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Development of Gas Monitoring Detector (GMD) Using Arduino UNO

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Abstract

This study presents a gas alert system, designed and implemented using an Arduino Uno microcontroller and an MQ135 gas sensor. The system is aimed to monitor indoor air quality by detecting a range of hydrocarbon gases, such as propane, propylene, butylene, isobutane, and butane, commonly found in LPG (Liquefied Petroleum Gas) fuel gas. Its primary purpose is to measure target gas levels, be constantly and accurately prepared for rapid response to dangerous situations, and instantly set off alarms when gas concentrations surpass predetermined safety limits, warning occupants of potential hazards. The sensor MQ135 is used in this project to detect gas level concentration. Arduino UNO functions to monitor air quality levels in designated rooms and process the data, shown on 16X2 LCD display module. The project outputs are a sign light and a bell to sound an alarm. Both gas detectors and the crucial safety factors are highly helpful in identifying gas in buildings. In addition to detecting gas in the air, a gas detector circuit reads and displays its amount. If the gas level rises above the desired level, this circuit will activate the buzzer.

1. Introduction

Indoor safety is a paramount concern in today's world. As we strive for convenience and efficiency in our daily lives, we must also acknowledge the potential risks that come with it. One such risk is the presence of harmful gases in our indoor environments, which can lead to health hazards, accidents, fires, and even explosions. To address this critical issue, a Gas Monitoring Detector (GMD) Using Arduino UNO is proposed as a beacon of innovation and safety, aimed at creating a safer indoor environment for all. This project was conceived with a singular mission – to ensure the safety and well-being of occupants in indoor spaces, by sounding early warning of potential gas leaks and harmful gas concentrations. The project acknowledges the increasing popularity of gases such as liquefied petroleum gas (LPG) as fuel sources due to their affordability and efficiency, which also brings forth the peril of highly flammable and explosive gas leaks, which might lead to catastrophic consequences.

At its core, the GMD functions as a vigilant guardian of indoor spaces. It achieves this through the deployment of advanced gas sensors, microcontroller technology, and intelligent alarm systems. These gas

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sensors, including the MQ135, are meticulously calibrated to detect the presence of specific gases within the environment. The microcontroller processes the data from these sensors, and will triggers alarms if hazardous gas concentrations surpass predefined safety thresholds. The primary function of the Gas Detector Using Arduino UNO is to provide timely alerts to occupants in the event of gas leaks or accumulation of harmful gases. This early warning alerts individuals to take immediate action, such as ventilating the area or evacuating, thus preventing potential harm and damage [1].

The Gas Detector Using Arduino UNO offers distinct advantages over the existing LPG Gas Leak Detection Smart Tool. Firstly, compared to the LPG-specific tool, the Gas Detector Using Arduino UNO is designed to detect a range of gases that could be present indoors. This makes it applicable in various environments. Secondly, the Gas Detector Using Arduino UNO is comparatively much simpler and more cost-effective [2]. By utilizing relatively simple components like gas sensors and microcontrollers, it is more accessible to a wider range of users. The project's focus on indoor air quality monitoring, rather than solely targeting LPG leaks, enhances its relevance in diverse settings. Lastly, the Gas Detector Using Arduino UNO holds educational value. By raising awareness about indoor air quality and gas detection, it contributes to a culture of safety-consciousness. This contrasts with the LPG Gas Leak Detection Smart Tool, which is specialized and might not address a broader context of indoor gas risks [1-3]. The Gas Detector Using Arduino UNO presents a holistic approach to indoor safety. It combines cutting-edge technology with user-friendliness, adaptability, and potential for customization [4-6]. The system's design revolves around the constant monitoring of indoor air for harmful gases, as well as ensuring the prompt detection of gas leaks and potentially hazardous concentrations.

The project architecture integrates gas sensors, microcontrollers, alarms, and data processing capabilities. This synergy creates an early warning system to empower individuals to take timely action, thus mitigating risks and ensuring a secure indoor environment. The Gas Detector Using Arduino UNO serves as a testament to the remarkable potential of technology to safeguard human lives and property. In conclusion, the Gas Detector Using Arduino UNO project is a testament to our commitment to safety and well-being. Its function as a vigilant guardian against potential gas leaks and harmful gas concentrations is instrumental in preventing accidents and protecting lives. The advantages it has over specialized tools, along with versatility and educational value, make it a cornerstone of indoor safety. The Gas Detector Using Arduino UNO stands as an embodiment of innovation, responsibility, and the drive to create safer environments for us.

2. Design of Gas Detector Using Arduino UNO

The block diagram of the proposed design is shown in Figure 1. This system has one Arduino microcontroller. The MQ135 sensor is used in this project to detect gas level concentration. The Arduino UNO functions to monitor air quality levels in designated rooms and process the data, which are shown on 16X2 LCD display module. The project outputs are a sign light and a bell to sound an alarm. Both gas detectors and the crucial safety factors are highly helpful in identifying gas in buildings. In addition to detecting gas in the air, a gas detector circuit reads and displays its amount. If the gas level rises above the desired level, this circuit will activate the buzzer.

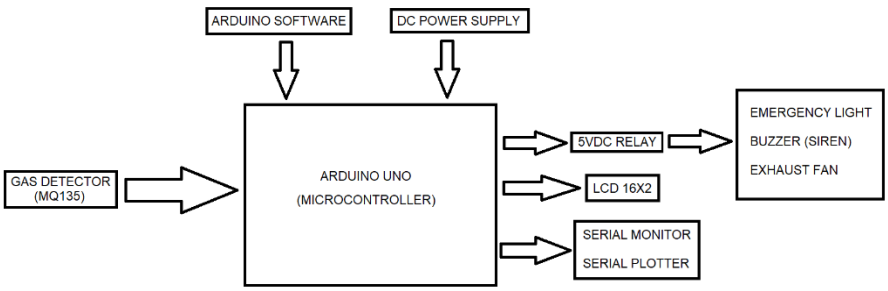

Figure 1: Block diagram of proposed system

As shown in the circuit diagram in Figure 2, the forefront of this system lies the MQ135 gas sensor. This device embodies the very essence of gas detection, capable of sensing the presence of various gases that pose potential harm to occupants. Its sensitivity to gases such as ammonia, nitrogen oxides, benzene, and carbon dioxide, CO_2 equips it to be a guardian against unseen dangers. The Arduino UNO as the brain, orchestrates the symphony of safety within this system. This microcontroller, accompanied by its dedicated software, forms the core intelligence that processes sensor data and makes informed decisions. The heart of the system's functionality resides in the Arduino's program. It seamlessly converts analog data from the MQ135 sensor into

meaningful gas concentration levels, then compares them against predefined safety thresholds. A steady supply of direct current (DC) power source fuels the Arduino's operations, ensuring its constant functionality. Integrating high-voltage devices into the system requires a bridge between the low-voltage logic of the Arduino and the power-hungry reality of devices, like the emergency light and exhaust fan. The 5VDC relay, with its ability to act as a switch controlled by the Arduino, bridges this gap effectively. The visual element of the Gas Detector system comes to life through the LCD 16×2 display. This screen, interlinked with the Arduino, serves as an interface that communicates vital information to occupants. Gas concentration levels, system status, and alerts are portrayed on this display.

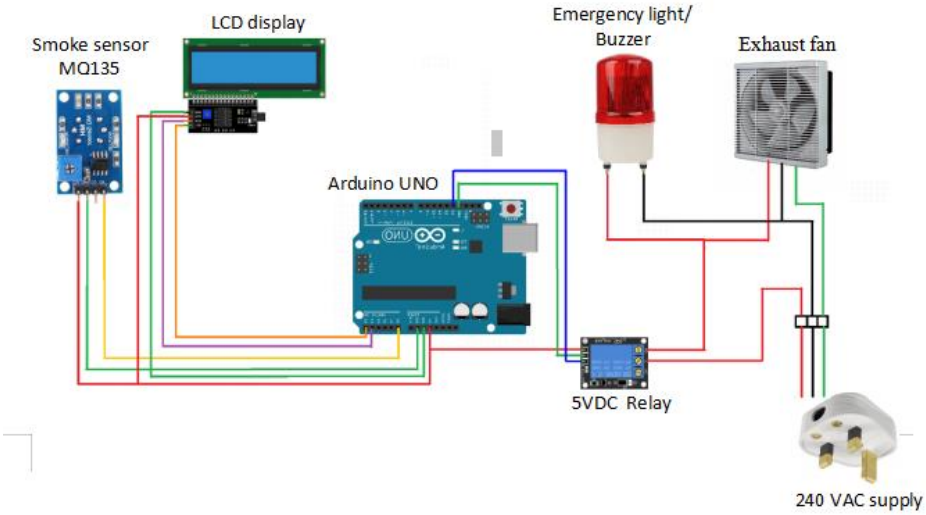

Figure 2: Circuit diagram of proposed system

For the purpose of debugging and monitoring during development, the Serial Monitor on Arduino IDE software acts as a window into the system's operation. It facilitates real-time communication between the Arduino and a connected computer, enabling engineers to assess data flows and system behavior. The Serial Plotter in Arduino offers a visual dimension to data analysis, by creating graphical representations of gas concentration levels over time, providing insights into the trends and fluctuations in indoor gas presence. In the event of gas concentration levels breaching safety thresholds, the 5VDC relay acts as a sentinel – sending commands from the Arduino to the emergency light. This, in turn, triggers a powerful source of illumination, alerting occupants about potential gas leaks and dangers. Simultaneously with the emergency light, the siren unleashes a resonating alarm. The siren sound serves as a forceful call to action, ensuring that occupants are promptly aware of the impending peril. When hazardous gas levels are detected, the exhaust fan springs into action, orchestrated by the Arduino and the 5VDC relay. Its purpose is to facilitate rapid ventilation, dispersing the gas and reducing the threat it poses.

3. Results and Discussion

The prototype had been tested for its functionality of the systems, which detect potentially hazardous gases. This part of study consisted of getting the final input and output from the Arduino UNO shown on the LCD display and on the MATLAB software. Lastly, the MATLAB software was used to analyze the gas concentration level, whose result is displayed in Table 1.

Table 1: Gas Concentration Level

Process	Gas value (PPM)
Input	35 (Normal)
Output	65 (Leak Detected)

Figure 3 (a) and (b) present the LCD segment results of the Gas Detection using Arduino UNO system, obtained from the MATLAB software. Initially, the MQ135 gas sensor detected a gas concentration level of 35 PPM, indicating a normal reading.

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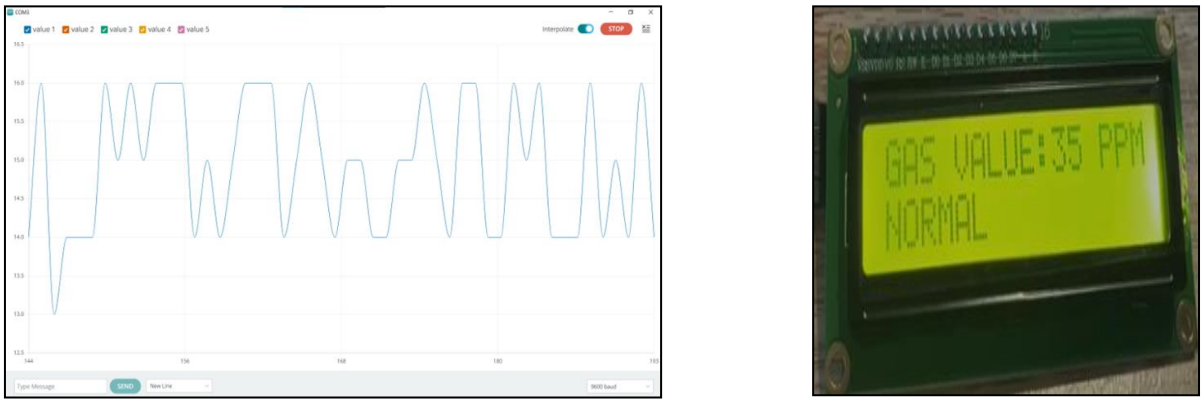
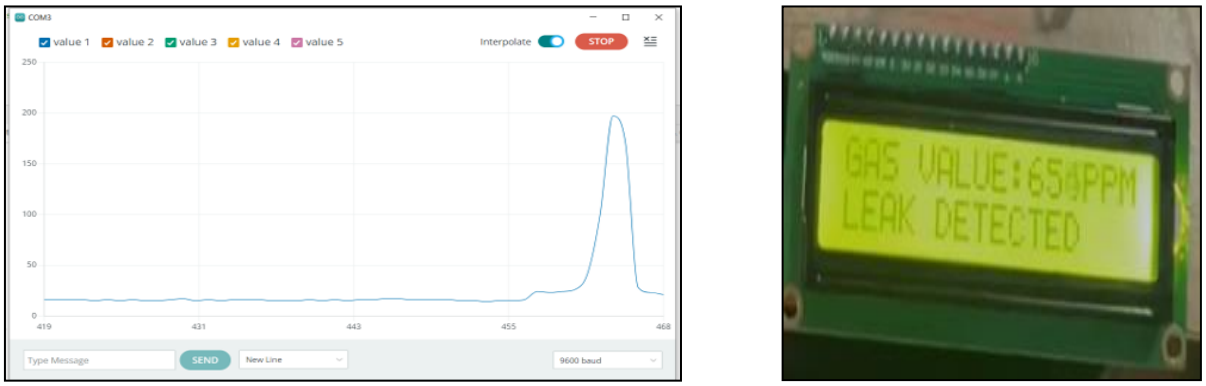


(a) (b)

Figure 3: (a) Data analysis of input and (b) result from LCD display reading of gas value of input

Figure 4 (a) and (b) present another LCD segment results of the Gas Detection using Arduino UNO system obtained from the MATLAB software. Consequently, the MQ135 gas sensor detected a gas concentration level of 65 PPM, indicating a gas leak.



(a) (b)

Figure 4: (a) Data analysis of output and (b) result from LCD display reading of gas value of output

4. Conclusion

In conclusion, the project "Gas Detector using Arduino UNO" has been successfully designed, implemented, and tested, showcasing an effective gas detection system with integrated emergency lighting. The project is aimed to detect the presence of hazardous gas in the environment and provide timely visual and optional audible warnings in the event of a gas leak. Through the utilization of an Arduino microcontroller and gas sensor, the system has demonstrated promising results, and poses potential applications in enhancing safety measures in various settings. Key findings and achievements of the project include:

i. Gas Detection Performance: The gas sensor exhibited reliable gas detection capabilities within the predefined sensitivity range. Proper calibration allowed for accurate and timely responses to hazard gas leaks, ensuring the safety of occupants and property.
ii. Emergency Light Activation: The Arduino-controlled relay module effectively triggered the emergency light, providing a bright visual indication of gas leaks. This immediate warning promptly alerted occupants to take necessary evacuation measures.
iii. Audio Alarm (Buzzer): The inclusion of an audio alarm (buzzer) further enhanced the system's effectiveness by providing an audible warning in conjunction with the emergency light.

The discussion highlights various aspects, including the system's accuracy, sensitivity, response time, safety considerations, and potential improvements. This project has demonstrated the feasibility of using Arduino-

based solutions for safety applications, particularly in gas leak detection scenarios. However, it is essential to recognize certain limitations and areas for future improvement, as follows:

i. Calibration and Sensitivity: Proper calibration of the gas sensor is critical to optimize its performance. Fine-tuning the sensitivity level for specific environments may be necessary to minimize false alarms or ensure timely detection.
ii. Response Time Optimization: Exploring other potential methods to further reduce the system's response time can enhance its ability to detect gas leaks more rapidly, thereby improving safety outcomes.
iii. Integration and Expansion: Exploring integration possibilities with building management systems or smart home setups can enhance the overall functionality and remote monitoring capabilities of the gas detection system.
iv. Safety Compliance: Adherence to safety standards and obtaining relevant certifications may be essential for commercial or industrial deployment.

Overall, the successful implementation of this gas detection system with an emergency light signifies its potential in enhancing safety measures in residential, industrial, and other relevant settings. The outcomes of this project contribute to the broader understanding of gas leak detection technologies, Arduino-based solutions, and safety applications. To maximize the project impact, further experimentation, testing, and refinement are recommended to further validate its reliability and adaptability to diverse scenarios. Moreover, conducting real-world deployment trials and gathering user feedback can provide valuable insights for continuous improvement.

In summary, the "Development of Gas Detector using Arduino Uno" project serves as a valuable foundation for future developments of gas leak detection systems and underscores the significance of technological innovations in promoting safety and security in various environments.

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