IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 12, December 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.625

© 2024 IJIRCCE | Volume 12, Issue 12, December 2024| DOI: 10.15680/IJIRCCE.2024.1212086

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.625| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Automatic LPG Gas Leakage Detection, Protection and Booking Alert System

Dr. K M Prakash[1], Anupama S Havinal[2], Chandana M[3], Venkatesh T[4], Hanumathappa[5]

Associate Professor, Department of E&CE, BIET, Davangere, Karnataka, India[1]

Students, Department of E&CE, BIET, Davangere, Karnataka, India[2,3,4,5]

ABSTRACT: With the increasing use of LPG (Liquefied Petroleum Gas) for domestic and industrial purposes, ensuring safety and efficiency in its handling has become paramount. This paper proposes an integrated system for LPG gas leakage detection, protection, and booking alert, aimed at enhancing safety, preventing accidents, and optimizing resource management. The system consists of three main modules: **Gas Leakage Detection:** Utilizing sensors capable of detecting LPG gas leaks, the system continuously monitors the environment for any signs of leakage. Upon detection, it triggers immediate alerts to notify users and authorities, mitigating potential hazards. **Protection Mechanism:** Upon detection of a gas leak, the system activates protective measures such as shutting off the gas supply and activating ventilation systems to prevent the accumulation of hazardous gas levels. This rapid response mechanism reduces the risk of fire or explosion. **Booking Alert System:** In addition to safety features, the system includes a booking alert functionality to facilitate efficient LPG cylinder replenishment. Users can set reminders for refilling based on their usage patterns, ensuring uninterrupted gas supply and minimizing inconvenience. The proposed system integrates advanced sensor technology with real-time monitoring and alert mechanisms to provide comprehensive safety and operational benefits for both residential and commercial LPG users. By proactively addressing gas leakage incidents and optimizing resource management, it contributes to a safer and more efficient LPG usage ecosystem.

KEYWORDS: LPG, Early Detection, Diverse Gas Types, Real-time Monitoring, Environmental Impact, Sensors.

I. INTRODUCTION

LPG (Liquefied Petroleum Gas) gas detection and protection systems play a crucial role in ensuring safety in both residential and industrial settings. LPG, consisting mainly of propane and butane, is a highly flammable and potentially hazardous gas. The implementation of an automated detection and protection system is essential to mitigate the risks associated with LPG leaks, which can lead to fire, explosions, and other serious consequences.

The use of gas in both industrial and residential environments is ever-increasing. Gas is mainly used for energy generation and as a process requirement in manufacturing industries. The aftermath of a gas leak can be devastating irrespective of the scale of leakage.

Gas leakage detection systems are an integral part of a safety system, providing the first line of defence against the possible disasters of gas leakage. Some leakages are too small to be smelled or are of an unscented gas, so it's a necessary investment to install a gas leakage detection system.

In the event of a detected gas leak, an automatic gas shut-off valve is activated to stop the flow of LPG. This swift response prevents further leakage, minimizing the potential for fire or explosion. By cutting off the gas supply immediately, this feature helps contain the situation and mitigates the risk of a hazardous incident.

This paper also aims to send an automatic alert upon detecting that the gas in the cylinder is below a threshold value. This is done so that the customer does not need to look after cylinder to book his cylinder at all, and relieve the customer from any such worries.

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II. RELATED WORK

In [1] authors used MQ-2 sensor to feel nearby gases, Arduino software to write the functionality of the system. The objective is to create a system that can detect the leakage of LPG and shut down the house's power supply. In [2] work was carried out using Arduino nano board, MQ-2/MQ-6 gas sensor, XBee and a GSM module. The sensor has excellent sensitivity combined with a quick response time at low cost. Under gas leaked condition message to the authorized person or family member using Arduino GSM shield is sent automatically. In [3] gas leakage is detected by the gas sensor MQ-6. This detects the gas leakage and gives the signal to the microcontroller with the help of ADC. After that in second step the microcontroller receive the signal, send by gas sensor. It sends activation signal to other external devices attached with it. Such as two stepper motor IC (ULN 2003A), buzzer, LCD (Liquid crystal display), GSM module and RF link. In the last step, many tasks have been performed such as buzzer activates simultaneously message display on liquid crystal display screen, GSM module activated, which send warning SMS to the user. Stepper motor IC (ULN 2003A) to drives the stepper motor attached it, as a result main power and gas supplies turn off. At the end, when the gas leakage is successfully stopped then with the help of reset button the whole system reached to the initial stage.

III. PROBLEM STATEMENT

The uncontrolled release of gases, whether flammable, toxic, or greenhouse gases, poses significant threats to human safety, the environment, and public health. Gas leaks can occur in various settings, including industrial facilities, residential areas, and transportation systems. Timely detection, effective prevention, and efficient mitigation strategies are imperative to minimize the potential hazards associated with gas leakage.

Challenges:
Early Detection: Developing reliable and sensitive gas detection systems capable of identifying leaks at an early stage to prevent escalation.

Diverse Gas Types: Addressing the detection and mitigation challenges posed by a wide range of gases, including but not limited to methane, propane, hydrogen, sulfur dioxide, and volatile organic compounds (VOCs).

Integration with Existing Infrastructure: Ensuring seamless integration of gas detection technologies with existing infrastructure in industries, homes, and transportation systems.

Real-time Monitoring: Implementing continuous, real-time monitoring systems that provide instant alerts upon gas leakage, allowing for swift response and intervention.

Environmental Impact: Minimizing the environmental impact of gas leaks, including air and water contamination, by implementing sustainable and eco-friendly mitigation strategies.

IV. OBJECTIVES

Objectives of this project are:
1. To provide early warnings by swiftly identifying gas leaks from their outset, preventing the dangerous build- up of gas.
2. We aim to minimize losses by promptly stopping gas leaks from getting worse, thereby saving property and money.
3. To alert user for booking, upon low level of gas in cylinder.

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V. METHODOLOGY

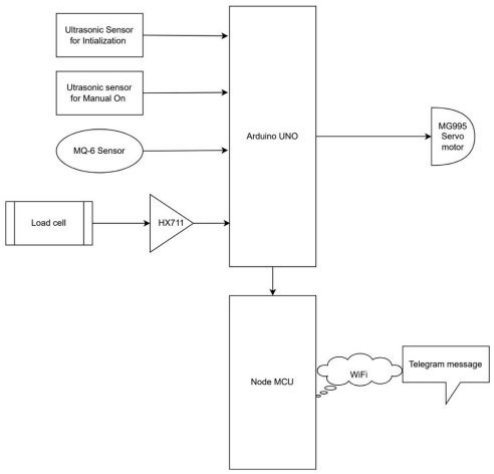

Fig: Block Diagram

Here, we have two subsystems working:
Whenever there is a gas leak due to any fault, MQ-6 Sensor detects the leakage, sends the signal to Arduino UNO to drive the servo motor attached to the gas cylinder regulator, so that it immediately switches off the regulator automatically.
Whenever the weight of the cylinder reduces below 30% (i.e., gas in the cylinder consumed to 70%) Load cell senses it, sends signal to Node MCU via Arduino UNO, to send a message upon detecting that the gas in the cylinder is below a threshold value to user.

VI. FLOW CHART

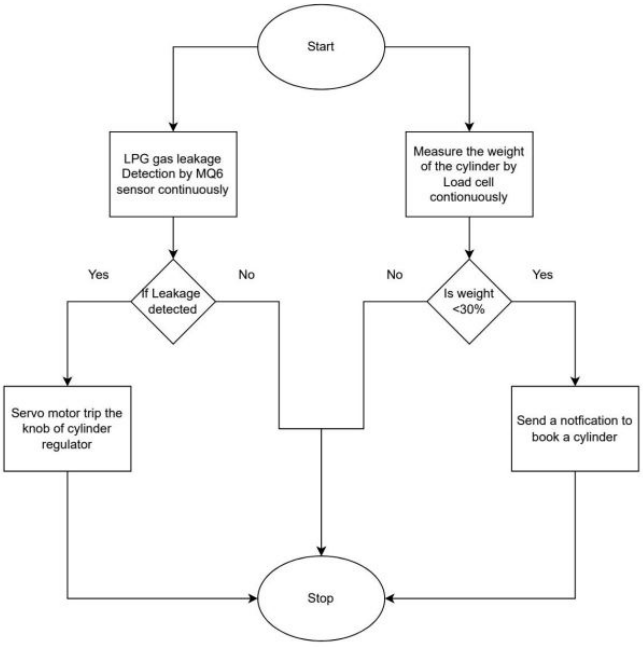

Fig. Flow Chart

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VII. HARDWARE AND SOFTWARE DESCRIPTION

A. MQ-6 Sensor

The MQ-6 gas sensor is part of the MQ series of gas sensors manufactured by Winsen Electronics. Here are some key details about the MQ-6 sensor:

• Gas Detection: The MQ-6 sensor is designed to detect various gases

• Sensitivity Adjustment: It has a built-in potentiometer for adjusting sensitivity.

• Operating Principle: It operates on the principle of "the change in conductivity of its sensing material when exposed to the target gas".

Fig. MQ-6 Sensor

B. Load Cell

A load cell is a transducer that converts force or load into an electrical signal. It is commonly used in industrial applications to measure and monitor force, weight, or pressure. Strain gauge load cells are particularly common, relying on the deformation of strain gauges to measure the applied force. These devices find applications in scales, industrial weighing systems, and force testing equipment. In our project, we use this to measure the weight of gas cylinder

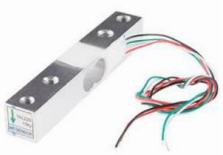

Fig. Load Cell

C. ESP 32

ESP32 is one of the microcontroller integrated Wi-Fi and dual mode Bluetooth its means it supports both Bluetooth 4.2 (BLE) and Bluetooth Classic (BT). The ESP32 is good option for peer-to-peer connection without the need of an access point supports Wi-Fi Direct as well.ESP32 is one of the microcontroller integrated Wi-Fi and dual mode Bluetooth its means it supports both Bluetooth 4.2 (BLE) and Bluetooth Classic (BT). The ESP32 is good option for peer-to-peer connection without the need of an access point supports Wi-Fi Direct as well.

Fig. ESP 32

D. Buzzer

A buzzer is an electronic device that produces sound. Here are some key points about buzzers:

• Functionality: Buzzers are used to generate audible alerts

• Types: There are different types of buzzers, including electromagnetic buzzers, piezoelectric buzzers, and magnetic buzzers.

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• Applications: Buzzers are commonly used in electronic devices and systems for various purposes, including alarms, notifications, and signalling.

Fig. Buzzer

E. Relay

A relay is an electromechanical or solid-state device that allows a low-power signal to control a higher-power circuit. Here are some key points about relays:

• Switching Functionality: Relays act as electrically operated switches.

• It consists of a coil, an iron core, and a set of contacts. When a current flows through the coil, it generates a magnetic field.

• Relays are used to control high-power devices with lowpower signals.

Fig. Relay

F. Servo Motor

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism.

Fig. Servo Motor

G. Arduino IDE

Fig. Arduino IDE

Arduino IDE is an open-source software that is mainly used for writing and compiling the code into the Arduino Module. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more. Each of them contains a micro-

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controller on the board that is actually programmed and accepts the information in the form of code. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

VIII. RESULTS AND DISCUSSIONS

Fig. Gas Leakage Detection and Protection

Whenever there is a gas leak due to any fault, MQ-6 Sensor detects the leakage, sends the signal to Arduino UNO to drive the servo motor attached to the gas cylinder regulator, so that it immediately switches off the regulator automatically.

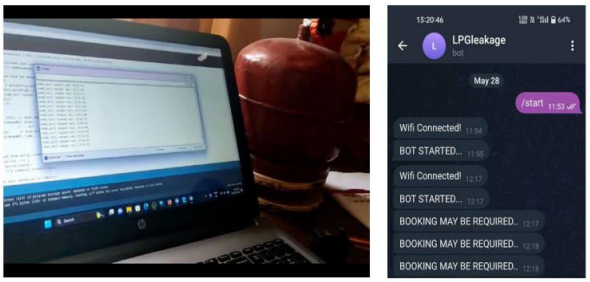

Fig. Booking Alert System

Whenever the weight of the cylinder reduces below 30% (i.e., gas in the cylinder consumed to 70%) Load cell senses it, sends signal to Node MCU via Arduino UNO, to send a message upon detecting that the gas in the cylinder is below a threshold value to user.

IX. CONCLUSION AND FUTURE SCOPE

CONCLUSION:

The system's ability to promptly detect gas leaks, trigger protective measures, and enhances safety by minimizing the risk of accidents, property damage, and environmental contamination. Additionally, the booking alert functionality optimizes resource management and notify users of refill requirements, ensuring uninterrupted gas supply and preventing unexpected disruptions in service.

In summary, the LPG gas leakage detection, protection, and booking alert system represents a valuable tool for promoting safety, efficiency, and sustainability in LPG usage, contributing to the well-being of individuals, communities, and the environment. Continued research, collaboration, and investment in this field are essential to realizing the full potential of these systems and ensuring their widespread adoption and impact in the years to come.

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FUTURE SCOPE:

Incorporating AI and machine learning algorithms can improve the accuracy of gas leak detection by analyzing historical data patterns and identifying anomalous behavior indicative of potential leaks. This can reduce false alarms and enhance overall system reliability.

Future systems may integrate with smart home platforms, allowing users to monitor and control their LPG systems remotely via voice commands or smartphone apps. This integration could enhance user convenience and accessibility.

Future systems may also incorporate additional sensors for monitoring environmental parameters such as air quality, temperature, and humidity. This holistic approach to environmental monitoring can provide valuable insights into indoor air quality and occupant comfort while complementing gas leak detection capabilities.

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INTERNATIONAL STANDARD SERIAL NUMBER INDIA

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