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Fabrication of a Smart LPG Monitoring and Alert System for Homes Using Node MCU and IoT

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Abstract

The "Smart LPG and MNGL Gas Monitoring System with Gas Leakage Detection" project is designed to enhance the safety and efficiency of liquefied petroleum gas (LPG) and Maharashtra natural gas limited (MNGL) distribution systems. LPG and MNGL are widely used for cooking and heating purposes, making it crucial to ensure their safe handling and distribution. Gas leakage can lead to life-threatening situations and environmental hazards. This project presents a comprehensive solution for monitoring gas supply, detecting leaks, and providing real-time alerts to prevent accidents. The system also integrates a camera module installed at MNGL meters, capturing images at specific intervals for accurate billing, and facilitating automatic booking through a dedicated mobile application. The incorporation of a gas leakage detection feature with real-time alerts and an automatic shutdown of mains power supply and regulator adds a safety aspect to the proposed system. This can contribute to preventing potential hazards and ensuring user safety. This safety measure aims to prevent potential hazards and protect users and property. The mobile application provides users with real-time information on gas consumption, meter readings, and billing details, offering a seamless platform for bill payments through an integrated gateway.

Keywords: Node MCU, Internet of Things (IoT), LPG, MQ3 sensor, Artificial Intelligence

INTRODUCTION

LPG is a combination of commercial propane and butane, containing both saturated and unsaturated hydrocarbons. Due to its versatile nature, LPG is widely used in various applications, such as domestic cooking, industrial purposes, vehicle fuel, heating, and lighting. As the demand for LPG continues to grow rapidly, there is an increasing risk of explosions when leaked gases are ignited. In recent years, the number of fatalities caused by gas cylinder explosions has been rising, highlighting the need for effective systems to detect and prevent LPG leakage [1].

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Prior to the introduction of electronic gas detectors in the 1980s and 1990s, the presence of gas was detected using chemically treated paper that changed color upon exposure to gas. Since then, various technologies and devices have been developed to detect, monitor, and alert users to the presence of gas leaks. This proposal outlines a microcontroller-based system using MQ2 and MQ3 gas sensors to detect hazardous gas leaks and smoke in the environment. These sensors are known for their high sensitivity, quick response time, and affordability. When a leak is detected, the system automatically sends an alert to an authorized person or family member via a GSM cellular network. Additionally, the system features an

LCD display shows the weight of the LPG cylinder. If the cylinder's weight drops to or below 300g, the system sends an automatic message to a supplier to arrange for a refill. Furthermore, the system notifies family members to refill the cylinder when its weight reaches 300g or less [2].

The growing reliance on liquefied petroleum gas (LPG) for cooking in homes has emphasized the need for effective monitoring and safety systems to detect gas leaks and prevent accidents. Conventional leak detection methods are often manual and depend on human intervention, which can result in delayed reactions and increased risks. To overcome these challenges, smart, automated LPG monitoring and alert systems have become crucial. The incorporation of advanced technologies like the Internet of Things (IoT) and microcontroller units (MCUs) has facilitated the creation of such systems, improving the safety, functionality, and dependability of LPG usage in households.

Node MCU, a cost-effective microcontroller based on the ESP8266 Wi-Fi chip, has become a preferred choice for IoT applications due to its small size, ease of programming, and wireless connectivity capabilities. It enables real-time monitoring, data storage, and remote management, making it perfect for developing intelligent gas monitoring systems. When paired with sensors, such as the LPG gas sensor, Node MCU can detect leaks and instantly notify users via mobile apps or other connected devices.

This review article delves into the design and fabrication of smart LPG monitoring systems for homes, emphasizing the integration of Node MCU and IoT technology. It covers the system's components, design principles, and operational mechanisms while also examining the potential advantages these systems offer for enhancing household safety.

LITERATURE SURVEY

K. Gavaskar, D. Malathi, G. Ravivarma, A. Arulmurug et al. (2021). Methodology is by using MQ3 and ATmega 328 P the system is detect the Leakage in LPG. Customers and the agency benefit from the automatic gas booking process made possible by the Internet of Things. Accuracy of this system is 80 to 85 percent [3].

Gas leakage detection and smart alerting and prediction using IOT is proposed by Asmita Varma, Prabhakar, S. Kayalvithi Jayavel et al. (2020). Methodology in this system is based on Arduino unoR3And MQ6 sensor. Detection of leak gas using MQ3 sensors. The accuracy of this system is 70 to 75 percent [4].

In 2020, Suma V., Ramya R. Shekhar, Akshay Kumar A., et al. proposed an IOT-based method for gas leak detection. Methodology in this system IOT module is used for app notification. In this project, the valve is automatically closed when a gas leak is detected. Accuracy of this system is 85 to 90 percent [5].

Sensor based gas leakage detection system is proposed by Mohammad Monirujja-mun Khan et al. (2019). Methodology in this system uses load cell for real-time weight monitoring. Alert messages will send to user after cylinder is going to empty. The accuracy of this system is 75 to 80 percent [6].

LPG Gas leakage detection using IOT is proposed by Arun Manhas, Neeraj Chambyal, Manish Raina, Dr. Simmi Dutta et al. (2018). Methodology in this system MQ3 sensor and GSM module is used. specifically indicate gas leakage and sent alert message simulation on proteus software is done [7].

DESIGN OF SYSTEM

Proposed methodology, involving the simultaneous actions of switching of the mains power supply and alerting the user through SMS upon detecting LPG leakage, is a proactive approach to enhance

safety. This not only addresses the immediate danger but streamlines the process for customers, reducing the burden of manually booking cylinder.

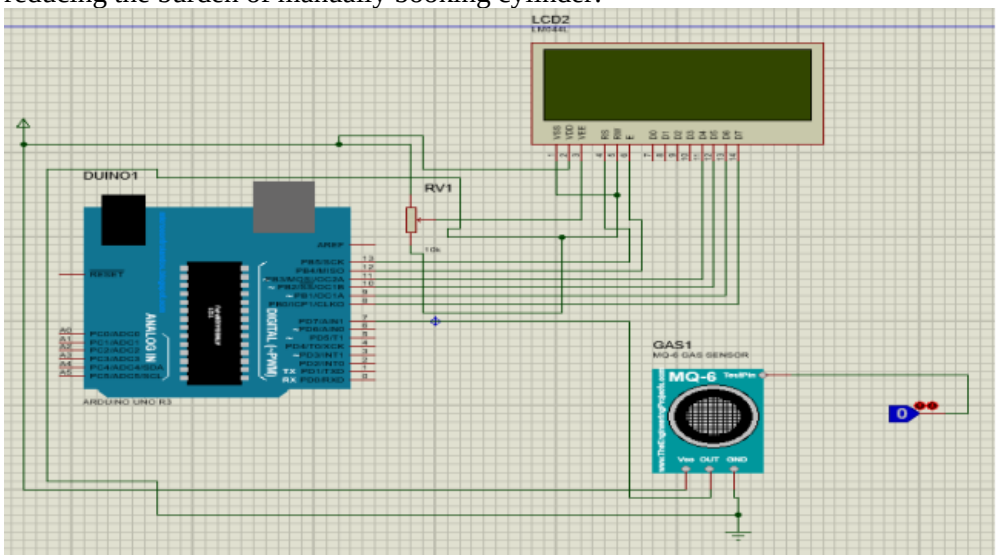

Figure 1. Circuit diagram for monitoring system.

The block diagram in Figure 1 illustrates the components and their interactions in a system incorporating Arduino Uno, GSM module, TFT display, power supply, and a temperature sensor. Below is a summary of each part and how it functions in the system:

POWER SUPPLY

By changing one type of electrical energy into another, power supplies enable devices to receive electrical energy. It highlights the versatility of power supplies, which can exist in various forms, from standalone units to integrated components within larger systems. Additionally, the text mentions different types of power supplies, including red, variable, and dual power supplies, showcasing their adaptability for a wide range of applications. Overall, the summary emphasizes the essential function and diverse nature of power supplies in the realm of electrical energy provision [8].

Node MCU ESP8266

ESP8266 (as shown in Figure 2) acts as a versatile system-on-a-chip (SoC) that operates independently as a standalone computer within embedded systems. It emphasizes the self-contained nature of the ESP8266, highlighting its ability to function as a dedicated and compact computing unit. The text also underscores the significance of the ESP8266's built-in Wi-Fi capabilities, which make it well-suited for Internet of Things (IoT) applications by enabling wireless connectivity and communication between devices over networks.

Figure 2. ESP8266.

LOAD CELL

The cylinder's weight is determined by using a load cell. It Operates on 5V DC signal, which gets forwarded to LCD display through NODE MCU, and displays the actual weight of the cylinder.

MQ3 Sensor

The MQ3 sensor (as shown in Figure 3), part of the MQ sensor series, is a metal oxide semiconductor (MOS) type sensor. It operates at 5V DC, and the controller supplies its power. The MQ-3 sensors detect alcohol gases within a specific concentration range. This sensor is highly sensitive to alcohol and resistant to interference from other substances like smoke or vapor. Notably, the MQ3 sensor is a digital sensor, indicating that it provides digital output signals [7].

Figure 3. MQ3 sensor.

LCD DISPLAY

The LCD display is equipped with a built-in controller that interprets specific commands to facilitate functions, such as setting cursor positions, clearing the display, and managing the on/off state. With its attributes of low power consumption, wide operating temperature range, and seamless interfacing with microcontrollers like Arduino, the LCD 16 x 2 offers versatility and ensures high visibility in diverse lighting conditions. Its capability to be controlled using a range of commands makes it a prevalent choice in electronics projects for effectively displaying text or data [9, 10].

METHODOLOGY

Flow of information through various components is shown in Figure 4.

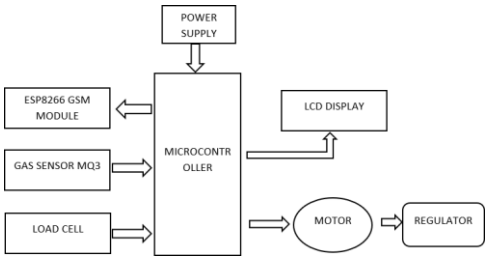

Figure 4. Block diagram of flow of information.

Circuit Diagram

Circuit diagram involve connections between various components used in the development of monitoring system is shown in below Figure 5.

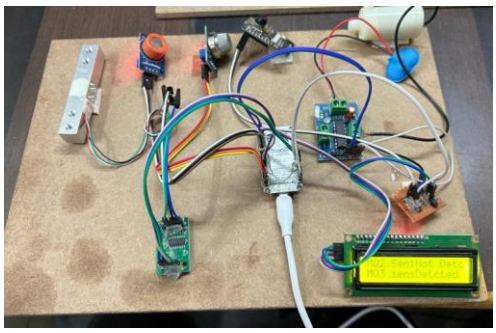

Figure 5. Circuit diagram involve connections.

FUTURE SCOPE

The creation of smart LPG monitoring and alert systems utilizing Node MCU and IoT technologies has unlocked numerous opportunities to improve household safety and energy efficiency. However, there is still significant potential for further development and innovation in this area. As IoT technology advances, the future potential for smart LPG systems is extensive, with many areas that can be explored.

One area of future growth is the integration of artificial intelligence (AI) and machine learning (ML) techniques into these systems. By leveraging historical data from sensors, AI could predict possible gas leak events, enhance the accuracy of leak detection, and even estimate when a gas cylinder might run out. This ability to predict could enable more proactive actions, reducing the occurrence of unnecessary disruptions for users.

Moreover, the potential for integration with other smart home technologies offers a promising direction. For instance, connecting the LPG monitoring system with smart kitchen appliances or home automation systems could trigger automated responses, such as turning off the stove or regulating the gas flow when a leak is detected. This level of integration would further boost both safety and convenience.

Improving sensor technology also represents an important future focus. Current sensors may face limitations in sensitivity, precision, and response times. Advancements in sensor technology could lead to more accurate and efficient detection, allowing the system to identify even the smallest leaks with greater speed and reliability.

Another area worth investigating is the application of blockchain technology for secure data transfer and storage. By encrypting and safely storing the data gathered by the monitoring system, users can be assured of the privacy and reliability of their information.

In summary, the prospects for smart LPG monitoring systems are bright, with potential for further developments in AI, sensor technology, smart home integration, and data security. These advancements could greatly enhance both safety and the overall user experience.

CONCLUSIONS

The Internet of Things (IoT) has gained significant popularity in recent times due to its diverse range of applications, which have contributed to a more convenient, secure, and streamlined way of life for individuals. Among its major uses are gas booking and the detection of gas leaks in both residential and business settings. While various techniques exist for these purposes, gas leakage detection remains a major concern and challenge. This paper presents a novel system, utilizing a microcontroller-based application for gas booking and gas detection systems through IoT. The sensor employed in this model can effectively detect gas leaks, providing users with notifications regarding the remaining gas percentage in the cylinder. It also allows for the seamless pre-booking of a new cylinder. This system can be easily integrated with an alarm unit or visual indicators to enhance LPG safety awareness,

making it valuable in sectors like hotels and shops. The primary goal of this work is to establish a safer and more efficient approach to gas booking and gas leakage detection, thus preventing potential disasters resulting from negligence

Our proposed methodology builds on these principles by executing multiple actions concurrently upon detecting gas leakage. It not only enhances safety by cutting off the mains power supply and alerting the user through SMS but also reduces the risk of fire hazards.

REFERENCES

1. Gavaskar K, Malathi D, Ravirama G, Arulmurugam A. Development of LPG leakage detection alert and auto exhaust system using. International Conference on Smart Systems and Inventive Technology (ICSSTT). Chennai, India; 2021, Feb 11–13. 558–563p. IEEE.
2. Varma A, Prabhakar S, Jayavel K. Gas leakage detection and smart alerting and prediction using IoT. 2nd International Conference on Computing and Communications Technologies (ICCCT). Chennai, India; 2017, Feb 23–24. 327–333p. IEEE.
3. Suma V, Ramya RS, Akshay Kumar A. Gas leakage detection based on IoT. International Conference on Smart Systems and Inventive Technology (ICSSIT). Coimbatore, India; 2019, June 12–14. 1312–1315p. IEEE.
4. Khan MM. Sensor-based gas leakage detector system. Eng Proc. 2020;2(1):28.
5. Manhas A, Chambyal N, Raina M, Dutta S, Singh EP. LPG gas leakage detection using IoT. Int J Sci Res Sci Technol. 2021:520–526.
6. Hotur VP, Prianka RR, LH HP, Padmavathi M, Ramaraj K, Thilagaraj M. Smart LPG monitoring system: Enhanced safety with leakage detection. 2nd International Conference on Networking, Embedded and Wireless Systems (ICNEWS). Bangalore, India; 2024, Aug 22–23. 1–7p. IEEE.
7. Umale VM, Bhagwat K, Yende S, Shah B, Damare N. Smart LPG Gas Level Monitoring and leakage Detection System using IOT. J Sci Eng. 2023;1(1):156–160.
8. Soh ZH, Abdullah SA, Shafie MA, Ibrahim MN. Home and industrial safety IoT on LPG gas leakage detection and alert system. Int J Adv Soft Comput Appl. 2019;11(1).
9. Bhargavi S, Sudarshan G, Upendra S, Shreyas SR. IoT enabled surveillance and alerting for LPG containers. International Conference on Knowledge Engineering and Communication Systems (ICKECS). Chikkaballapur, India; 2024, Apr 18–19. 1–6p. IEEE.
10. Hotur VP, Prianka RR, LH HP, Padmavathi M, Ramaraj K, Thilagaraj M. Smart LPG monitoring system: Enhanced safety with leakage detection. 2nd International Conference on Networking, Embedded and Wireless Systems (ICNEWS). Bangalore, India; 2024, Aug 22–23. 1–7p. IEEE.

