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Survey on Real-Time Gas Leak Detection and Prevention System with IoT

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ABSTRACT

Gas leaks, particularly involving LPG, pose severe safety hazards in homes,industries, and commercial spaces, leading to potential explosions, fires, and health risks. Traditional gas leak detection systems often lack automation and remote monitoring, leaving gaps in timely intervention. This project addresses these issues by designing a comprehensive **Gas Leakage Detection and Prevention System** using IoT. The **MQ6 gas sensor** is employed for accurate real-time detection of gas leakage, while an **ESP32 microcontroller** processes the data and triggers a **relay module** to shut off the gas supply via a **solenoid valve** in the event of a leak. The system provides local alerts through a **buzzer** and **LED indicator,** while displaying gas concentration and leakage status on an **LCD display.** The integration of the **Blynk IoT platform** allows users to monitor gas levels remotely and receive alerts on their mobile devices. Key

findings from the system's implementation demonstrate its ability to automatically prevent gas leaks and enable timely responses. The project offers a scalable, cost-effective solutionfor enhancing gas safety, with applications in residential, commercial, and industrial settings. In conclusion, this system significantly improves gas leakage prevention by combining automation, real-time monitoring, and remote access for enhanced safety and control.

Key words

Gas Leakage detection, LPG, IoT, ESP32, MQ6gas sensor,relay module,solenoid valve,Blynk IoT platform,remote monitoring,gas safety.

1.INTRODUCTION

The proposed IoT-based system is designed to proactively safeguard against the potentially catastrophic consequences of LPG gas leaks. By seamlessly integrating advanced gas sensing technology, a robust microcontroller, and precise actuators, this system offers a comprehensive solution for early detected, the system

initiates a multi-layered safety protocol: a high-decibel alarm is activated, the gas supply is automatically and securely shut off, and real-time notifications are dispatched to designated devices. This proactive approach empowers users with essential information, providing them with ample time to evacuate and take necessary precautions.

Beyond immediate safety measures, the system's data collection and analysis capabilities enable valuable insights into gas consumption patterns, potential leak sources, and overall system performance. By leveraging these insights, users can optimize gas usage, identify maintenance needs, and implement targeted preventive measures. Furthermore, the system's remote monitoring and control features enhance convenience and peace of mind, allowing users to stay informed about the status of their gas supply and take corrective actions from anywhere.

The primary objectives of the research include designing a system that:

- Detects LPG gas leaks using an **MQ6 sensor.**
- Automatically shuts off the gas supply using a **relay module** and **solenoid valv.**
- Provides immediate alerts through **buzzer** and **LED indicators,** and
- Facilitates remote monitoring via the **Blynk IoT platform.**

2. LITERATURE SURVEY

SR	AUTHOR	TITLE	DESCRIPTION
1	Bhagyashree,Dharaskar, Alkesh Gaigawali, Sahil,Meshram, Ayush Tembhurne, Abhishek Gautam,,Aman Nanhe	LPG Gas Leakage Detection and Alert System (2023).	The project proposes a wireless and GSM gas leakage detection system for households and industries to prevent accidents, fires, and explosions.
2	]. G. N. Sai, K. P. Sai, K. Ajay and P. Nuthakki	Smart LPG Gas Leakage Detection and Monitoring System (2023).	A cloud-based IoT system is proposed to detect and minimize gas leaks in LPG gas, using a gas sensor MQ-2 connected to a NodeMCU. The system sends alerts to the user's smartphone and triggers an alarm.
3	L. Dewi and Y. Somantri	Wireless Sensor Network on LPG Gas Leak Detection & Automatic Gas Regulator System Using Arduino (2018).	A cloud-based IoT system is proposed to detect and minimize gas leaks in LPG gas, using a gas sensor MQ-2 connected to a NodeMCU. The system sends alerts to the user's smartphone and triggers an alarm.

3. PROJECT SCOPE

1.Real-time gas concentration monitoring and visualization: Continuously measure and display LPG gas levels in the environment in an easily understandable format, providing users with immediate awareness of gas conditions.

2.Automatically shut off the gas supply when gas concentration exceeds a predefined safe threshold, incorporating redundant safety measures to prevent accidental or malfunction-induced gas leaks.

3.Remote monitoring and control with user-friendly interface: Enable users to monitor gas levels and system status, and remotely control the gas regulator, through an intuitive IoT platform interface.

4.Comprehensive user alerts and notifications: Send timely and informative notifications to the user via the IoT platform or SMS in case of gas leaks, system malfunctions, or low battery levels, ensuring prompt response to critical situations.

5.Advanced data logging, analysis, and reporting: Store gas concentration data for in-depth analysis, generating insightful reports on gas usage patterns, leak trends, and system performance, facilitating proactive maintenance and optimization.

4.component of project

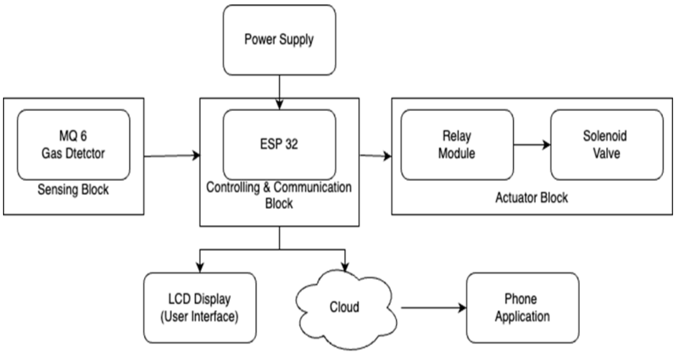
Sensor Calibration: The LPG gas sensor's output is typically an analog voltage that varies with gas concentration. To establish a quantitative relationship between sensor output and gas concentration, a calibration curve is required. This curve is generated by exposing the sensor to known gas concentrations and recording the corresponding sensor output voltages. Once calibrated, the sensor's output can be accurately converted into gas concentration

Gas Concentration Calculation: After the calibration curve is established, the microcontroller can use it to convert the real-time sensor output into gas concentration. This involves interpolating or fitting the calibration data to a suitable mathematical model, such as a linear or polynomial equation. The calculated gas concentration is then compared to the predefined threshold to determine if any action is required.

Threshold Determination: The gas concentration threshold is a critical parameter that defines the safe limit for gas exposure. It should be set based on safety standards and recommendations, considering factors like the type of gas, ventilation conditions, and occupancy levels. The system should incorporate flexibility to allow users to adjust the threshold based on their specific requirements

Working of project

Block diagram :



Process : The system operates in a continuous monitoring cycle. At its core, the LPG gas sensor diligently measures the gas concentration in the surrounding environment, transmitting the gathered analog data to the ESP32 microcontroller. This data undergoes meticulous processing within the microcontroller, transforming it into a meaningful gas concentration value through the application of the previously established calibration curve. The calculated gas concentration is then subjected to a rigorous comparison against the predefined safety threshold.

Should the gas concentration surpass the established threshold, indicating a potential gas leak, the microcontroller swiftly activates the motor driver, which in turn energizes the DC motor. The motor's precise operation controls the mechanism that decisively shuts off the gas regulator, effectively stemming the flow of gas and mitigating the risk of leakage. Simultaneously, the system proactively alerts the user via the Blynk IoT platform, delivering a timely notification regarding the detected gas leak and the subsequent automatic shutoff action.

To empower users and ensure a comprehensive safety framework, a manual override feature is thoughtfully integrated. This provision grants users the ability to temporarily suspend the automatic shutoff mechanism, facilitating tasks such as manual gas leak inspections or routine maintenance. However, it is imperative to emphasize the paramount importance of reinstating the automatic shutoff function upon task completion to uphold the system's safety integrity.

DEPENDENCIES

Hardware:

ESP32 microcontroller: This versatile and powerful microcontroller serves as the system's central processing unit. It handles data acquisition from the LPG sensor, decision-making based on gas concentration levels, control of the motor driver, and communication with the Blynk IoT platform.

LPG gas sensor: This critical component detects the presence and concentration of LPG gas in the surrounding environment. The sensor's output, typically an analog voltage, is processed by the microcontroller to determine the gas level.

DC motor: Responsible for actuating the gas regulator on/off mechanism. The motor's speed and direction are controlled by the motor driver to ensure precise and reliable operation.

Motor driver: This electronic circuit interfaces between the microcontroller and the DC motor, providing the necessary power amplification and control signals to drive the motor accurately.

Power supply: A stable and reliable power source is essential for the system's operation. It supplies electrical energy to all components, including the microcontroller, sensors, motor driver, and wireless communication module.

Gas regulator: The core component of the LPG system, the gas regulator controls the flow of gas to appliances. The system's automatic shutoff mechanism interacts with this regulator to prevent gas leakage.

Blynk compatible IoT shield (optional): This shield simplifies the integration of the ESP32 with the Blynk IoT platform, providing a convenient way to establish wireless communication and enable remote monitoring and control.

Software:

Arduino IDE: A widely used integrated development environment (IDE) for programming the ESP32 microcontroller. It provides a user-friendly interface for writing, compiling, and uploading code to the device.

Blynk IoT platform: A cloud-based platform that enables remote monitoring, control, and data visualization. It provides a mobile app and web interface for users to interact with the system.

Required libraries: A collection of software libraries is necessary for various functionalities. These include libraries for Wi-Fi connectivity, Blynk integration, motor driver control, sensor data processing, and other essential tasks.

LIMITATIONS

The system's effectiveness hinges on the accuracy and reliability of the LPG gas sensor, which can be influenced by environmental factors such as temperature and humidity. Additionally, the system relies on a stable power supply to ensure uninterrupted operation. The motor driver and DC motor components may have inherent limitations in terms of torque and speed, potentially affecting the system's ability to handle specific gas regulator configurations. Moreover, the accuracy of gas concentration measurements can be impacted by factors like sensor calibration and potential interferences from other gases. Regular maintenance and calibration are crucial to maintain the system's performance and reliability.

FUTURE SCOPE

1) Enhanced Sensor Fusion: Integrating additional sensors such as temperature, humidity, and fire detectors can provide a more comprehensive environmental monitoring system. This data can be used to improve gas leak detection accuracy, predict potential hazards, and enable proactive safety measures.

2) Advanced User Interface: Developing a dedicated mobile app would enhance user interaction and accessibility. The app could provide real-time gas level visualization, remote control functionalities, and customizable alerts.

3) Predictive Maintenance: Implementing machine learning algorithms to analyze sensor data patterns can enable predictive maintenance for system components. This would optimize system reliability and reduce downtime by anticipating potential failures.

4) Multi-Gas Detection: Expanding the system to detect multiple gases would increase its versatility and applicability in various industrial and commercial settings. This would require the integration of additional gas sensors and corresponding data processing algorithms.

5) Cloud-Based Data Management: Storing sensor data and system logs in the cloud would enable long-term data analysis, trend identification, and remote troubleshooting. This would also facilitate data sharing and collaboration between system users and maintenance personnel.

6) Emergency Response Integration: Integrating the system with emergency response services could streamline incident handling and improve response times. This would involve developing protocols for automatic emergency notifications and data sharing with relevant authorities.

CONCLUSION

Gas Leakage Detection and Prevention System represents a significant advancement in safety technology by integrating real-time gas detection with automated prevention mechanisms and remote monitoring. The key takeaways from the project include theThe effective utilization of MQ6 gas sensors and ESP32 microcontrollers to detect and respond to LPG gas leaks, the importance of combining local alerts with automated shutoff systems, and the benefits of IoT integration through platforms like Blynk for enhanced remote monitoring and control.

The implications for future research involve further improving sensor accuracy, expanding the integration of these systems into broader smart home and industrial automation frameworks, and exploring the potential of artificial intelligence to enhance predictive maintenance and reduce false alarms. Practical applications could extend to various settings, from residential buildings to large-scale industrial facilities, contributing to safer environments and more effective emergency response protocols.

In summary, this project's contribution lies in demonstrating a scalable and user-friendly approach to gas safety that effectively combines automation with real-time monitoring. It sets a foundation for future innovations in gas detection technology and highlights the importance of integrating modern IoT solutions to address critical safety challenges.

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