“IOT Enabled Surveillance and alerting for LPG containers”

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ABSTRACT—Gas leakages from LPG cylinders pose significant safety risks in residential and commercial environments. This paper presents an IoT(Internet of Things) based system to address these risks by monitoring LPG cylinder parameters and providing real-time updates via a mobile app. When the gas level drops below a predetermined threshold, the device notifies consumers through an app and a buzzer. When a cylinder’s gas level falls below twenty percent, a load cell sensor precisely calculates how much gas is left in the cylinder, updating the app and allowing automatic replenishment scheduling for after-hours use. The system alerts users through the app and a buzzer when the gas level falls below a set threshold. For cylinders with gas levels below 20 percent, a load cell sensor accurately measures the remaining gas, updating the app and enabling automatic prebooking for late refills. Additionally, the system detects gas leaks and fires, notifying users promptly through the app and buzzer. GPS is used to locate fire accidents, aiding in swift response. This system enhances safety and convenience by offering real-time monitoring, automatic prebooking, and precise location tracking for emergencies.

Keywords: IoT, LPG cylinder Monitoring, Gas leak detection, Fire detection, Automatic prebooking, Real-time updates, Safety, GPS tracking.

I. INTRODUCTION

Liquid Petroleum Gas (LPG) stands out as a widely embraced fuel, celebrated for its efficiency and convenience, especially in domestic settings. However, the looming threat of LPG leakage presents a grave safety concern, warranting the continuous monitoring of LPG cylinders. This paper introduces an IoT-based system designed to monitor LPG cylinder gas levels and swiftly detect leaks, providing real-time updates to users. Upon detecting a leak, the system promptly notifies users, significantly bolstering safety and averting potential accidents.

The indispensable role of fire alarm systems in ensuring safety in both residential and commercial premises cannot be overstated. These systems incorporate various devices, including smoke and heat detectors, capable of automatic or manual activation, thereby offering early warning in emergency situations. Ensuring safety requires the dissemination of industry expertise and guidelines among stakeholders such as producers, suppliers, and installers. Collaborative efforts among these stakeholders are pivotal for the effective discharge of safety responsibilities. The development of fire protection methods tailored for LPG storage facilities is imperative for risk mitigation, with a focus on preventing the escalation of minor leaks and fires. LPG's efficient storage and delivery, characterized by a gas-to-liquid volume ratio of approximately 250:1, renders it a cost-effective fuel option.

This paper aims to enhance safety in LPG usage by implementing an IoT-based monitoring system for LPG cylinders. By leveraging the expertise and guidelines available in the industry, this paper seeks to improve safety standards and prevent accidents due to LPG usage.

II. LITERATURE SURVEY

IOT Based Smart LP Gas Monitoring and Detection System Approach.
Authors: Nagib Mahfuz, Shawan Karmokar, Md. Ismail Hossain Rana.
This paper [1] presents an intelligent IoT-based method for monitoring LPG gas leaks. It details an intelligent electronic system designed to use a web server to track temperature, humidity, heat index, butane, natural gas and LP gas present. In order to prevent accidents caused by gas leakage, the system may detect gas leaking or exceed threshold values in any monitored parameter. In either case, it would sound an alarm and send an SMS to the relevant authority.

An IoT-based interactive LPG Cylinder Monitoring System with Sensor-Based Safety Protocol for Country Development.
Authors: Ali Ahsan, Mohammad Zahirul Islam, Rumali Siddiqua, Md. Khalilur Rahman.
This paper [2] presents an IoT-based smart LPG cylinder monitoring system designed to enhance the safety and efficiency of LPG cylinder usage. The system utilizes a

robust model with a custom-designed PCB for easy integration with existing LPG cylinder systems. A mobile application and central server connect users to the system via IoT, providing gas leakage alarms and reducing gas wastage. The system also offers automated predictions of future LPG usage based on user habits, ensuring efficient gas management.

Smart gas level monitoring, Booking gas and Leakage detector over IOT

Authors: Sabbani Hemanth, Kumar Keshamoni.

This paper [3] introduces a system to monitor gas levels, place gas orders, and detect gas leakage using IoT. The system includes a load cell for continuous weight measurement of gas containers, an RF TX Rx module for transmitting this information, and sensors like MQ-2 for gas detection and LM35 for temperature sensing. When any sensor detects a change, a siren is triggered to alert users.

Smart Gas Management System Driven by IoT

Authors: R. Chaitanya, Sony Shrestha, V. P. Krishna Anne.

This paper [4] addresses issue of fire detection and LPG gas leakage by designing an Smart Gas Management System Driven by IoT. The system detects gas leakage and user is notified via SMS and calls to turn off the gas valve. It also includes a fire sensor to detect flames, triggering a buzzer to alert users. Additionally, the system facilitates automatic gas cylinder booking using a load sensor, sending notifications to the booking agency when the gas cylinder weight drops below a threshold. These collectively highlight the importance of using IoT for managing and monitoring LPG gas systems, focusing on safety, efficiency, and user convenience.

Intelligent Fire Safety and Monitoring System

Authors: Rashedur M. Rahman, and Adnan Al Neon, Sal Sabila.

The purpose of this work[5] is to develop and build a real-time web-integrated smart fire detection and security system using microcontrollers. The majority of fire alarms on the market today rely only on gas sensors, which are insufficiently effective to protect people and property. The authors suggest a multi-sensor fire detection and notification system as a solution to this problem. Their research is important because it aims to use a variety of sensors, including as temperature, gas, and flame sensors, to identify fires early on. A motion sensor is also employed for security purposes in order to detect movement during a fire incident.

A Fire Prevention/Monitoring Smart System

Authors: Hasan Abdulredha, Ahmed Al-Faqsh, and Ashraf Zaher.

This Paper[6] discusses the growing likelihood of fires in newly constructed structures due to excessive melting and other fire-related processes. These kinds of buildings can catch fire, and the smoke they release can seriously harm people's health. For instance, while camping, individuals may breathe in harmful gases from burning charcoal, such as carbon monoxide, which can have a serious negative impact on their health. Furthermore, leaks of gas and oil are a major worry throughout the Middle East and the Gulf Cooperation Council (GCC), especially with regard to Kuwait's refineries and oil rigs. Large volumes of H2S and liquid petroleum gas leaks are among the leaks that might worsen fire risks and spread dangerous infections.

III. PROPOSED SYSTEM ARCHITECTURE

The configuration of the proposed system is shown in Fig1. The system components are Arduino UNO R3, gas sensor, GSM module, load cell, power supply, GPRS SIM 800L, fire sensor, buzzer, and 16x2 LCD display.

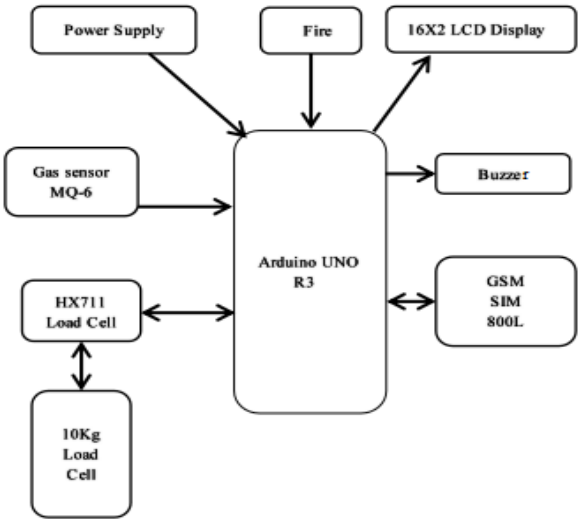

Fig1: Block diagram of the proposed system.

Gas and fire sensors are used by the system to continuously scan for possible threats. The GSM module ensures prompt emergency response by sending an SMS alert to the user's mobile phone upon detection of gas leaking. The gas level in the cylinder is measured by the load cell, and the results are easily viewed on a 16x2 LCD display. Furthermore, real-time remote monitoring is made possible by the system's transfer of the gas level data to the Thing Speak platform. The suggested architecture offers customers peace of mind and raises safety requirements by delivering a complete solution for LPG gas safety.

IV. COMPONENTS DESCRIPTION

A. Hardware components

1. Arduino Uno R3

The ATmega328P-powered Arduino Uno R3 stands out as a well-received microcontroller board, equipped with 14 digital I/O pins (6 offering PWM functionality), 6 analog inputs, a 16 MHz quartz crystal, a USB port, a power jack, an ICSP header, and a reset button, making it a favored choice among users. The Arduino Uno R3 can be powered either through a USB connection or with an external power supply. It is compatible with various shields (add-on boards) and can be programmed using the Arduino IDE (Integrated Development Environment).

2. **Gas Sensor**

The MQ-6 Gas sensor which is also known as semiconductor sensor whose main purpose is for detecting a variety of gases, including LPG, propane, butane, methane, alcohol, hydrogen, and smoke. It operates on the principle of gas absorption by the sensor's sensitive material, leading to a change in its resistance. The sensor provides an analog output voltage that can be read by a micro controller like Arduino to determine

the gas concentration in the environment. It is commonly used in gas leak detection systems and is suitable for domestic and industrial applications.

3. Fire Sensor

A fire sensor is a electronic device that is especially designed for detection and give quick response to the presence of a flame or fire. There are different types of fire sensors, including flame detectors and heat detectors. Flame detectors work by sensing the light emitted by flames, while heat detectors respond to changes in temperature caused by a fire. Fire sensors are used in fire alarm systems to alert occupants and authorities of a potential fire, allowing for prompt evacuation and firefighting actions.

4. Load Cell

A load cell is a transducer used to detect force and convert it into an electrical signal.A load cell is employed to determine the weight of the cylinder. The precision of the load cell is typically less than 0.1 percent of the total scale. To convert the electrical signals from the load cell into digital output, a high-resolution ADC (Analog-to-Digital Converter) converter board is required. The HX711 board is used in this paper to connect the load cell to the ESP8266, enabling the conversion of electrical impulses into digital signals for further processing and monitoring.

5. GSM module

A GSM (Global System for Mobile Communications) module is a hardware component that enables devices to communicate over cellular networks. It typically consists of a GSM modem and a SIM card slot. The module allows devices to send and receive SMS messages, make voice calls, and connect to the internet using GPRS (General Packet Radio Service). It operates on different frequency bands, which vary based on the region and network provider. GSM modules are commonly used in IoT (Internet of Things) applications for remote monitoring and control, asset tracking, and data logging. They are often integrated into devices such as alarm systems, tracking devices, and industrial machines to enable wireless communication capabilities.

6. 2X16 LCD Display

A 2x16 LCD display is a type of liquid crystal display that can display two lines of text with up to 16 characters per line. It is commonly used in electronic devices to provide a simple and readable interface for displaying information. The display consists of a grid of pixels that can be controlled to show alphanumeric characters, symbols, and custom graphics. The 2x16 LCD display is popular for its simplicity, low cost, and ease of use, making it ideal for many application purposes, including electronics used by consumers, industrial equipment, and embedded systems.

7. Buzzer

A buzzer is an electronic component that generates sound when an electric current passes through it. It typically consists of a coil of wire and a magnet, which causes a diaphragm or other sound-producing element to vibrate and create sound waves. Buzzers are used in a variety of applications, including alarms, timers, and notification systems, to alert users to certain events or conditions. They are simple, low-cost devices that are easy to interface with micro controllers and other electronic circuits.

8. Power Supply Board

A power supply board is a circuit board that provides the necessary electrical power to operate other electronic components in a system. It typically converts AC (alternating current) power from a wall outlet or other power source into DC (direct current) power at the voltage levels required by the system. Power supply boards are used in a wide range of electronic devices, including computers, televisions, and audio equipment, to ensure that the components receive stable and reliable power.

B. Software Requirement

The software requirement includes the use of the Arduino Integrated Development Environment (IDE) is a crucial component of the open-source Arduino electronics platform, providing a user-friendly interface for programming Arduino boards. It is designed to enhance programmer productivity by integrating various development tasks into a single program. The IDE simplifies the configuration process by offering a unified platform with comprehensive capabilities, minimizing setup time and boosting developer efficiency.

One of the key features of the Arduino IDE is its tight integration with the Arduino hardware, providing a seamless development experience. It offers tools for authoring, modifying, compiling, deploying, and debugging software, all within a single interface. This integration extends beyond setup procedures, with the IDE continuously parsing code as it is being edited, providing instant feedback on syntax errors.By using the Arduino IDE, developers can quickly and efficiently write code for the LPG gas monitoring system, reducing development time and ensuring compatibility with the Arduino hardware.

V. METHODOLOGIES

A flow chart for the LPG gas leak detection and fire monitoring system is displayed in the Fig.2.

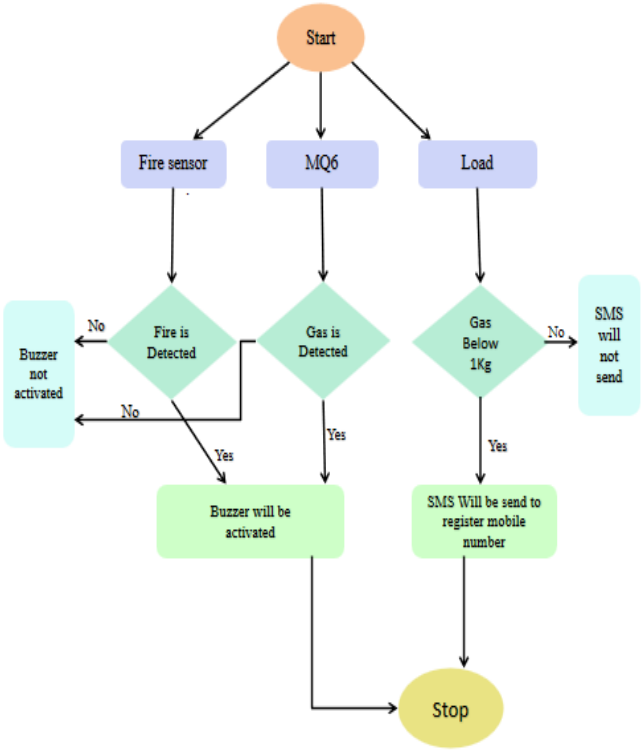

Fig 2. A typical Flow chart of an LPG gas leakage, Fire detection and overall Monitoring system.

The flowchart explains the main functionalities of your system, including gas level monitoring, gas leakage detection, fire detection, and LPG cylinder weight monitoring, with corresponding alerts and actions.
The proposed IoT-based system is designed to enhance safety in LPG usage by integrating fire and MQ6 gas sensors, alongside a load sensor. The system initiates by checking for fire and gas leaks upon initialization. If a fire or gas leak is detected, the system activates a buzzer for immediate local alert. Additionally, if the gas level falls below 1 kg, an SMS is sent to a registered mobile number for prompt action. The system's real-time monitoring and alerting capabilities ensure timely responses, minimizing the risk of accidents. Its integration of sensors and SMS alerts enhances efficiency and safety in LPG usage, making it a valuable contribution to the field.

VI. RESULT AND DISCUSSION

The system's successful implementation will result in increased efficiency in LPG gas reserves management and enhanced safety for users. It is expected to accurately detect LPG gas leaks within the detection radius of the MQ-6 gas sensor, providing timely alarms and SMS notifications to the owner. The system's ability to continuously measure the gas cylinder's weight and transmit data to the via IoT cloud for monitoring daily consumption is crucial for effective resource management. The results are shown in Figs 3,4,5,6,7,8 and 9.

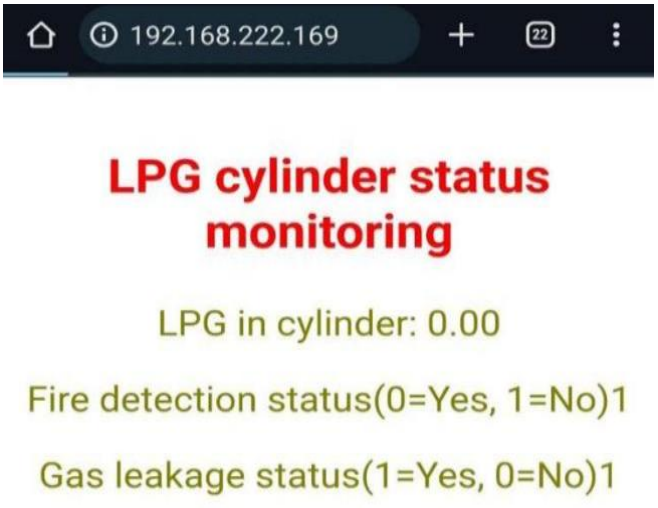

Fig 3. Before detecting gas leak and fire view on Web page

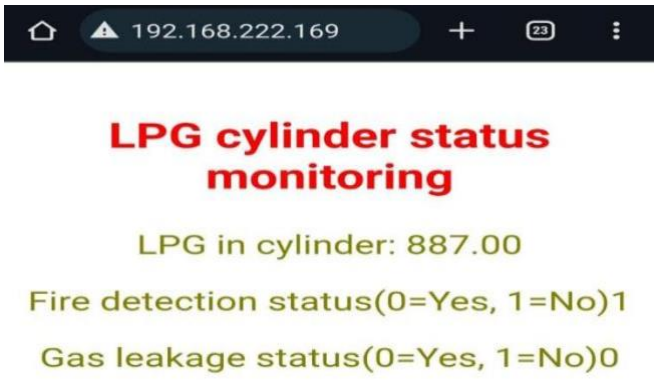

Fig 4. After detecting the weight and fire status on Web page.

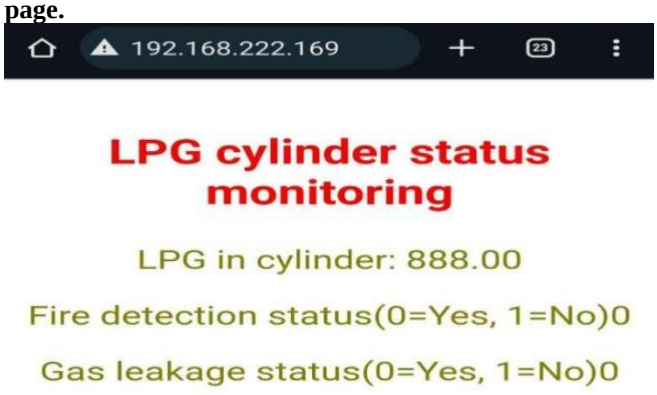

Fig 5. After detecting the weight, fire and leakage status on Web page

Fig 6. Display of weight on LCD

Fig 7. Display of leakage on LCD

Fig 8. Display of Fire on LCD

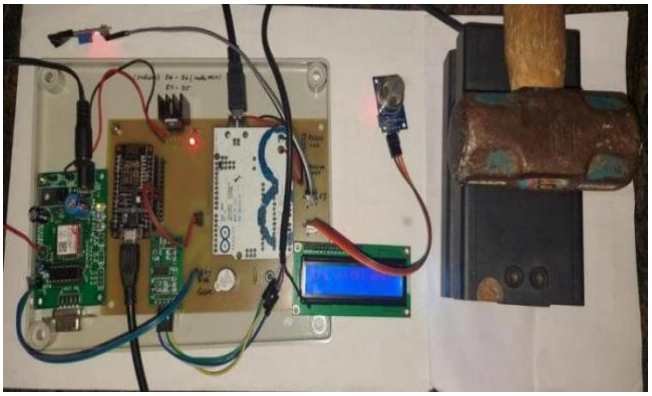

Fig 9. An overall circuit connection of the System

The connection of all the components is shown in Fig 9 which outputs the gas level on an LCD and also displays it in a web page. The fire indication is done through display in LCD, web page and give SMS alert to respected mobile number. The leakage indication is done through display in LCD, web page and give SMS alert to respected mobile number.

VII. CONCLUSION

The escalating use of LPG gas has heightened the risk of gas leakage and the potential damages it poses. The Smart Gas Management system presented in this paper effectively addresses this concern by continuously monitoring for gas leakages. Upon detection, the system promptly alerts users to take immediate action, such as turning off the gas valve, to prevent further damage. Moreover, the system notifies users when the gas cylinder's weight drops below a predefined threshold, ensuring timely refills and uninterrupted gas supply. Additionally, the integration of a buzzer for gas leakage or wastage, along with fire detection capabilities, further enhances safety measures. By leveraging IoT-enabled surveillance and alerting for LPG containers, the system minimizes damages caused by gas leakage and fire, making it a valuable asset for ensuring safety in LPG usage. Its real-time monitoring and proactive alerting capabilities empower users to take timely preventive actions, mitigating potential risks effectively. The Smart Gas Management system offers a comprehensive solution for mitigating the risks associated with LPG gas leakages and fires. Its ability to monitor gas levels, detect leakages, and provide timely alerts makes it an essential tool in ensuring the safe use of LPG.

VIII. FUTURE SCOPE

The future scope of the IoT-enabled surveillance and alerting system for LPG containers includes several key enhancements. Integration with advanced machine learning algorithms for predictive maintenance can enable proactive identification of potential issues, reducing the risk of accidents. Incorporating advanced communication protocols like NB-IoT or Lo Ra WAN can extend the system's reach to remote areas. The addition of environmental sensors can provide context on air quality during gas leakages, enhancing safety measures. Improving the user interface with mobile applications or web dashboards can enhance user experience and data visualization. Overall, future developments aim to leverage emerging technologies to enhance system capabilities, improving the safety and security of LPG usage.

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