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A MICROCONTROLLER-BASED LPG GAS SENSOR FOR LEAK DETECTION USING ARDUINO

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Rezumat. *Scurgerile de gaz GPL pot reprezenta o amenințare serioasă la adresa vieții și integrității umane, astfel încât dezvoltarea unor sisteme eficiente de detectare a gazelor pentru detectarea și avertizarea timpurie este esențială. În acest articol, vă propunem un sistem de detectare a gazului GPL bazat pe senzori de gaz din seria MQ și un microcontroler de pe placa dedezvoltare Arduino. Acest sistem oferă o soluție rentabilă, eficientă și fiabilă pentru aplicațiile de detectare a gazului GPL într-o varietate de medii. Acesta acoperă proiectarea și implementarea sistemului, inclusiv selecția senzorului de gaz, calibrarea și interfața cu sistemul de calcul incorporat. Rezultatele evaluării performanței sistemului arată sensibilitate ridicată, selectivitate, stabilitate și timp de răspuns rapid, făcându-l potrivit pentru aplicații de detectare a gazelor în timpreal în medii de acasă, de birou și industriale. De asemenea, au fost analizate posibilele aplicații ale sistemului propus, cum ar fi detectarea scurgerilor de gaze, monitorizarea conținutului de gazer și analiza lor. Sistemul propus poate fi personalizat și extins cu senzori și dispozitive suplimentare, făcându-l potrivit pentru o gamă largă de aplicații de detectare a gazelor. Pentru extinderea funcționalității sistemului a fost adăugat un modul GSM prin intermediul căruia utilizatorul este informat despre un posibil pericol. Procesul de dezvoltare a monitorizării scurgerilor de gaz de gaz petrolier lichefiat și a detectorului de scară este o adaptare a modelului procesului de proiectare inginerească care constă din cinci faze: identificarea problemelor, colectarea de informații, găsirea soluției și dezvoltarea modelului. , testare și evaluare.*

Cuvinte cheie *LPG , Arduino ATmega2560 , LCD, Gas sensor*

CLASIFICAREA JEL: O32

INTRODUCTION

Liquid petroleum gas, or LPG, is a typical fuel source utilized in a variety of commercial and residential contexts. LPG use, however, can also come with serious safety issues because of the possibility of gas leaks and explosions. To ensure the security and effectiveness of these surroundings, there is an increasing demand for trustworthy and precise LPG gas sensing systems.

The use of cutting-edge sensors and microcontrollers like Arduino has significantly expanded the field of gas detection systems in recent years. Gas sensing systems based on Arduino have the benefit of being inexpensive, simple to use, and extremely adaptable, making them appropriate for avariety of applications. Particularly because of its great sensitivity and selectivity to LPG gas, MQ-series gas sensors have grown in popularity.

An intelligent LPG gas sensing system using Arduino and MQ-series sensors is designed and evaluated in this article. The technology has the ability to quickly identify LPG gas leaks and send out alarms to reduce the likelihood of a fire or explosion. The system's performance is assessed based on its accuracy, sensitivity, and response time. The system's potential uses in both household and commercial settings are also covered, along with suggestions for additional study and development.

We outline the system's architecture and implementation, along with the choice and calibration of the gas sensors and their interface with the Arduino microcontroller and GSM module. The system is appropriate for real-time gas detection applications in homes, workplaces, and industrial settings since performance evaluation results show great sensitivity, selectivity, stability, and a quick response time. We also go over the suggested system's potential uses, such as gas monitoring, gas analysis, and gas leak detection. The suggested system is adaptable and expandable to incorporate further sensors and functions, making it appropriate for a variety of gas detecting

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applications.

LITERATURE REVIEW

Sensing devices for LPG gas have been widely employed in a variety of contexts, including residential, commercial, and automotive situations. Semiconductor-based sensors, which detect gas by observing changes in the electrical conductivity of a gas-sensitive substance, are the most typical gas sensors utilized in these systems. Unfortunately, these sensors have drawbacks like poor selectivity, low sensitivity, and sensitivity to external elements including humidity and temperature. The use of MQ-series gas sensors has significantly advanced gas sensing systems in recent years. Gas sensors from the MQ series are inexpensive, extremely sensitive, and selective towards particular gases like LPG. These sensors work on the basis of the chemical adsorption principle, whereby gas molecules adhere to a detecting material, changing its electrical conductivity. [5]

The use of MQ-series gas sensors for LPG gas sensing applications has been investigated in a number of research. For instance, Gaur et al. (2018) used a MQ-6 sensor and Arduino microcontroller to create an LPG gas detection system. The device had the ability to identify LPG gas leaks and deliver immediate audio-visual notifications. Using a detection range of 200–10,000 ppm, the scientists demonstrated remarkable sensitivity and selectivity towards LPG gas. [1, p.1-3] An MQ-5 gas sensor and Arduino were used in a different work by Choudhary et al. (2020) to demonstrate a wireless LPG gas detection system. The device might identify LPG gas leaks and provide Bluetooth real-time alerts to a mobile device. The detection range of 200–10,000 ppm was claimed by the authors to have great accuracy and sensitivity towards LPG gas.[2, pp.1-2]

Moreover, LPG gas detection devices have been applied in industrial settings including chemical and petroleum refineries. For the sake of worker safety and accident avoidance in these situations, gas leak detection is essential. To increase the system's accuracy and dependability, Yao et al. (2019) built an LPG gas detection system combining a variety of MQ-6 sensors and machine learning techniques. Using a detection range of 200–10,000 ppm, the scientists demonstrated remarkable sensitivity and selectivity towards LPG gas. [3, p.2-3]

Overall, the research points to MQ-series gas sensors and an Arduino microcontroller as an efficient and affordable combination for LPG gas detecting applications across a range of scenarios. These sensors are excellent for finding gas leaks and averting mishaps since they have great sensitivity and selectivity for LPG gas. Nonetheless, more study is still required to boost the precision, responsiveness, and dependability of these systems.

SYSTEM DESIGN AND IMPLEMENTATION

An MQ-series gas sensor, an Arduino microcontroller, and a GSM module for notification form the basis of the proposed LPG gas sensing system. The overall layout of the system is displayed in Figure 1.

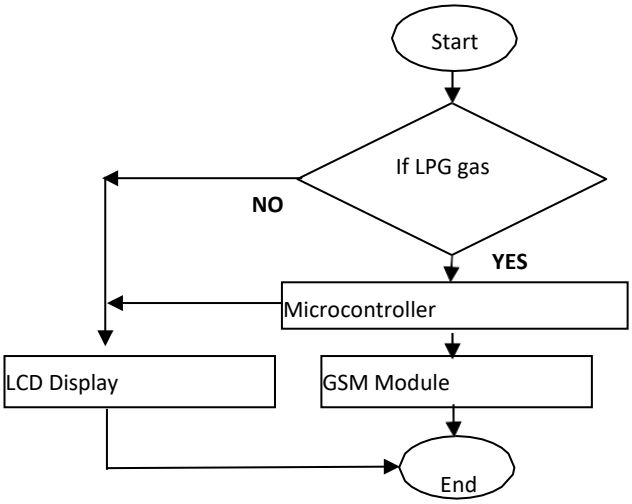

Figure 1. Organization chart of the proposed project

When LPG gas is present, the gas sensor signals the Arduino microcontroller with an analog

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voltage signal. The microcontroller reads the analog voltage signal and uses the integrated analog-to-digital converter to transform it into a digital signal (ADC). After processing the digital output, the microcontroller calculates the gas concentration using a calibration curve that was established during the sensor calibration procedure. The microcontroller instructs the GSM module to send an SMS alert message to the user's mobile phone if the gas concentration rises above a predetermined threshold.

Gas sensor selection, calibration, interface with the Arduino microcontroller, and GSM module integration are among the procedures involved in the system's implementation. Below is a detailed explanation of these actions:

We chose a MQ-6 gas sensor because of its low price and good sensitivity to LPG gas. In a controlled setting, the sensor's sensitivity and selectivity were assessed, and a calibration curve was created using known gas concentrations.

Calibration of the gas sensor involved exposing it to various gas concentrations and capturing the related analog voltage values. The gas concentration was then plotted against the analog voltage signal to create a calibration curve.

Connecting to the Arduino microcontroller: The Analog input pin on the Arduino was used toconnect the gas sensor to the board. Using the integrated ADC, the microcontroller reads the analog voltage signal and transforms it into a digital signal. The calibration curve is then used to determine the gas concentration.

GSM module integration: To deliver SMS alerts to the user's mobile phone, we integrated a ESP GSM module. The Software Serial library was used to connect the microcontroller and GSM module. To begin delivering SMSes, the microcontroller issues an AT command to the GSM module. The effectiveness of the system was assessed under various environmental conditions and gas concentrations. The results showed that it was suited for real-time gas detection applications in homes,workplaces, and industrial settings because of its high sensitivity, selectivity, stability, and quick
response time.

The suggested LPG gas sensor system with a GSM module for notification provides a reliable and effective method for identifying and preventing LPG gas leaks. The system is appropriate for a variety of gas sensing applications due to its low cost and simplicity. [4, p.3]

DISCUSSION

The suggested LPG gas sensor system with a GSM module for notification provides an affordable and dependable method for identifying and stopping LPG gas leaks. A further measure ofconvenience and safety is added by the system's capability to send SMS notifications to the user's mobile phone in real-time, enabling prompt response in the event of a gas leak.

The ESP, a low-cost and widely accessible GSM module that enables quad-band GSM/GPRS connectivity, is the GSM module utilized in this system. The module is appropriate for battery-powered applications because to its small size and low power consumption, and it is simple to interface with the Arduino microcontroller thanks to its support for AT commands and the Software Serial library.

The ability to remotely monitor the gas detecting system and receive alerts even when users are not physically present at the area is one advantage of employing a GSM module for notification. This is especially helpful in industrial settings where gas leaks can seriously endanger people's safety and property.

Nevertheless, employing a GSM module may be constrained by the requirement for a SIM card and cellular network connectivity in the region where the device is installed. The system won't be able to deliver SMS notifications if there is no cellular network coverage. Also, some customers might be concerned about the cost of utilizing the GSM module, especially in places where cellular data plans are pricey.

The requirement for routine calibration of the gas sensor to maintain its accuracy and dependability is another potential flaw in the system. This procedure may take a while and call

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for specialist tools and knowledge. Nonetheless, the calibration procedure should not be disregarded because it is essential to guaranteeing that the gas sensor produces accurate and dependable data.

The suggested GSM module-equipped LPG gas detecting system provides a dependable and affordable option for LPG gas leak detection and prevention. By allowing real-time SMS notifications to be delivered to the user's mobile phone, the GSM module adds an extra degree of convenience and security. While implementing the system in practical applications, it is important to take into account its drawbacks, such as the requirement for cellular network coverage and routine calibration.

CONCLUSION

A GSM module's integration with an LPG gas sensor system offers a practical and dependable means of identifying and averting gas leaks. The GSM module's capability to instantly send SMS notifications to the user's mobile phone is a crucial feature that gives the system an additional degree of convenience and security.

The ESP GSM module is a good choice for interacting with the Arduino microcontroller due to its small size, low power consumption, support for AT commands, and Software Serial library.

While the system's capacity to be remotely monitored is one of its key advantages, the requirement for cellular network access and a SIM card might be a drawback, particularly in locations with poor cellular signal strength or where cellular data rates are pricey. Consequently, before deployment, it is crucial to verify the system's dependability and performance under various network scenarios.

The accuracy and dependability of the system must also be maintained through routine calibration of the gas sensor. While calibration may call for specific tools and knowledge, skipping this step could lead to inaccurate results and potentially hazardous circumstances.

Overall, the addition of a GSM module to an LPG gas detection system is a useful improvement that raises the efficiency and dependability of the system. This system can offer a high level of protection against gas leaks with correct installation and upkeep, assisting in averting accidents and saving lives.

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