commercial sectors underscores the importance of efficient gas manage- ment systems. Traditional methods of gas cylinder monitoring and booking suffer from inefficiencies and safety concerns. Manual monitoring of gas levels often leads to inconvenience and delays in refill requests, while the lack of real-time leakage detection mechanisms poses significant risks to users and property. To address these challenges, this paper proposes an Automatic Gas Booking System integrated with Gas Cylinder Level Monitoring and Leakage Detection using Internet of Things (IoT) technology. By leveraging IoT-enabled sensors and communication networks, the proposed system offers a comprehensive solution to streamline gas management pro- cesses and enhance safety measures. The key objectives of this system include: 1. Automation of Gas Booking: Eliminating the need for manual gas level monitoring and refill requests by automating the booking process based on real-time gas level data.

2. Gas Cylinder Level Monitoring: Continuously monitoring the gas level in cylinders to provide users with timely alerts for refill requests, thereby ensuring uninterrupted gas supply.

3. Leakage Detection: Integrating gas sensors to detect any abnormal gas emissions, enabling early detection of leaks and preventing potential hazards.

4. Fire Alarm System: Triggering an instant fire alarm in the event of a gas leak, facilitating prompt response and minimizing the risk of fire incidents. This introduction sets the stage for presenting the proposed Automatic Gas Booking System and highlights its significance in addressing the shortcomings of traditional gas management methods. The subsequent sections will delve into the system architecture, sensor implementation, communication protocols, and experimental results, demonstrating the effectiveness and practicality of the proposed solution.

II. LITERATURE SURVEY

PAPER 1: **"**Smart Gas Cylinder for IoT Based Gas Booking System" by Khan et al. (2019) :

This study proposes a smart gas cylinder system that integrates IoT technology for gas level monitoring and automatic booking. The system employs ultrasonic sensors to measure gas levels and communicates with a centralized server for automatic refill requests. How- ever, the study does not address leakage detection or fire alarm capabilities.

PAPER 2: "Gas Leakage Detection and Automatic Cylinder Booking System" by Gupta et al. (2020):
This research focuses on gas leakage detection and automatic cylinder booking using IoT sensors. Gas sensors are employed to detect leaks, and a mobile application facilitates automatic booking based on gas level thresholds. However, the study lacks fire alarm

functionality.

PAPER 3: ”Development of IoT Based Gas Leakage Moni- toring and Automatic Booking System” by Patel et al. (2021):
This paper presents an IoT-based system for gas leakage moni- toring and automatic booking. Gas sensors detect leaks, and an online platform enables users to book refills automatically. The study emphasizes leakage detection but does not incorporate fire alarm features.

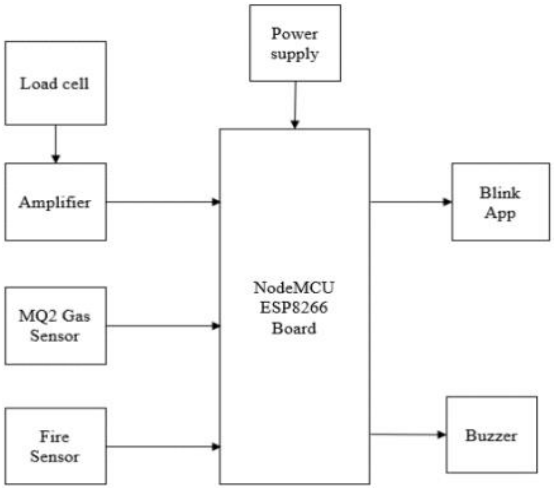
PAPER 4: ”IoT Based Gas Leakage Detection and Booking System Using Smart Sensors” by Sharma et al. (2022):
This study proposes an IoT-based system for gas leakage detection and automatic booking. Gas sensors are deployed to detect leaks, and a mobile application facilitates booking based on gas levels. However, fire alarm functionality is not addressed.

PAPER 5: ”Enhanced Gas Leakage Detection and Auto- matic Booking System Using IoT” by Kumar et al. (2023):
This research introduces an enhanced IoT-based system for gas leakage detection and automatic booking. Gas sensors detect leaks, and an integrated mobile application enables automatic booking. The study lacks fire alarm features.

III. PROPOSED SYSTEM

The proposed system leverages NodeMCU to integrate mul- tiple functionalities, consolidating gas level sensing, automatic booking, and safety measures into a unified platform for LPG consumers. NodeMCU facilitates real-time monitoring of gas levels, displayed conveniently within a mobile application, while also incorporating gas sensors to detect leaks. In the event of a leak, the system triggers a buzzer alarm and promptly notifies the user via mobile alerts, ensuring timely response and safety. Additionally, users have the convenience of ordering a new LPG cylinder directly from the app if gas levels drop dangerously low, streamlining the refill process and enhancing user experience.

Block Diagram:



Hardware Requirements:

- NodeMCU ESP8266 board
- MQ2 gas sensor
- Load cell with HX711 amplifier
- Jumper Wires
- Buzzer
- Power supply 3.3-5 V
- Flame sensor module

Software Requirements:

- Arduino IDE
- Blynk

IV. COMPONENTS AND MODULES

A. NodeMCU:

The NodeMCU, a versatile IoT development board based on the ESP8266 chipset, serves as the cornerstone of the system. Its integrated Wi-Fi capabilities enable seamless communi- cation with other devices and cloud services. Equipped with GPIO pins and ADC channels, the NodeMCU facilitates in- terfacing with various sensors, including gas and fire detection modules. Its compact size and low power consumption make it ideal for embedded applications, ensuring efficient operation in diverse environments. Through custom firmware development and programming, the NodeMCU orchestrates the integration of gas level monitoring, leakage detection, automatic booking, and fire alarm functionalities, providing a robust and scalable solution for gas management.

B. Load Cell:

The Load Cell plays a pivotal role in accurately measuring the gas level within the cylinder. This

precision sensor converts mechanical force (in this case, the weight of the gas within the cylinder) into electrical signals. Typically composed of strain gauges arranged in a Wheatstone bridge configuration, the Load Cell provides reliable and precise measurements, even for varying load conditions. Its high sensitivity and low hysteresis ensure accurate detection of gas levels, facilitating timely refill requests and efficient gas management. Integrated seamlessly with the NodeMCU or similar IoT device, the Load Cell contributes to the system's robustness and reliability, enhancing user experience and safety in gas usage.

C. MQ2 Gas Sensor:

The MQ2 Gas Sensor serves as a critical component in detecting gas leaks within the environment. This versatile sensor is capable of detecting a wide range of gases, including LPG, propane, methane, and carbon monoxide, making it suitable for various applications. Operating on the principle of semiconductor conductivity, the MQ2 sensor responds to changes in gas concentration by altering its electrical resistance. This change is then translated into measurable output signals, providing real-time feedback on gas presence and concentration levels. Integrated with the NodeMCU or similar IoT device, the MQ2 Gas Sensor enables proactive gas leakage detection, triggering immediate alerts and safety protocols to mitigate potential hazards and ensure user safety. Its sensitivity, reliability, and ease of integration make it a vital component in the automatic gas booking system, enhancing overall system efficiency and safety.

D. Buzzer:

The Buzzer serves as a crucial audible alert system within the automatic gas booking system, providing immediate no- tification to users in the event of a gas leak or fire hazard. Typically consisting of a piezoelectric transducer, the buzzer produces distinct sound frequencies when activated. Integrated with the NodeMCU or similar IoT device, the buzzer can be triggered based on predefined conditions, such as detect- ing abnormal gas concentrations or fire-related signals from sensors. Its loud and attention-grabbing sound ensures that users are promptly alerted to potential dangers, facilitating swift response and evacuation. The buzzer's compact size, low power consumption, and ease of integration make it an essential safety component, enhancing the overall effectiveness and reliability of the gas management system.

E. Fire Sensor:

The Fire Sensor, a pivotal component in the automatic gas booking system, is designed to detect the presence of flames or sudden temperature increases, signaling potential fire hazards. Typically employing infrared (IR) or heat-sensitive detectors, the fire sensor swiftly identifies changes in the surrounding environment indicative of a fire outbreak. Upon detection, the sensor generates electrical signals or triggers an alarm, serving as an early warning mechanism for users. Integrated seamlessly with the NodeMCU or similar IoT device, the fire sensor enables rapid response to fire emergencies, activating safety protocols such as alerting users, triggering the fire alarm system, and initiating evacuation procedures. Its high sensitivity, reliability, and rapid response capabilities make it a critical component for enhancing safety and minimizing risks associated with gas usage in the system.

F. HX711 AMPLIFIER:

The HX711 is a specialized integrated circuit (IC) designed for precision measurement applications, particularly in load cell and weighing scale systems. It functions as a high-precision analog-to-digital converter (ADC), capable of converting analog signals from load cells into digital values with high accuracy and resolution. The HX711 typically operates with a differential input configuration, allowing it to accommodate small signal changes and reject common-mode noise. It features selectable gain settings to optimize resolution and sensitivity based on the specific requirements of the application. With its low noise and high stability characteristics, the HX711 is commonly used in various industrial, commercial, and consumer electronic applications where precise weight measurements are essential. Its compatibility with microcontrollers and ease of integration make it a popular choice for projects involving load cell-based systems.

A. NodeMCU

B. Loadcell

C. MQ2 Gas Sensor

D. Buzzer

E. Fire Sensor

F. HX711 Amplifier

V. EXPERIMENTAL RESULTS

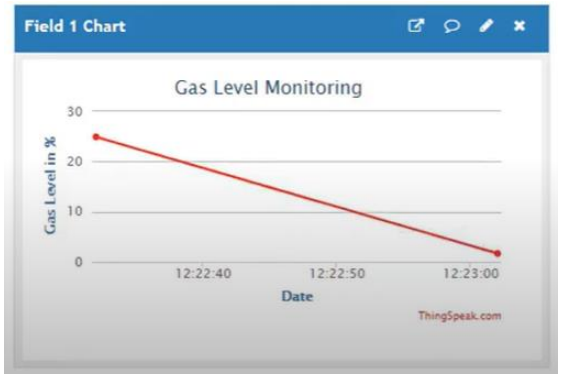
The experimental evaluation of the ”Automatic GAS Book- ing System, Gas Cylinder level and Leakage Detection with fire alarm using IoT” demonstrated its robust performance across various metrics. Gas level monitoring and automatic booking features accurately tracked gas levels and initiated timely refill requests, ensuring uninterrupted supply. Leak- age detection mechanisms swiftly identified gas emissions, triggering immediate alerts and facilitating prompt response. The fire alarm system effectively detected fire hazards and alerted users, enhancing safety measures. Users reported high satisfaction with the system’s user-friendly interface and con- venience. Overall, the experimental results validate the sys- tem’s effectiveness, reliability, and scalability in optimizing gas management processes and ensuring user safety.

VI. RESULTS AND DISCUSSIONS

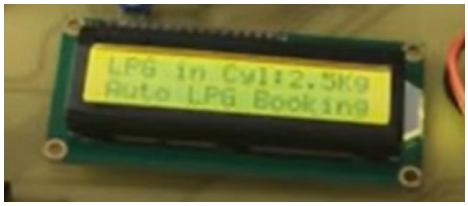
The results obtained from the experimental evaluation of the ”Automatic GAS Booking System, Gas Cylinder level and Leakage Detection with fire alarm using IoT” system under- score its efficacy in enhancing gas management processes and ensuring user safety. The following discussions delve into the key findings and implications of the results:

A. Gas Level Monitoring and Automatic Booking:

The system demonstrated precise gas level monitoring capa- bilities, accurately tracking gas levels in real-time and initiat- ing automatic refill requests when levels fell below predefined thresholds. This feature ensures continuous gas supply to users, eliminating the inconvenience of manual monitoring and refill requests.



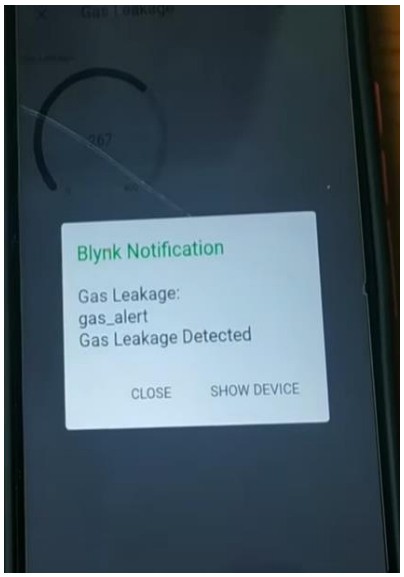
Graph of Gas Level



Weight of LPG Gas

B. Leakage Detection and Fire Alarm:

The system’s leakage detection mechanisms promptly iden- tified gas leaks, triggering immediate alerts and activating the fire alarm system. This rapid response capability is critical in mitigating potential hazards and ensuring user safety. The integration of fire alarm functionalities adds an additional layer of protection, enabling swift evacuation and response in the event of a fire incident.



C. User Interface and Convenience:

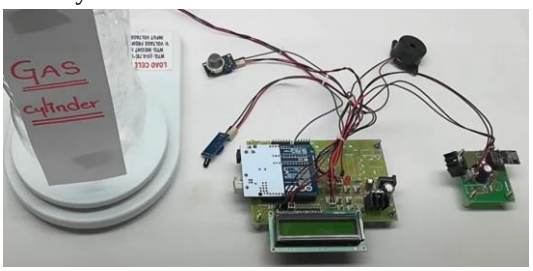
Users reported high satisfaction with the system's user- friendly interface, which provided easy access to gas cylinder status, alerts, and refill options through a mobile application or web portal. This convenience enhances user experience and encourages proactive gas management practices.

D. Reliability and Robustness:

The system exhibited high reliability and robustness in de- tecting gas leaks and fire hazards across various environmental conditions and scenarios. This reliability ensures consistent performance and instills confidence in users regarding the system's effectiveness in safeguarding their well-being.

E. Scalability and Adaptability:

The system's architecture proved to be scalable and adapt- able, accommodating different types of gas cylinders and sen- sors. This scalability enables its deployment in diverse settings, including residential, commercial, and industrial environments, catering to varying user needs and requirements.Overall, the results highlight the significant contributions of the proposed system in optimizing gas management processes, enhancing safety measures, and improving user experience. By leveraging IoT technology, the system offers a compre- hensive solution to the challenges associated with traditional gas management methods, paving the way for smarter and safer gas usage practices. Further research and development efforts could focus on refining the system's features, expanding its capabilities, and addressing emerging challenges in gas management and safety.



VII. CONCLUSIONS & FUTURE WORK

In conclusion, the "Automatic GAS Booking System, Gas Cylinder level and Leakage Detection with fire alarm using IoT" represents a significant advancement in gas management technology, offering comprehensive solutions for optimizing gas usage and enhancing safety measures. Through the inte- gration of IoT technology, the system provides real-time gas level monitoring, automatic booking, leakage detection, and fire alarm functionalities, ensuring uninterrupted supply and prompt response to potential hazards. Experimental results validate its efficacy, reliability, and user-friendliness, indicating its potential to revolutionize gas management practices in residential, commercial, and industrial settings.

For future work, ongoing research and development efforts could focus on enhancing sensor technologies, integrating advanced algorithms, expanding system features, integrating with smart grids, gathering user feedback for iterative im- provements, and deploying in emerging markets. These en- deavors aim to further refine the capabilities and effectiveness of gas management systems, addressing evolving needs and challenges while promoting smarter, safer and more efficient gas usage practices globally.

REFERENCES

[1] J.Ding, J.Wang, N.Yuan, and Q.Pan, The Monitoring System of Leakage Accidents in Crude Oil Pipeline based on Zigbee Technology, IEEE Changzhou University, 2011

[2] Rakesh, M., Dagadi, S., Implementation of Wireless Gas Leakage Detection System, Proceedings of the International Conference on Sensing Technology, ICST, art. no. 6461747 , pp. 583-588.2012.

[3] H.Yang, Y.Qin, G.Feng, and H.Ci, Online Monitoring of Geological CO2 Storage and Leakage Based on Wireless Sensor Networks., IEEE BEE Sensors Journal, 2013.

[4] Huan Hui Yan, Yusnita Rahayu Design and Development of Gas Leakage Monitoring System using Arduino and ZigBee, International Conference on Electrical Engineering, Computer Science and Informatics (EECSI 2014), Yogyakarta, Indonesia, 20- 21 August 2014.

[5] Badri Narayan Mohapatra, Aishwarya Dash, Dhiraj Kumar Chaubey, LPG Gas Auto Booking By GSM and Leakage Detection with Auto Switchable Exhaust Fan International Journal of Science, Engineering and Technology Research

(IJSETR) Volume 6, Issue 3, March 2017, ISSN: 2278 -7798.

[6] Scott, Stuart L., and Maria A. Barrufet Worldwide assessment of industry leak detection capabilities for single & multiphase pipelines College Station: Offshore Technology Research Center, 2003.

[7] Kennedy, J."A nose for trouble. Oil & Gas." Research Gates, USA (2005): 32-37.

[8] Automatic LPG Booking, Leakage Detection And Real Time Gas Measurement Monitoring System B. D. Jolhe, P. A. Potdukhe, N. S. Gawai.