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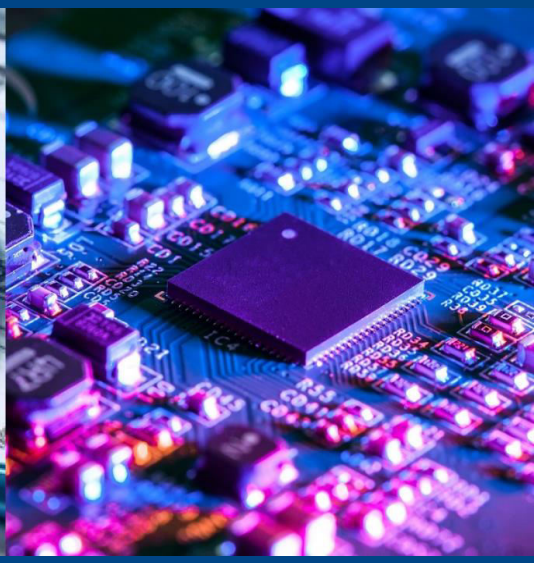

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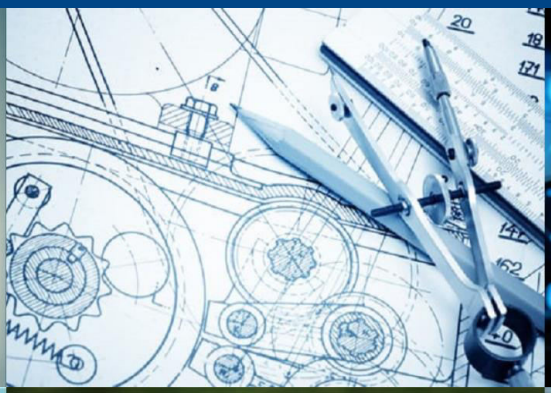

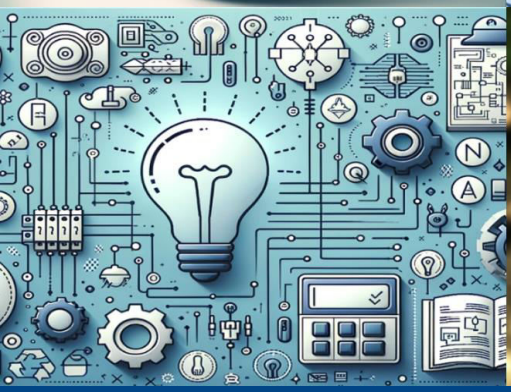

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LPG Gas Leakage Detection System with Auto Cut off Regulator using Arduino

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ABSTRACT: The increasing safety concerns related to LPG (Liquefied Petroleum Gas) usage in households and industries have prompted the need for an efficient gas leakage detection system. This paper presents a design for an LPG gas leakage detection system integrated with an automatic shut-off regulator using an Arduino microcontroller. The system aims to detect the presence of LPG gas leaks and automatically cut off the gas supply to prevent potential hazards, such as explosions or fire accidents. The detection of LPG leakage is achieved through a gas sensor, specifically the MQ-6 sensor, which is capable of detecting the presence of LPG in the air. The sensor outputs an analog signal, which is processed by the Arduino to determine the concentration of gas in the environment. In addition to the detection mechanism, the system also provides visual and audible alerts to inform users of a gas leak. This serves as a secondary safety measure, ensuring that even if the automatic cut-off mechanism fails, the user will be warned in time to take corrective action. The entiresystem is designed to be cost-effective, easy to implement, and reliable, making it suitable for both residential and commercial applications. The integration of the Arduino platform provides flexibility and scalability, allowing for easy modification and customization of the system. This project contributes to enhancing safety measures in environments where LPG is used, reducing the risk of accidents due to gas leaks.

I. INTRODUCTION

Liquefied Petroleum Gas (LPG) is widely used for cooking, heating, and industrial applications due to its affordability and efficiency. However, LPG leakage poses a significant safety risk, as it can lead to fires, explosions, or poisoning when inhaled in high concentrations. Despite advancements in safety regulations, gas leaks still account for a significant number of accidents worldwide. The need for a reliable and cost-effective system to detect gas leaks and prevent catastrophic events has become more crucial than ever. This project introduces an LPG gas leakage detection system integrated with an automatic cut-off regulator, utilizing an Arduino microcontroller. The system aims to enhance safety by detecting the presence of LPG gas leaks and promptly shutting off the gas supply, thereby minimizing the risk of dangerous situations such as fires or explosions. The system consists of an MQ-6 gas sensor, which is sensitive to LPG, and an Arduino board that processes the sensor data. When the gas concentration in the environment exceeds a predefined safe threshold, the system activates an automatic shut-off mechanism connected to a relay that controls the gas valve, ensuring that the gas supply is immediately cut off. Alongside this automatic response, the system also provides visual and audible alerts to warn individuals of a potential gas leak. By integrating these components into a single, cohesive system, this project seeks to provide a comprehensive safety solution for households and commercial establishments. The use of an Arduino microcontroller ensures simplicity, flexibility, and scalability, allowing the system to be easily customized and expanded. With its low cost and efficient operation, this system offers an accessible way to significantly reduce the risk of accidents caused by LPG leaks and improve overall safety in environments where LPG is used.

II. LITERATURE REVIEW

LPG gas leakage detection systems have been a subject of extensive research due to the hazardous nature of LPG, which is highly flammable and poses significant risks in the event of leakage. Several approaches have been proposed and developed over the years to address these safety concerns. This literature review presents an overview of relevant work in the field, focusing on the technologies and methods used for gas detection and automatic shut-off systems.

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a) Gas Detection Technologies:

The detection of gas leakage is a critical component of safety systems. A variety of sensors have been explored for detecting the presence of LPG in the air, with the most common being semiconductor-based, electrochemical, and infrared sensors. Among these, semiconductor sensors such as the MQ series (e.g., MQ-6, MQ-2) are particularly popular due to their low cost, ease of use, and reasonable sensitivity to gases like LPG, methane, and carbon monoxide.

In a study by Patel et al. (2015), the MQ-6 sensor was identified as a reliable and cost-effective choice for detecting LPG gas leaks. The authors noted that the MQ-6 sensor provided a quick response time and good sensitivity to LPG gas, making it suitable for real-time applications. The sensor works by detecting the change in resistance of a sensitive material (usually tin oxide) when exposed to the gas, which can be measured and processed by a microcontroller.

b) Automatic Shut-Off Mechanisms:

Several studies have explored methods for automatically cutting off gas supply once a leak is detected. One approach involves the use of solenoid valves controlled by relays, which can be activated to close the gas line. In research by Singh et al. (2017), an automatic gas shut-off system was designed using a gas sensor and a relay connected to a solenoid valve. This system successfully shut off the gas flow in the event of a detected leak, preventing potential hazards.

Moreover, the integration of automatic shut-off mechanisms with gas detectors has been shown to improve safety. A key advantage of this method is that it offers immediate intervention without requiring human input, which can be critical in preventing accidents. In a project conducted by Verma et al. (2018), a similar system was built using Arduino and a relay-based solenoid valve. Their findings demonstrated that the system successfully detected the gas leak and triggered the shut-off valve, significantly reducing the risk of fire.

c) Integration with Arduino:

The use of Arduino microcontrollers in gas detection systems has gained popularity due to their simplicity, low cost, and flexibility. Arduino boards are widely used for prototyping and automation in various IoT applications, including safety systems. In a study by Kumar et al. (2020), an LPG leakage detection system was developed using an Arduino Uno board, an MQ-6 gas sensor, and a relay module to control a solenoid valve. The system was capable of detecting gas leaks and shutting off the gas supply while also providing real-time notifications through LED indicators and buzzer alarms.

Arduino's versatility allows for easy integration with other components such as GSM modules for remote alerts or Wi-Fi modules for IoT-based solutions. This flexibility makes it an attractive option for designing customized and scalable safety systems.

III. BLOCK DIAGRAM

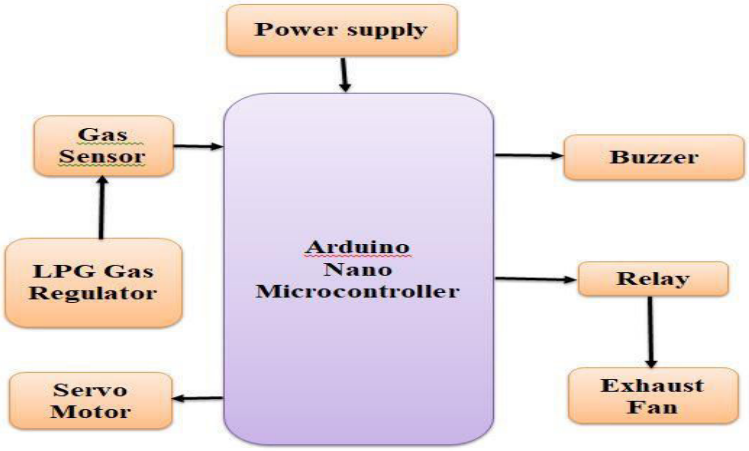

Fig. Block Diagram

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The LPG gas leakage detection system with an auto cutoff regulator using Arduino involves a detailed methodology where an MQ-6 gas sensor is used to continuously monitor the air for the presence of LPG gas. When the gas concentration surpasses a predefined threshold, the sensor sends a signal to the Arduino microcontroller, which processes the data. If a leakage is detected, the Arduino triggers an alarm system, such as a buzzer to alert nearby individuals of the potential danger. Simultaneously, the Arduino sends a command to a relay module connected to an electric valve or regulator that controls the gas supply. The relay, upon receiving the command, activates the valve to automatically shut off the gas flow, preventing further leakage and minimizing the risk of fire or explosion. The system is powered by a suitable power supply and includes safety features like manual override and testing options to ensure reliable operation.

IV. METHODOLOGY

The LPG gas leakage detection system with an auto cutoff regulator using Arduino involves a detailed methodology where an MQ-6 gas sensor is used to continuously monitor the air for the presence of LPG gas. When the gas concentration surpasses a predefined threshold, the sensor sends a signal to the Arduino microcontroller, which processes the data. If a leakage is detected, the Arduino triggers an alarm system, such as a buzzer to alert nearby individuals of the potential danger. Simultaneously, the Arduino sends a command to a relay module connected to an electric valve or regulator that controls the gas supply. The relay, upon receiving the command, activates the valve to automatically shut off the gas flow, preventing further leakage and minimizing the risk of fire or explosion. The system is powered by a suitable power supply and includes safety features like manual override and testing options to ensure reliable operation.The LPG leakage detection system with an auto cut-off regulator using Arduino works on the principle of detecting the presence of LPG gas and automatically shutting off the gas supply to accidents

A) Working Principle :

The LPG Gas Leakage Detection System with an auto cut-off regulator using Arduino is designed to detect the presence of an LPG gas leak in a specific environment and take corrective actions to prevent accidents. The system consists of a gas sensor, an Arduino microcontroller, a relay module, a solenoid valve, and a buzzer for alarms.

B) Detection of LPG Gas:

The system uses an LPG gas sensor (like the MQ-6 or MQ-2) that detects the concentration of LPG in the air. The sensor works by measuring the conductivity between two electrodes. The gas molecules (such as LPG) affect the sensor's conductivity, which results in an analog voltage output. The analog output of the sensor is read by the Arduino's analog input pin (e.g., A0). The Arduino continuously monitors this value to detect any abnormal increase in gas concentration.

C) Gas Concentration Analysis:

The Arduino receives the sensor data in the form of an analog value that corresponds to the concentration of LPG gas in the air. This analog value is compared to a predefined threshold value (which can be adjusted based on the sensitivity of the sensor and the environment). For example, a threshold of 300 can be set to trigger the system when the gas concentration exceeds a certain level. If the gas concentration exceeds the threshold, it indicates that there is a gas leak present.

D) Triggering the Auto Cut-Off Mechanism:

Once the gas concentration exceeds the set threshold, the Arduino triggers the relay module to cut off the gas supply by closing the solenoid valve. The solenoid valve acts as an electronic valve that controls the flow of gas. When the relay sends a signal to close the solenoid valve, the gas flow is cut off, preventing further leakage or accumulation of gas in the environment.

E) Activating the Alarm System:

At the same time, the Arduino triggers the buzzer to emit a loud sound, alerting people in the vicinity of the potential danger (gas leak). This alarm provides an audible warning so that necessary actions can be taken quickly to address the situation.

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F) Returning to Normal Operation:
After the system has detected and mitigated the gas leak (i.e., cut off the gas supply and activated the alarm), the sensor continues to monitor the air for gas concentration. Once the gas concentration returns to normal levels, the Arduino signals the relay to open the solenoid valve, allowing the gas supply to resume. The buzzer is turned off, and the system returns to its normal monitoring mode.

G) Activating the Alarm System:
At the same time, the Arduino triggers the buzzer to emit a loud sound, alerting people in the vicinity of the potential danger (gas leak).This alarm provides an audible warning so that necessary actions can be taken quickly to address the situation.

H) Returning to Normal Operation:
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V. RESULT

The LPG Gas Leakage Detection System is designed to improve safety by automatically detecting gas leaks, cutting off the gas supply, and alerting people nearby to avoid any potential risks associated with gas leaks, such as fire or explosion. The system's operation, as well as the outcome of its implementation, can be summarized as follows:

1. Gas Leak Detection:
The LPG gas sensor (MQ-6 or MQ-2) continuously monitors the air for the presence of LPG gas. The sensor provides an analog output that corresponds to the concentration of gas in the air. When a gas leak occurs and the concentration of LPG exceeds the threshold set by the system, the Arduino detects this change in sensor output. The Arduino processes the sensor data and activates the appropriate actions based on the gas concentration. If the gas concentration is above the threshold, it determines that a gas leak is present.

2. Automatic Gas Cut-Off:
Upon detecting a gas leak, the Arduino triggers the relay module, which controls the solenoid valve. The relay cuts off the gas supply by closing the solenoid valve, which prevents the further release of LPG gas. This automatic shutdown of the gas supply ensures that gas leakage does not continue, thus reducing the risk of fire or explosion. The system also ensures that the gas supply can be automatically restored once the gas concentration returns to a safe level (i.e., when the leak is resolved and the gas concentration falls below the threshold).

3. Alert System (Buzzer):
The buzzer is activated simultaneously with the gas shut-off process. It provides a loud sound, alerting people in the vicinity of the gas leak.
This alert gives individuals time to react quickly to the situation, evacuate if necessary, and address the cause of the leak. The buzzer will remain on as long as the gas concentration exceeds the threshold, providing a continuous warning until the gas levels return to normal.

4 . System Reset:
When the gas concentration drops back to a safe level, the Arduino automatically resets the system. It opens the solenoid valve, restoring the gas supply to the environment. The buzzer is turned off, and the system enters its normal operating mode, ready to detect any future gas leaks.

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VI. CONCLUSION AND FUTURE WORK

LPG Gas Detector with Auto Cut-off using Arduino includes the integration of multi-gas detection to detect gases like methane, carbon monoxide, and natural gas. Advancements in sensor technology could improve accuracy and sensitivity, reducing false alarms and enhancing reliability. The system could also benefit from cloud-based data logging for real-time monitoring, predictive maintenance, and analytics. Further integration with IoT devices could enable automatic responses, such as activating ventilation systems or sending alerts. Additionally, user-friendly installation and battery-powered models would increase accessibility, while reducing production costs could make the system more affordable for a broader audience. These improvements could make the system a more versatile and accessible safety solution

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