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ADVANCED GAS LEAKAGE DETECTION SYSTEM

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ABSTRACT

This paper presents the design and implementation of an advanced gas leakage detection system that leverages IoT technologies and precise sensors for enhanced safety in industrial and residential applications. The system integrates an ESP32 microcontroller, MQ2 gas sensors, and the Blynk IoT platform for real-time monitoring, automated alerts, and safety measures. Key features include continuous gas concentration monitoring, immediate notifications, and remote accessibility. Testing results demonstrate the system's efficiency, scalability, and robustness, offering a cost-effective and reliable solution to prevent gas-related hazards.

Keywords: Gas Leakage Detection, Iot, MQ2 Sensors, ESP32, Real-Time Monitoring, Automated Alerts, Safety Systems.

1. INTRODUCTION

Gas leakage incidents pose severe safety risks in industrial and residential environments, often leading to catastrophic consequences. Traditional detection systems relying on manual intervention or wired sensors are limited by their lack of flexibility and delayed responsiveness. Leveraging advancements in IoT, this project introduces a wireless gas leakage detection system that enhances safety through automated alerts and real-time data visualization.

This study emphasizes the need for robust, scalable, and cost-effective systems capable of addressing limitations in existing setups. Our proposed system demonstrates significant improvements in monitoring and hazard prevention, with applications ranging from homes to large industrial facilities.

2. METHODOLOGY

The system employs MQ2 sensors and an ESP32 microcontroller to detect gas levels and trigger threshold-based alerts. Data is transmitted to the Blynk IoT platform for real-time monitoring and remote control. Implementation involves sensor calibration, integration with IoT dashboards, and testing under varying conditions.

2.1 System Architecture

The system integrates hardware components, including MQ2 gas sensors, an ESP32 microcontroller, a relay module, and a servo motor, with IoT-based monitoring via the Blynk platform. The architecture ensures:

- Real-time data acquisition from sensors.
- Threshold-based alerts to notify users.
- Activation of safety mechanisms such as alarms and ventilation systems.

2.2 Data Flow

Data from MQ2 sensors is processed by the ESP32 microcontroller, which triggers alarms when gas concentrations exceed predefined thresholds. Simultaneously, the system transmits data to the Blynk platform for remote monitoring and control.

2.3 Implementation

The system employs the Arduino IDE for programming and integrates various libraries, including Blynk and ESP32 Servo. Key implementation steps include:

- Sensor calibration to ensure accuracy.
- Integration with the Blynk IoT platform for real-time visualization.
- Testing under various environmental conditions to validate reliability.

2.4 Data Flow Diagram

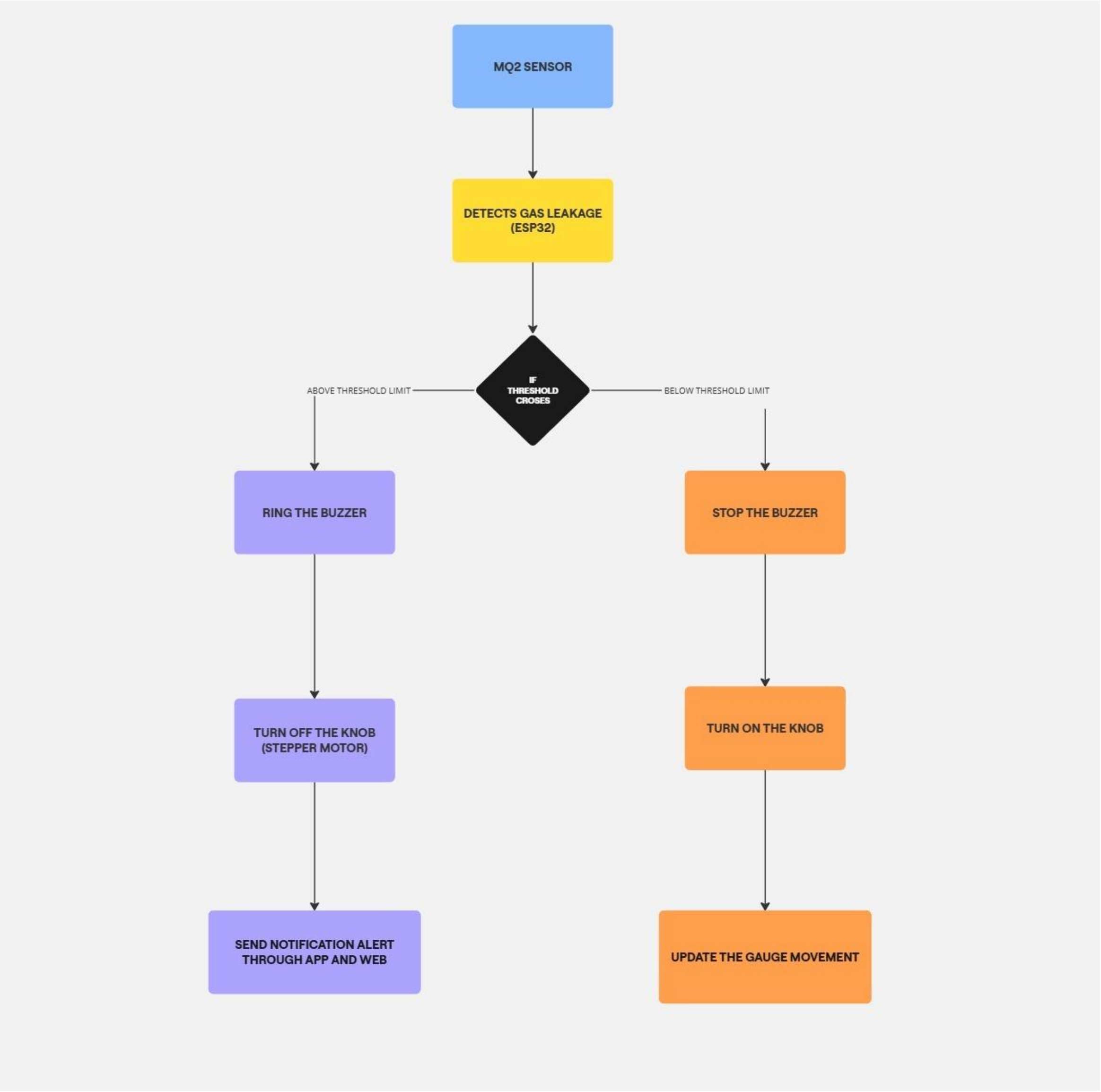

Figure 1: Dataflow diagram.

3. RESULTS AND DISCUSSION

3.1 System Performance

The system was tested under controlled conditions to evaluate its sensitivity and responsiveness. Key findings include:

- Real-time alerts triggered within 1 second of threshold breaches.
- Accurate detection of LPG and methane gases.
- Reliable remote monitoring via the Blynk app.

3.2 Comparative Analysis

Compared to traditional systems, the proposed model exhibits:

- Enhanced scalability for industrial and residential applications.
- Reduced false alarm rates due to precise sensor calibration.
- Lower installation and maintenance costs.

3.3 Limitations

While the system demonstrates robust performance, it is reliant on stable internet connectivity and periodic sensor maintenance to sustain accuracy.

3.4 Future Scope

Future enhancements include:

- Support for multi-sensor arrays to detect a broader range of gases.
- Cloud-based data analytics for predictive maintenance.
- Integration with smart assistants for voice alerts and advanced user interaction.
- Expanded applications in automotive safety and environmental monitoring.

4. CONCLUSION

This study presents a cost-effective and reliable gas leakage detection system with IoT integration for real-time monitoring and hazard prevention. By addressing limitations in traditional systems, our approach enhances safety standards in various settings. Future work will focus on expanding system capabilities and refining user interaction.

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