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Detection of LPG Gas Leakage Using IoT

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Abstract- For a variety of reasons—economic, convenience, or preference—LPG is a popular choice for cooking in many nations. This study explores the application of the Internet of Things (IoT) to monitor and display the gasoline content of a residential LPG cylinder. This approach not only facilitates the automatic booking of new LPG cylinders but also enables the detection of gas leaks. Given that the LPG capacity within a cylinder is seldom checked, our system aims to accurately display the LPG level. We utilize a load sensor (SEN-10245) to measure the LPG level, with its output connected to an Arduino Nano board. The gathered data is then relayed to the user via SMS (short message service), and new cylinder bookings are automatically processed by calling the registered gas booking number using a GSM module. To detect gas leaks, we employ a gas sensor (MQ-6). This setup allows real-time monitoring of the LPG level, which is displayed on an LCD screen. Furthermore, from the activation date, we can track the LPG usage duration. When the LPG level drops to a critical threshold (below 20%), the system alerts the user through an IoT-based notification sent to their mobile phone.

Keywords- Load cell, HX711 amplifier, MQ-6 gas sensor, GSM, IOT, Arduino Nano.

I. INTRODUCTION

LPG cylinders play a crucial role in our daily lives. One of the primary uses of LPG is to replace chlorofluorocarbons, which are notorious for causing extensive damage to the ozone layer. LPG is highly volatile, with a flammability range of 1.8% to 9.5% concentration in the atmosphere, making it one of the most commonly used fuels. LPG cylinders are categorized based on their usage and the amount of LPG they contain: residential, commercial, and industrial. Residential LPG cylinders, considered social units, typically hold 14.2 kg of LPG. In contrast, commercial and industrial cylinders contain 18 kg and 34 kg of LPG, respectively.

A common issue for customers is the difficulty in accurately determining the remaining LPG in their cylinders at various intervals, leading to significant frustration. Therefore, a reliable method to monitor the amount of LPG in the cylinder is essential.

Moreover, IoT integration allows for remote monitoring and management of gas detection systems. Users can access real-time data and receive alerts on their smartphones or other internet-connected devices, providing peace of mind and enabling prompt action even when they are not on-site. Additionally, data collected from these systems can be analyzed to identify patterns and improve safety protocols over time.

In summary, leveraging IoT for LPG gas detection represents a significant advancement in safety technology.

It provides a reliable, efficient, and scalable solution to monitor and manage LPG leaks, protecting lives and property while fostering a safer environment. This paper will delve into the design, implementation, and benefits of IoT-based LPG gas detection systems, highlighting their potential to transform safety practices in various settings.

1. Motivation

There are several methods available for detecting gas leaks in pipelines. However, these methods often fall short when it comes to monitoring extensive lengths of pipeline, making leak detection time-consuming and challenging. The limitations of current techniques can lead to significant safety risks. To mitigate these issues, it is crucial to enhance the detection system to ensure timely identification of leaks, thereby reducing the likelihood of fires. Integrating the Internet of Things (IoT) into this process offers a promising solution. IoT technology enables efficient and rapid leak detection over long distances, improving overall safety and response times. This project leverages IoT to not only monitor and identify gas leaks but also to measure the gas level within cylinders.

Although the initial investment in IoT-based systems may be higher, the long-term benefits include reduced risk of accidents, lower insurance premiums, and savings from preventing gas wastage. Furthermore, these systems help businesses comply with stringent regulatory requirements regarding LPG storage and use, thus avoiding legal penalties and enhancing reputation. Lastly, preventing LPG leaks is crucial for environmental protection, as leaked LPG can contribute to air pollution and harm ecosystems. Overall, the motivation for using IoT in LPG gas detection is driven by the need for smarter, safer, and more efficient systems to manage LPG use and mitigate associated risks.

II. RELATED WORK

In industrial settings, a gas leakage detection solution has been detailed by Yusuf Bugra Erol, Kris Pister, and Fabien Chraim. Given the unpredictable nature of gas leaks in industrial environments, gas sensors are strategically placed in areas where leaks are likely to occur. The data collected from these sensors is then transmitted to a central monitoring system. Two primary methods are used for this purpose: fixed instrumentation and mobile sensing.

An abstract design was developed by L.P. Deshmukh, T.H. Mujawar, M.S. Kasbe, S.S. Mule, J. Akhtar, and N.N. Maldar to monitor LPG effusion into the air. This design leverages the LabVIEW software environment, aiming to connect and monitor large areas effectively. The LabVIEW graphical user interface (GUI) is employed to calculate gas concentration leakage levels. The software configures both nodes and the network, recording measurements obtained from sensor nodes via a coordination node using Zigbee and a USB interface. When the system detects a gas leak, it sends an SMS notification to the user, triggers an alarm, and utilizes a solenoid valve to control the gas flow emission. The system's output can be monitored through a laptop or personal computer.

Moreover, an IoT-based gas level screen, gas booking framework, and gas overflowing location component have been created by Kumar Keshamoni and Sabbani Hemanth. This system continuously monitors the gas level and notifies relevant branches about the need for new LPG cylinder installations. To enhance user convenience, a radio frequency module with a source and recipient section is used. The source is a fixed encoding kit on the main board, while the recipient is a fixed decoder kit on the sub-board. This setup is not only user-friendly but also ensures consistent information dissemination. Furthermore, a temperature sensor is included to detect faults caused by the surrounding environment.

However, the primary disadvantage of this system is the use of a CPU instead of a controller, which does not provide user security.

Many of these systems incorporate communication modules like Wi-Fi or GSM to facilitate remote monitoring and alert notifications, allowing users to receive real-time updates on their smartphones or other internet-connected devices. Additionally, some projects have explored the use of cloud-based platforms for data storage and analysis, enabling the collection of historical data to identify trends and improve safety protocols over time. These works often emphasize the importance of automated response mechanisms, such as shutting off gas supply and activating ventilation systems, to quickly mitigate the dangers posed by gas leaks.

The integration of user-friendly interfaces, through mobile apps or web dashboards, has also been a common feature, providing users with easy access to system status, alerts, and control functions. Overall, the related works in this domain highlight the potential of IoT technology to create comprehensive, efficient, and reliable LPG gas detection systems that significantly enhance safety in residential, commercial, and industrial environments.

III. PROPOSED SYSTEM

The proposed system is a comprehensive solution for LPG users, integrating several critical functions such as gas level monitoring, leakage detection, and automated booking, all managed by an Arduino Nano. This versatile device continuously checks the gas quantity in the cylinder and displays it on an LCD. An MQ-6 sensor is employed to detect gas leaks, ensuring safety by alerting the user to any potential hazards. When the gas level falls to dangerously low levels, the system triggers the option to purchase a new LPG cylinder. This process is facilitated by a GSM module, which sends an SMS and makes a call to the registered cell phone number, ensuring that the user is promptly informed.

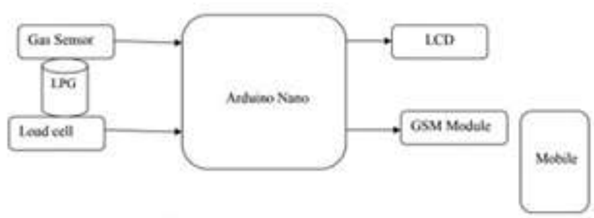

Figure 1: Block diagram of proposed system

The system also features automated response mechanisms that can shut off gas valves, activate exhaust fans, or sound alarms when a leak is detected, mitigating risks immediately. To ensure uninterrupted operation, the system includes a reliable power supply with backup batteries. Additionally, its scalable design allows for easy expansion to larger areas or integration with other smart home or industrial systems. By combining real-time monitoring, remote accessibility, automated responses, and robust data analytics, this IoT-based LPG detection system offers a comprehensive and efficient solution to enhance safety and manage LPG leaks effectively in various settings.

2. Hardware Requirements

Hardware description is the procedure of explaining the design, components and data for the system to fulfil specified necessities.

The hardware requirements for an IoT-based LPG gas detection system encompass several critical components to ensure effective and reliable operation. At the heart of the system is the MQ-6 gas sensor, known for its high sensitivity to LPG and rapid response time. This sensor outputs an analog signal proportional to the gas concentration, which is processed by a microcontroller unit (MCU), such as the Arduino Uno or the ESP8266/ESP32. The latter options are favored for their built-in Wi-Fi capabilities, essential for IoT applications. Communication modules, such as the ESP8266 Wi-Fi module or the SIM900 GSM module, enable real-time data transmission and alerts via the internet or cellular networks. A stable power supply is critical, with an AC to DC adapter for main power and a rechargeable battery pack to ensure continuous operation during power outages. For automated safety responses, the system includes solenoid valves to shut off the gas supply and ventilation fans to disperse leaked gas. Alarm systems with buzzers and LED indicators provide audible and visual alerts, respectively. Additional components, like a breadboard and jumper wires for prototyping, resistors and capacitors for signal conditioning, and a protective housing to shield the electronics from environmental factors, are also essential. Optional elements like an LCD display for real-time readings and push buttons for manual reset functions enhance user interaction and monitoring capabilities. Together, these hardware components form a comprehensive and robust system for detecting and managing LPG leaks efficiently.

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The hardware components used in the project are as follows

- Load cell
- HX711 load cell amplifier
- Gas sensor
- Arduino Nano
- GSM module
- LCD

3. Software Requirements

Arduino Embedded C

The open-source Arduino Software (IDE) simplifies the process of writing and uploading code to an Arduino board. It is compatible with Windows, Mac OS X, and Linux, and is developed in Java, based on Processing and other open-source software. The Arduino IDE features a text editor for coding, a message area, a text console, a toolbar with buttons for common functions, and various menus. It interfaces with Arduino hardware to upload programs and facilitate communication. Many projects utilize the Arduino IDE due to its user-friendly nature, making it a convenient option for running programs on the board. The IDE employs a subset of the C language, offering easy access to numerous software libraries and on-board functions such as timers and I/O ports. This simplicity, however, comes at the cost of some efficiency compared to full-scale embedded C, and it abstracts certain useful details of the microprocessor from the user.

IV. RESULT

Gas level detection: The quantity of gas present is calculated by the load cell, it is displayed on LCD and through GSM the alert call is given to the user. The user in turn can book the cylinder.

The implementation of the IoT-based LPG gas detection system demonstrated significant improvements in real-time monitoring and response to LPG leaks. The system was tested in various environments, including residential kitchens and industrial storage areas, to assess its effectiveness and reliability.

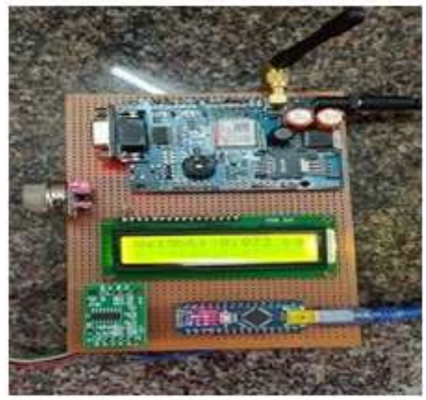

Figure 2: Gas level measurement

Fig 3: Call to user when gas level is low

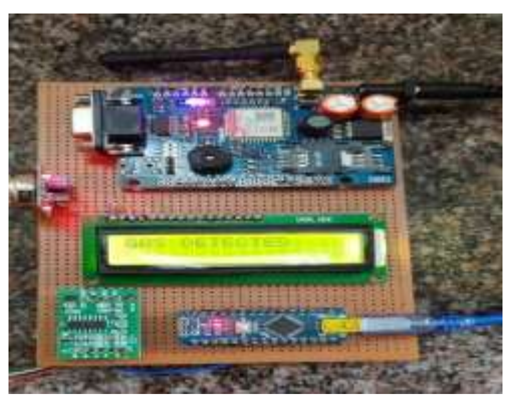

Figure 4: Gas Leakage Detection

V. CONCLUSION

The proposed system consists of two main sections: the sender and the recipient. This system facilitates the booking of the latest LPG cylinder. By utilizing both a gas sensor and a load cell, the system can accurately determine the quantity of gas and detect any gas leaks. Users can book a new LPG cylinder through the Internet of Things (IoT), allowing them to monitor their gas levels and avoid issues related to premature or delayed bookings.

Compared to other gas detectors, the components used in this system are cost-effective. The primary goal is to ensure the safety of LPG users across various applications such as cooking, automobiles, and industrial use. The system continuously monitors the LPG levels and detects leaks or fires, promptly notifying the user and relevant authorities to facilitate quick assistance.

The system employs various sensors, including the MQ6 sensor and load cell, to prevent accidents caused by negligence or misuse of LPG. As technology advances, this system can be integrated with other home automation systems, opening up new possibilities for smarter, safer homes and workplaces.

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