Smart IoT System for Gas Level Monitoring, Leakage Detection and Automatic Booking

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***Abstract*—This project focuses on creating an IoT-based solution for monitoring gas levels and automating the booking process, offering a smarter and safer approach to managing LPG cylinders. The system is designed to track the gas levels in real-time and alert users when the levels drop below a specified threshold. It also streamlines the booking process by automating it, saving time and reducing inefficiencies.**

By incorporating IoT technologies such as gas sensors, microcontrollers, and cloud platforms, along with APIs for refill booking, the project aims to provide a user-friendly and reliable solution. Affordable and scalable, this system is suitable for both homes and industries, making gas management more convenient while reducing the risk of accidents.

***Index Terms*—IoT, gas level monitoring, LPG cylinder management, automatic booking system, gas leakage detection, real-time monitoring, microcontrollers, cloud integration, smart home solutions, safety automation, residential and industrial applications, API integration, gas sensor technology, smart gas management.**

I. Introduction

LPG cylinders provide a reliable and efficient source of fuel for both households and industries. However, the traditional method of manually managing gas levels often leads to users forgetting to monitor their cylinders until they run out of gas. This results in delays in booking refills, and at times, users are unable to place an order in time. This disrupts daily routines and causes frustration for many users. Additionally, the failure to detect gas leaks in a timely manner can pose significant safety risks, highlighting the need for a smarter solution.

To address these issues, this project introduces an innovative IoT-based system that aims to solve these challenges effectively. By integrating gas sensors, the system ensures users can monitor their gas levels at all times. Whenever the gas level drops below a predetermined threshold, the user is notified, and a refill is automatically arranged. This eliminates the need for manual intervention, significantly reducing delays and making the process more efficient.

The system also focuses on enhancing safety by detecting gas leaks. The gas sensors are capable of identifying leaks in real-time and sending instant alerts to the user. This enables prompt action, helping to prevent potential accidents and ensuring the safety of homes and industrial environments.

The core of the solution is built on IoT technologies, including microcontrollers. Additionally, users will receive notifications about gas bookings via email, through the Blynk IoT app, making it easy for them to stay informed and take necessary actions without delay.

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II. Literature Review

Sugumar et al. [1] introduced the AGaRMS system, leveraging IoT sensors and machine learning for real-time gas monitoring, predictive analytics, and dynamic booking. The system optimizes gas supply chains, improves energy efficiency, and supports both residential and industrial applications with a scalable and flexible design.
Oni et al.[2] proposed a low-cost system employing an MQ-2 sensor and Arduino for detecting LPG, smoke, and CO leaks. With an accuracy of 82.3 percentage, it ensures real-time safety alerts through an LCD display. The system is designed for domestic and commercial use, with future enhancements targeting mobile alerts and improved wireless functionality.
Pallavi et al. [3] introduced the SafeHaven system, an IoT-based gas leakage detection and response framework that enhances safety in residential and commercial settings. Utilizing the MQ-2 gas sensor, GSM modules, and automated safety protocols, the system detects hazardous gases, initiates safety measures like power shutoff and exhaust fan activation, and sends instant alerts via a Telegram bot. The scalable design integrates seamlessly into existing smart environments, offering real-time monitoring and efficient prevention of gas-related accidents(CHAPTER+14).
El Barkani et al. [4] proposed a gas leakage detection system utilizing Tiny Machine Learning (TinyML) to enhance real-time monitoring on edge devices. Integrating MobileNetV1

and EfficientNet-B0 CNN models with the Arduino Nano 33 BLE Sense and the MLX90640 thermal camera, the system achieved high detection accuracy—88.92 percentage for MobileNetV1 and 91.73 percentage for EfficientNet-B0. The approach leverages model quantization to reduce memory usage, ensuring compatibility with resource-constrained devices. This solution addresses latency, scalability, and cost challenges, providing a reliable and efficient method for detecting gas leaks in both residential and industrial settings(electronics-13-04768).

Bairagi et al. [5] introduced SmartGuard, an intelligent LPG leakage detection and control system designed for residential and industrial applications. The system integrates an MQ6 gas sensor with a microcontroller, GSM module, and control mechanisms to detect gas leakage and automatically shut off the supply to prevent hazards. It alerts users via SMS, activates a buzzer, and displays warnings on an LCD. The solution offers real-time monitoring, manual override capabilities, and a low-cost, energy-efficient design, enhancing safety and reliability in preventing gas-related accidents(IJETT-V72I9P121).

Murty et al. [6] proposed an IoT-based gas leakage detection system that integrates components such as an Arduino microcontroller, gas sensors, a Wi-Fi module, and GPS for real-time monitoring and safety management. The system provides local and remote alerts through an LCD display, buzzer, and GSM-based SMS notifications. By dispersing leaked gas using a DC fan and pinpointing locations with GPS, the system enhances safety in domestic and industrial environments, ensuring timely interventions. This comprehensive approach mitigates fire risks and protects human resources effectively(IJISAE).

Parashar et al. [7] proposed an IoT-based smart gas leakage detection and alert system. Utilizing the MQ6 gas sensor, Arduino UNO, and ESP8266 WiFi module, the system detects gas leakage, sends alerts via SMS, and prevents accidents by turning off the gas supply and activating safety mechanisms like buzzers and exhaust fans. The system is designed for home, industrial, and commercial applications with a focus on affordability and effectiveness.

Bari and Chattopadhyay [8] developed a gas leakage detection system for regions lacking consistent internet access. Utilizing an Arduino UNO R3, MQ-6 sensor, GSM module, and BLDC motor, the system efficiently detects leaks, stops gas flow with a control valve, and disperses leaked gas using a fan. SMS alerts ensure timely notifications, enhancing safety in households and industries(IJMIT20240210R1214R2).

Suganya et al. [9] proposed an IoT-based gas leakage detection system aimed at improving safety in urban environments. The system integrates components such as an Arduino Uno microcontroller, gas sensor, GSM module, and WiFi module. It performs real-time monitoring to detect gas leaks, fire, or smoke and responds promptly by activating safety mechanisms like fans or valves. Alerts are sent to stakeholders via SMS, ensuring timely intervention. The solution emphasizes scalability, efficiency, and real-time hazard detection for utility infrastructures.

Zinnuraain et al. [10] proposed a Smart Gas Leakage Detection and Monitoring System using IoT technologies. The system combines LPG monitoring, leakage detection, and an automatic safety mechanism, using components such as the MQ-2 sensor, Node-MCU ESP8266, solenoid valves, and a mobile app. It enhances safety by notifying users about gas levels and leakage events through a mobile app while automatically shutting off gas supply during emergencies. The system is cost-effective, scalable, and suitable for households, hospitals, and commercial applications.

III. Proposed Methodology

A. Workflow of the System

The innovative approach to Gas Level Monitoring, Leakage Detection, and Automatic Booking System AGaRMS, The system begins with the MQ-2 gas sensor and HX711 load cell monitoring the gas levels and weight of the cylinder in real time. Sensor data is sent to the ESP8266 microcontroller, which processes the inputs and transmits the information to the cloud using MQTT or HTTP protocols. The centralized gateway aggregates data from multiple sensors, applying predictive analytics to forecast gas consumption trends and determine refill schedules. Alerts and updates are sent to users via the Blynk IoT platform, accessible through mobile or web interfaces, where users can monitor gas levels and receive optimization tips. When gas levels approach the threshold, the system automatically communicates with supplier APIs to initiate a refill request, ensuring uninterrupted supply. Meanwhile, the system's energy optimization feature provides actionable recommendations to users, enhancing overall efficiency.

B. Methods and Materials

The AGaRMS system employs a combination of hardware and software components to monitor gas levels, detect leaks, and facilitate automatic booking. Hardware components include the MQ-2 gas sensor, which detects gas concentration and potential leaks, and the HX711 load cell for precise weight measurement of gas cylinders. The ESP8266 microcontroller acts as the processing hub, collecting sensor data and enabling communication with the cloud via MQTT and HTTP protocols. Cloud platforms such as Blynk IoT provide data visualization, alerts, and user interaction interfaces through mobile apps or web browsers. Software components include the Arduino IDE for coding the microcontroller, the ESP8266 WiFi library for internet connectivity, and Blynk IoT widgets for creating interactive dashboards. Predictive analytics models, trained on historical data and user behavior, optimize gas usage forecasting and refill planning.

C. Materials specification

1) NodeMCU ESP8266 v3: The NodeMCU ESP8266 v3 is a compact IoT development board with built-in Wi-Fi and 11 GPIO pins for versatile applications. It supports protocols like I2C, SPI, and UART, and features a 10-bit

ADC pin for analog input. Compatible with Arduino IDE and MicroPython, it's ideal for projects like home automation and sensor logging. Affordable and beginner-friendly, it's widely used for prototyping IoT solutions.

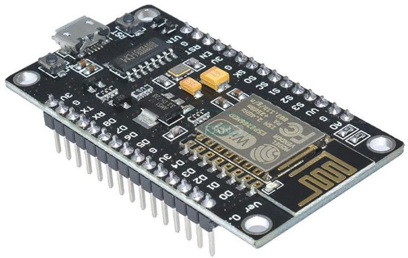

Fig. 1: NodeMCU ESP8266 v3

2) Servo motor: A servo motor is a compact, precise actuator commonly used in IoT projects for controlled motion. It operates using a control signal (PWM) to set the position of its shaft, typically within a 0-180° range. Powered by 5V or 6V, servo motors are ideal for tasks like robotics, smart locks, or automated mechanisms. They're easy to interface with microcontrollers like Arduino or NodeMCU.

Fig. 2: servo motor

3) 12V brushless DC (BLDC) exhaust fan: A 12V brushless DC (BLDC) exhaust fan is a reliable and efficient solution for IoT projects requiring airflow control, such as smart ventilation systems. It operates on 12V DC, consumes low power, and is quieter than traditional fans. Equipped with speed control and feedback options (like PWM or tachometer signals), it integrates easily with microcontrollers for automated systems. Common applications include air purifiers, cooling devices, and environmental monitoring setups.

Fig. 3: 12V brushless DC (BLDC) exhaust fan

4) Load cell and hx711 module: A load cell is a sensor used to measure force or weight by converting it into an electrical signal. In IoT projects, the HX711 module is commonly paired with load cells to amplify and digitize the small analog signal for microcontroller processing. The HX711 supports high-resolution measurements and operates on 3.3V or 5V, making it compatible with devices like Arduino and ESP8266. This combination is ideal for creating smart scales, weighing systems, and force-sensitive IoT applications.

Fig. 4: Load cell and hx711 module

5) MQ2 gas sensor: The MQ2 gas sensor detects the presence of gases such as methane, butane, propane, and carbon monoxide. In IoT applications, it can be used to monitor indoor air quality or detect gas leaks. The sensor provides an analog voltage output that varies with gas concentration, which can be read by microcontrollers like Arduino or ESP8266. It integrates easily into smart home systems for automated alerts and controls.

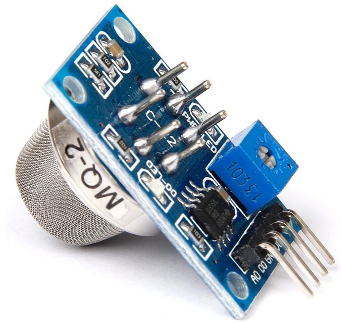

Fig. 5: MQ2 gas sensor

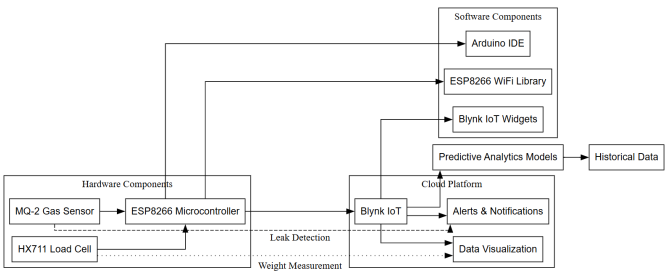

Fig. 6: System Diagram

IV. Results and Discussions

The AGaRMS system demonstrated reliable performance in real-time monitoring, gas leakage detection, and automated booking under various test conditions. The MQ-2 gas sensor effectively identified gas leaks with high sensitivity, while the HX711 load cell provided accurate cylinder weight measurements, ensuring precise gas level estimation. Integration with the ESP8266 microcontroller allowed seamless data processing and transmission to cloud platforms.

The Blynk IoT platform enabled intuitive and user-friendly visualization of gas levels, leak alerts, and refill status through mobile apps and web dashboards. Users received timely notifications, ensuring quick responses to potential hazards. Predictive analytics accurately forecasted gas consumption patterns based on historical usage, environmental factors, and user behavior, enabling proactive refill bookings before gas depletion. This feature minimized supply disruptions and ensured continuous service.

Automated communication with supplier APIs streamlined the refill process, significantly reducing manual intervention and associated delays. Energy optimization recommendations helped users adjust their consumption patterns, enhancing efficiency and reducing waste. The system operated reliably in real-world scenarios, with no significant delays or false alarms observed during testing.

In terms of scalability, AGaRMS proved adaptable to various deployment scales, from single household units to larger industrial setups. However, minor challenges were noted, such as occasional network latency during data transmission and limited compatibility with certain supplier API formats. These issues can be addressed by implementing advanced network protocols and standardizing supplier integrations.

Overall, the AGaRMS system successfully combines IoT technologies, predictive analytics, and user-centric interfaces to provide a robust, efficient, and automated solution for gas level monitoring and management.

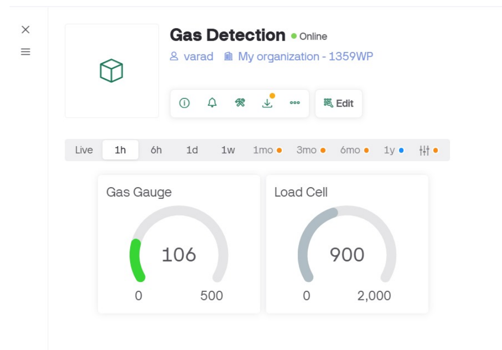

Fig. 7: Gas Detection snapshot

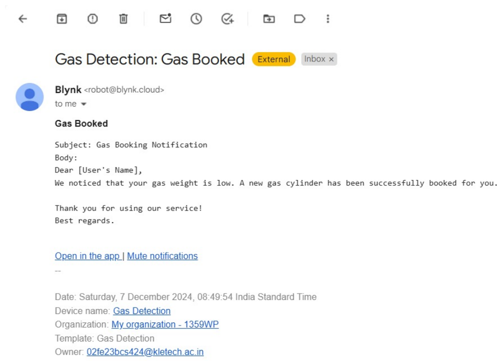

Fig. 8: Gas Detection:Gas Booked notification snapshot

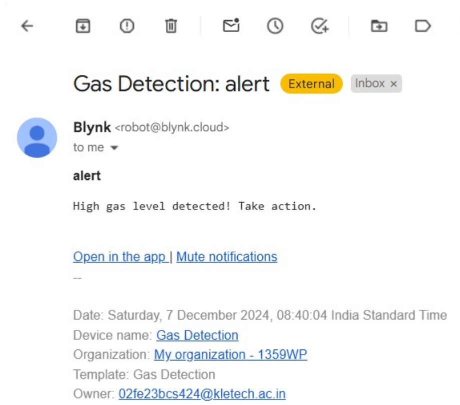

Fig. 9: Gas Detection:Alert notification snapshot

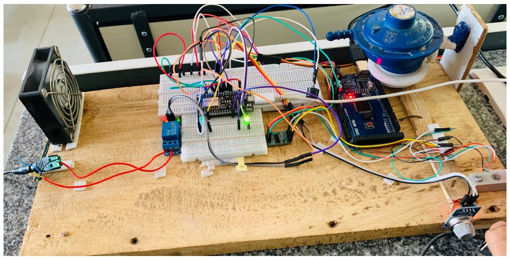

Fig. 10: Model Implementation

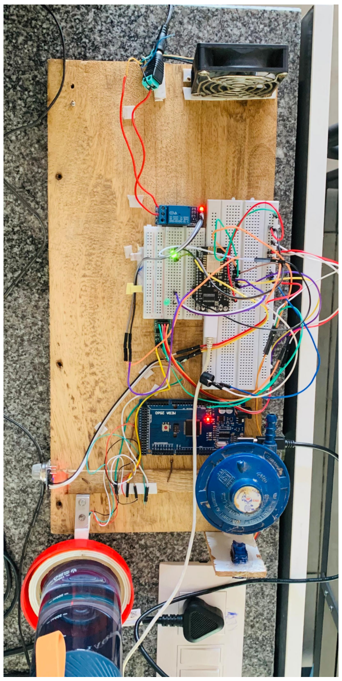

Fig. 11: Model Implementation

V. Conclusion

The AGaRMS system effectively addresses critical challenges in gas level monitoring, leakage detection, and automated refill management by integrating IoT technologies, predictive analytics, and user-friendly platforms. Through the use of MQ-2 gas sensors, HX711 load cells, and the ESP8266 microcontroller, the system ensures real-time monitoring and accurate gas level estimation. The seamless communication infrastructure and cloud-based visualization via the Blynk IoT platform enable timely alerts and actionable insights for users.

Predictive analytics enhances efficiency by forecasting gas consumption patterns and ensuring proactive refill scheduling, while automated supplier communication prevents disruptions. The system's energy optimization recommendations further empower users to manage consumption effectively, contributing to cost savings and environmental benefits.

The AGaRMS system demonstrated reliability, scalability, and ease of use, making it suitable for residential and industrial applications. While minor challenges, such as network latency and supplier API compatibility, were noted, these can be mitigated with future enhancements. Overall, AGaRMS represents a significant advancement in smart gas management, offering a safe, efficient, and user-centric solution.

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