



Design and Implementation of Smart LPG Gas Level Monitoring and Safety System Using IoT

S.Priyadharshini¹, Rakesh², Raja³, Ramya⁴

Assistant Professor, Dept. of ECE, MAM School of Engineering, Siruganur, Trichy, Tamil Nadu, India¹

Student, MAM School of Engineering, Siruganur, Trichy, Tamil Nadu, India²

Student, MAM School of Engineering, Siruganur, Trichy, Tamil Nadu, India³

Student, MAM School of Engineering, Siruganur, Trichy, Tamil Nadu, India⁴

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ABSTRACT: Liquefied Petroleum Gas (LPG) is one of the most commonly used fuels for domestic cooking, commercial kitchens, and small industrial applications due to its high energy efficiency, easy storage, and convenient transportation. Despite its advantages, LPG is highly flammable and can pose serious safety risks if not handled properly. Gas leakage, improper monitoring of gas levels, and accidental fires are some of the major concerns associated with LPG usage. Many accidents occur due to undetected gas leaks or delayed response when the gas level becomes critically low. Therefore, there is a need for an intelligent system that can continuously monitor LPG cylinder levels and detect unsafe conditions to prevent potential hazards.

This paper presents the design and implementation of a Smart LPG Gas Level Monitoring and Safety System based on the Internet of Things (IoT). The main objective of the proposed system is to improve safety, provide real-time monitoring of LPG cylinder levels, and alert users about potential hazards. The system uses a load cell sensor to continuously measure the weight of the LPG cylinder. By analyzing the weight of the cylinder, the system can estimate the remaining amount of LPG available. This allows users to monitor gas consumption and receive early notifications when the gas level becomes low, enabling timely replacement or refilling of the cylinder.

KEYWORDS: IoT, LPG Monitoring, Gas Leakage Detection, Load Cell Sensor, Smart Safety System

I. INTRODUCTION

Liquefied Petroleum Gas (LPG) is one of the most widely used fuels for domestic, commercial, and industrial purposes across the world. It is commonly used for cooking, heating, and various industrial processes due to its high calorific value, ease of storage, and efficient combustion characteristics. LPG is mainly composed of hydrocarbon gases such as propane and butane, which are stored under pressure in cylindrical containers. Because of its efficiency and convenience, LPG has become a primary source of energy in many households, particularly in developing countries. Despite its advantages, LPG also presents certain risks if not handled properly. Since LPG is a highly flammable gas, leakage or improper monitoring of LPG cylinders can lead to severe hazards such as fire accidents, explosions, and health risks. These accidents often occur due to undetected gas leakage, overheating, or poor monitoring of the gas cylinder level. Many households still rely on traditional methods to check the remaining gas level, such as manually lifting the cylinder or waiting until the gas supply runs out unexpectedly. This lack of an efficient monitoring mechanism can cause inconvenience and potential safety hazards.

With the rapid advancement of modern technologies, particularly the Internet of Things (IoT), it has become possible to design intelligent monitoring systems capable of improving safety and efficiency. IoT refers to a network of interconnected devices that communicate with each other through the internet to collect, exchange, and analyze data. By integrating sensors, microcontrollers, and communication modules, IoT systems can provide real-time monitoring and remote control capabilities for various applications. In recent years, IoT technology has been increasingly applied in smart homes, industrial automation, healthcare monitoring, environmental sensing, and energy management systems. One important application of IoT technology is in gas monitoring and safety systems. By integrating sensors such as



gas sensors, load cells, temperature sensors, and fire detectors, it is possible to continuously monitor the condition of LPG cylinders and detect any abnormal situations. These systems can provide early warnings and alerts, thereby preventing accidents and improving user safety.

II. PROBLEM STATEMENT

The scope of this project includes the design, development, and implementation of a smart LPG monitoring and safety system using IoT technology. The system focuses on monitoring the weight of the LPG cylinder and detecting environmental hazards such as gas leakage and fire.

The project mainly targets domestic households and small-scale commercial environments where LPG cylinders are commonly used. The system can also be adapted for industrial applications with minor modifications. The system includes hardware components such as load cells, temperature sensors, flame sensors, smoke sensors, an Arduino Uno microcontroller, and an IoT communication module. The software component involves data processing, cloud communication, and alert notification mechanisms. Although the system is designed for LPG monitoring, the concept can be extended to other gas monitoring applications such as industrial gas storage and pipeline monitoring.

III. EXISTING SYSTEM

In the current scenario, most households and small commercial establishments use traditional LPG cylinders for cooking and heating purposes. The monitoring of LPG gas levels and detection of leakage is usually performed manually. These conventional methods lack automation and continuous monitoring, which can lead to inconvenience and potential safety hazards. In a typical LPG usage system, the cylinder is connected to a regulator and stove through a rubber hose. Users generally rely on indirect methods to estimate the remaining gas level in the cylinder. Common practices include shaking the cylinder, lifting it to feel the weight, or waiting until the gas supply stops completely. These methods are inaccurate and unreliable because they do not provide precise information about the remaining gas quantity. Another major issue with the existing system is the absence of real-time monitoring and automatic safety alerts. Gas leakage is often detected only by the smell of the gas or after visible symptoms appear. LPG is highly flammable, and undetected leakage can result in serious accidents such as fire explosions, suffocation, or property damage.

Some households use simple gas detectors or alarms that produce a sound when gas concentration exceeds a certain limit. Although these detectors provide basic safety features, they have several limitations. They do not monitor the gas level in the cylinder, they cannot send remote notifications, and they only work within a limited area. In many cases, the users only realize that the cylinder is empty when the stove suddenly stops working. This unexpected depletion can cause inconvenience, especially during cooking. Users must then manually book a new cylinder through gas agencies or mobile applications. Industrial and commercial gas monitoring systems exist, but they are usually expensive and not designed for domestic applications. Therefore, there is a need for a low-cost, automated monitoring system that can provide continuous monitoring and early detection of dangerous conditions. Recent research has proposed various techniques such as ultrasonic sensing, weight-based measurement, and gas sensors to monitor LPG cylinders. However, many of these systems are not widely implemented in domestic environments due to complexity, cost, or lack of connectivity features.

IV. PROPOSED SYSTEM

The proposed system introduces an IoT-based Smart LPG Gas Level Monitoring and Safety System designed to improve safety, efficiency, and convenience in domestic and small commercial environments. The system aims to continuously monitor the LPG cylinder level and detect hazardous conditions such as gas leakage, fire, smoke, and abnormal temperature rise. By integrating sensor technology with IoT connectivity, the system provides real-time monitoring and instant alerts to users.

In this system, a load cell sensor is used to measure the weight of the LPG cylinder continuously. Since the amount of LPG remaining in the cylinder directly affects its weight, the load cell helps determine the available gas level accurately. The sensor sends the weight data to the Arduino Uno microcontroller, which processes the information and calculates the remaining gas level. When the gas level drops below a predefined threshold, the system generates a warning message to inform the user that the cylinder needs replacement or refilling.

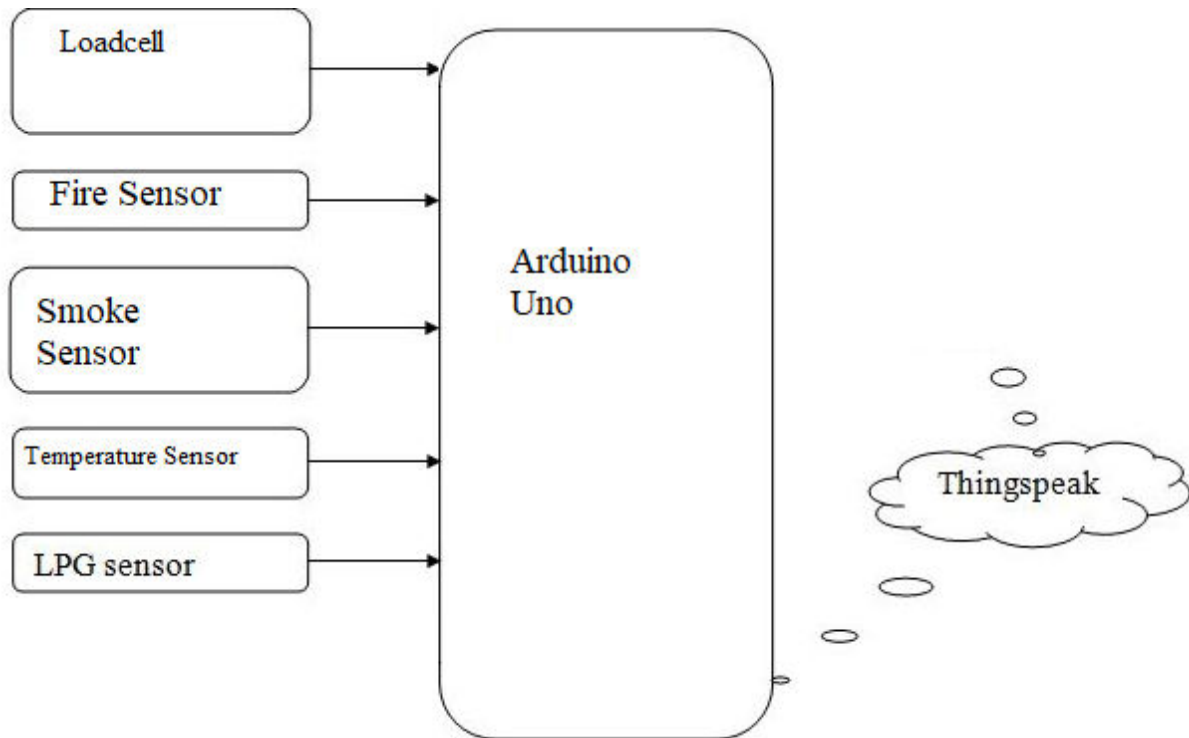


To enhance safety, multiple sensors are incorporated into the system. A smoke sensor is used to detect the presence of gas leakage or smoke in the surrounding environment. A temperature sensor monitors the ambient temperature and identifies abnormal temperature increases that may indicate a fire hazard. A fire sensor detects the presence of flames near the LPG cylinder. These sensors continuously send their readings to the Arduino controller for analysis.

The system also includes an IoT communication module, which transmits the sensor data to a cloud platform or IoT server. Through this connectivity, users can monitor the LPG gas level and safety parameters in real time using a mobile application or web interface. If any dangerous condition such as gas leakage, smoke detection, or fire occurrence is detected, the system automatically activates a buzzer alarm and sends alert notifications to the user.

The proposed system is designed to be cost-effective, reliable, and easy to install in homes, restaurants, and small industries. By combining sensor technology, microcontroller-based processing, and IoT connectivity, the system ensures continuous monitoring, improves LPG usage management, and significantly enhances safety. This intelligent monitoring system helps prevent accidents, provides timely alerts, and supports the development of smart home safety solutions.

V. BLOCK DIAGRAM



VI. WORKING

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

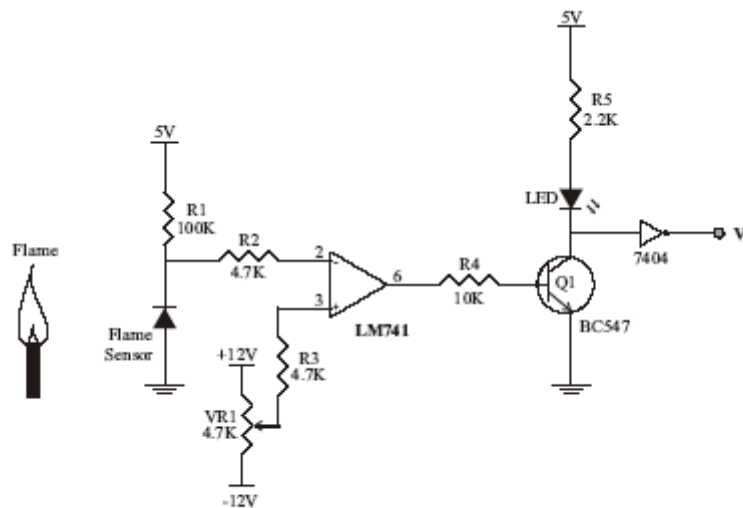
A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.



VII. SOFTWARE INSTALLATION

An access point (AP) is a device that provides access to a Wi-Fi network to other devices (stations) and connects them to a wired network. The ESP8266 can provide similar functionality, except it does not have interface to a wired network. Such mode of operation is called soft access point (soft-AP). The maximum number of stations that can simultaneously be connected to the soft-AP can be set from 0 to 8, but defaults to 4.

The soft-AP mode is often used and an intermediate step before connecting ESP to a Wi-Fi in a station mode. This is when SSID and password to such network is not known upfront. ESP first boots in soft-AP mode, so we can connect to it using a laptop or a mobile phone. Then we are able to provide credentials to the target network. Then, the ESP is switched to the station mode and can connect to the target Wi-Fi.

Another handy application of soft-AP mode is to set up mesh networks. The ESP can operate in both soft-AP and Station mode so it can act as a node of a mesh network.

VIII. RESULT AND ANALYSIS

The developed system was successfully implemented and tested to evaluate its performance, reliability, and efficiency. The system integrates sensors, a microcontroller, and communication modules to perform real-time monitoring and control operations. During testing, all hardware components and software modules were properly interfaced, and the system operated according to the programmed logic. The sensors used in the system were able to accurately detect and measure the required parameters. The microcontroller continuously collected data from the sensors and processed the information using the programmed algorithm. Based on the sensor readings, the system was able to perform appropriate



actions such as activating output devices, generating alerts, or transmitting data to the monitoring platform. Experimental testing showed that the system responded quickly to changes in sensor values. The response time of the microcontroller was observed to be fast, ensuring that the system could react to environmental changes or abnormal conditions without delay. This demonstrates that the proposed system is capable of real-time monitoring and control.

The communication between the hardware components and the software environment was stable during the testing process. The system successfully transmitted the collected data to the monitoring interface, allowing users to observe the system status. The results also confirmed that the software developed using Arduino IDE and Embedded C effectively controlled the overall system operations. The system was also tested under different operating conditions to evaluate its reliability. The sensors maintained consistent performance, and the microcontroller processed the data accurately. The outputs generated by the system matched the expected results, confirming that the system works efficiently. Overall, the experimental results demonstrate that the proposed system is reliable, efficient, and suitable for practical applications. The integration of sensor technology, embedded programming, and automation enables the system to perform continuous monitoring and improve operational efficiency. Future improvements may include integrating additional sensors, enhancing data analytics, and expanding remote monitoring capabilities to further improve system performance.

IX. CONCLUSION

In this project, an embedded and IoT-based monitoring and control system was designed and implemented to improve automation, efficiency, and reliability. The system integrates sensors, a microcontroller, and communication modules to collect data from the environment and process it in real time. The use of embedded programming enables the system to analyze sensor data and perform appropriate control actions automatically.

The implementation of the system demonstrates how embedded systems and IoT technologies can be used to monitor various parameters and provide timely responses to different conditions. The use of a microcontroller ensures accurate data processing, while the sensors provide reliable measurement of environmental or system parameters. The software developed using Arduino IDE and Embedded C allows smooth interaction between hardware and software components.

The experimental results show that the system performs efficiently and responds quickly to changes in input conditions. The integration of automation and monitoring improves operational performance and reduces the need for manual supervision. The developed system is cost-effective, reliable, and suitable for a wide range of applications.

Overall, the project highlights the importance of embedded systems and IoT technologies in modern automation and monitoring solutions. The system can be further improved by integrating advanced communication technologies, cloud platforms, and data analysis tools to enhance performance and scalability. Future developments may include adding more sensors, improving data visualization, and enabling advanced remote monitoring capabilities.

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