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AUTOMATED GAS LEAK DETECTION AND ALERT SYSTEM FOR SMART HOMES

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ABSTRACT

Effective management and safety measures for natural gas are critical in modern urban environments, where liquified petroleum gas (LPG) is widely used in homes and industries. However, LPG leaks can lead to severe consequences, including explosion risks, health hazards, and environmental damage. This study presents a novel IoT-enabled LPG leakage detection system designed to enhance safety and responsiveness. The system leverages gas sensors, microcontrollers, and wireless communication modules for continuous, real-time monitoring of LPG concentrations. When a leak is detected, it promptly sends alerts through a mobile application or other communication channels, enabling rapid evacuation and response. The IoT-based architecture supports remote monitoring, real-time data analysis, and record-keeping for improved safety management. Experimental setups simulating various leakage scenarios demonstrate the system's reliability and accuracy in gas leak detection. By incorporating IoT technology, this approach significantly enhances response times and provides insights for preventive maintenance. This adaptable solution represents a substantial advancement in gas leak detection, offering scalable safety improvements for residential and industrial applications.

Keywords: IOT LPG Leakage Detection, Iot-Based Safety Systems, Natural Gas Safety, Gas Sensors, Remote Monitoring, Wireless Communication Modules.

I. INTRODUCTION

The IoT-Based System for Detecting Gas Leaks is an advanced safety solution designed to monitor and manage gas leaks in various environments, including residential, commercial, and industrial settings. This system integrates multiple components to create a robust and responsive gas detection network. At its core is an nodeMCU , which processes data from an MQ gas sensor. This sensor is crucial for detecting the concentration of gases in the air, providing the Arduino with real-time measurements.

When the MQ sensor identifies a gas concentration that exceeds a predetermined safety threshold, the Arduino takes immediate action. It activates a relay module connected to an exhaust fan, which is designed to ventilate the area by removing the gas and reducing its concentration. Additionally, the system inculcates a servo motor that is used to open or close a mechanical valve or vent, further enhancing the ventilation process and ensuring that gas is efficiently cleared from the environment.

II. METHODOLOGY

NodeMCU Module Setup: The NodeMCU ESP8266, with its integrated Wi-Fi capabilities, serves as the primary controller, connecting to sensors and handling data transmission. Program the NodeMCU using the NodeMCU(ESP8266) IDE to facilitate data collection, process sensor readings, and transmit information to a remote monitoring platform.

Sensor Module Integration: Integrate MQ gas sensors (e.g., MQ-2 or MQ-7) with the NodeMCU to detect specific gas concentrations. Calibrate the sensor to establish accurate baseline readings, as its resistance changes with gas exposure. This configuration provides real-time data on gas levels, which the NodeMCU processes for further action.

Relay Module Configuration: Connect a relay module to the NodeMCU, linking it to high-power devices like exhaust fans. The relay activates based on sensor input, enabling the fan to ventilate the area when gas levels exceed a set threshold. This electrical isolation ensures safe and efficient control of the exhaust fan by the low-power NodeMCU.

Servo Motor Setup: Install a servo motor to control mechanical vents or valves in the system. Program the NodeMCU to send PWM signals to the servo, which adjusts the vent position based on gas concentration. This step allows for precise airflow control, further enhancing ventilation and safety during gas leaks.

Buzzer Alarm Integration: Add a buzzer module to serve as an immediate auditory alert system. Program the NodeMCU to activate the buzzer when gas levels rise above safe limits, providing a loud and clear warning to nearby individuals to take immediate safety precautions.

Exhaust Fan Control

Connect the exhaust fan to the relay module to automatically activate upon detecting high gas levels. The fan expels the accumulated gas from the area, preventing the risk of harmful gas buildup and promoting safer air quality.

III. MODELING AND ANALYSIS

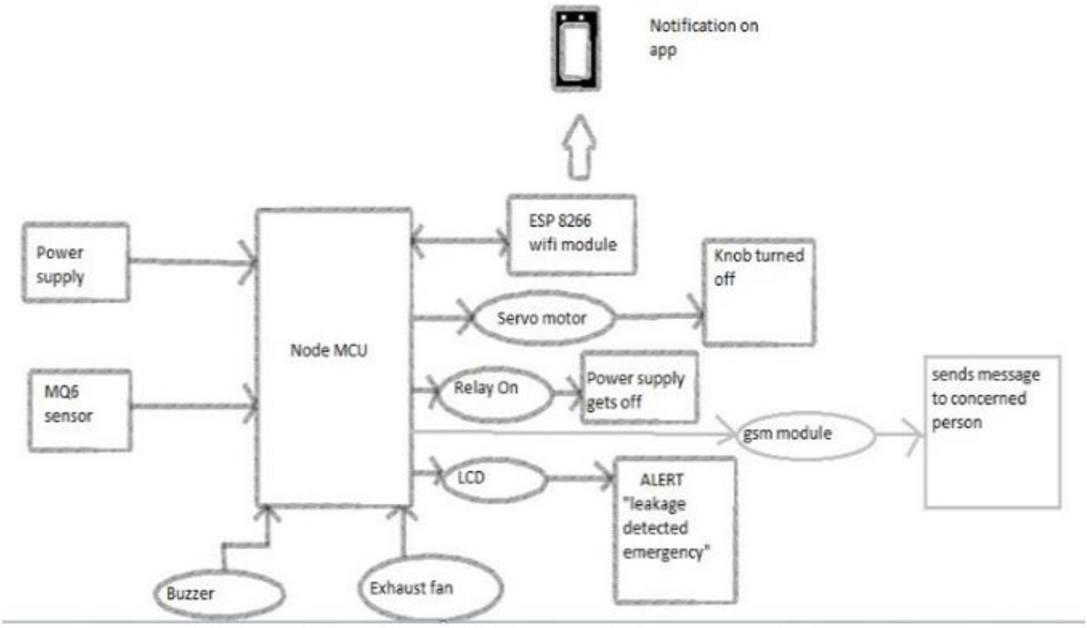

Figure.1 Shows the architecture of the proposed system

The block diagram of an IoT-Based Gas Leakage Detection System illustrates the flow and interaction of various components. Gas sensors, such as MQ-2 or MQ-7, detect the presence and concentration of specific gases and provide analog signals. These impulses are transformed into digital data by an Analog-to-Digital Converter (if necessary).

The microcontroller receives this digital data, processes it, and performs analysis by comparing gas levels to predefined safety thresholds. When hazardous gas levels are detected, the microcontroller activates the relay module, which controls high-power devices like the exhaust fan to ventilate the area. Additionally, the microcontroller triggers the buzzer to provide an audible alert. If the system includes a servo motor, it adjusts mechanical systems such as vents or valves based on commands from the microcontroller.

The Wi-Fi module, such as the ESP8266, enables communication with external networks. It sends real-time data to cloud platforms or applications for mobile devices that allow for remote monitoring and control and receives commands from these platforms. The cloud platform or a mobile application offers users with real-time updates, system status, and notifications.

The user interface, either web-based or mobile, displays the current data and alerts, allowing users to interact with and manage the system remotely. The entire system is powered by a power supply that ensures all components function correctly.

IV. RESULTS AND DISCUSSION

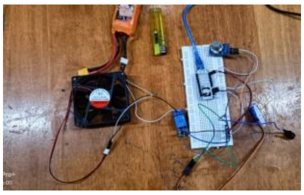

Figure 2: Model

The IoT-Based Gas Leak Detection System combines advanced sensor technology, automated response mechanisms, and remote monitoring to create a comprehensive safety solution. By providing real-time detection, automated ventilation, and remote alerts, this system enhances safety and operational efficiency, making it an asset for any environment where gas leaks are a concern.

Recent advancements in Internet of Things (IoT) technology provide a promising avenue for enhancing LPG leak detection systems. IoT enables the integration of smart sensors, microcontrollers, and communication networks to create a robust and adaptive monitoring system. By leveraging IoT components, possibilities of achieving continuous, real-time detection and alerting of LPG leaks, significantly improving safety outcomes.

V. CONCLUSION

The IoT-Based Gas Leakage Detection System represents a significant advancement in ensuring safety and enhancing environmental monitoring. This system integrates a suite of sophisticated components to provide a robust solution for detecting and responding to hazardous gas leaks in real-time. At the core of the system are MQ series gas sensors, such as the MQ-2 and MQ-7, which continuously monitor the air for gases like methane, propane, and carbon monoxide. These sensors provide essential data on gas concentrations through analog signals that are processed by a central microcontroller.

The microcontroller, which may be an Arduino or an ESP8266 NodeMCU, plays a crucial part in interpreting this sensor data. It processes the signals to determine if the gas levels exceed predefined safety thresholds. When hazardous levels are detected, the microcontroller triggers a series of actions: activating a relay module to turn on an exhaust fan for ventilation, sounding a buzzer to alert individuals, and possibly adjusting mechanical systems using a servo motor.

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