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GAS LEAKAGE AND GAS LEVEL INDICATOR

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ABSTRACT

Home fires have been increasing, posing a significant risk to both human lives and properties. Liquefied petroleum gas (LPG), known for its high flammability, can ignite even at a distance from a leak. Many fire incidents are attributed to poor-quality rubber tubing or failure to turn off the regulator when not in use. Thus, creating an effective gas leakage alert system is essential. This paper introduces a gas leakage alert system designed to detect gas leaks and warn nearby individuals. The system utilizes a gas sensor to detect gases such as LPG, methane, and propane, and a weight sensor to monitor the gas cylinder level (Subramanian et al., 2020). When a gas leak is detected, the system activates an alarm to alert occupants and automatically shuts off the gas supply (Chafekar et al., 2018).

KEYWORDS

Liquid petroleum gas, Gas sensor, Leakage detection, Monitoring system, Automatic gas shut-off.

1. INTRODUCTION

Gas leaks can cause significant accidents, resulting in both property damage and human injuries. The risks associated with gas leaks, including explosions, fires, and suffocation, depend on their physical properties like toxicity and flammability. Recently, there has been a rise in fatalities due to gas cylinder explosions. These incidents are often the result of substandard cylinders, aged valves, worn-out regulators, and a lack of awareness regarding proper gas cylinder handling. Liquefied Petroleum Gas (LPG) or propane, a flammable hydrocarbon gas mixture, is commonly used as fuel in homes, hostels, industries, automobiles, and other vehicles due to its high energy content, low smoke and soot production, and relatively low environmental impact. Natural gas is another widely used household fuel. Both gases burn cleanly, but a 1996 study by E. Jebamalar Leavline et al. emphasizes the serious leakage problems associated with them. These gases, being heavier than air, do not disperse easily, posing suffocation risks and potential explosions. The rise in LPG-related fatalities underscores the necessity of an effective LPG leak detection system. Detecting gas leaks involves identifying hazardous leaks with various sensors. Several innovative LPG detection and alert systems have been outlined in existing literature. For example, Apeh et al. introduced a sophisticated kitchen gas leakage detection and automatic shut-off system. while T. Soundarya et al. introduced a cylinder LPG gas leakage detection system. Moreover, gas detectors utilizing wireless and GSM technology have also been suggested. This paper presents an LPG leakage detection and alert system designed to prevent fire accidents and improve household safety.

2. LITERATURE REVIEW

Liquefied Petroleum Gas (LPG) is a mixture of gases used in heating appliances, cooking equipment, and as a vehicle fuel, commonly known as Autogas. Since LPG is naturally odorless, ethyl mercaptan

is added to it to help detect leaks by smell, enhancing safety. LPG is predominantly sourced from fossil fuels, being produced through the refinement of petroleum or wet natural gas during the crude oil refining process.Due to its explosive potential when pressurized, LPG is classified as a hazardous material and can cause fire explosions if mishandled.

Initially, gas detection relied on chemically infused paper that changed color upon exposure to gas. With technological advancements, electronic gas detectors were developed, offering a proactive approach to early fault detection and improving safety for both people and property. An Android-based automatic gas detection system was later introduced to further bolster safety measures. Over the years, various gas detection methods have been researched and implemented, including optical sensors, cable sensors, negative pressure methods, vapor sampling, signal processing, mass volume analysis, and pressure point analysis.

Researchers have categorized these technologies into software and hardware methods, with ongoing research leading to three main approaches:

2.1 The "FPGA-GSM Based Gas Leakage Detection Method" study implemented a simple, yet effective system using an FPGA and MQ6 sensor to detect LPG leaks. The system promptly alerts the first response team via GSM for immediate action. However, it lacks remote monitoring capabilities and automatic gas supply shut-off mechanisms.

2.2 The "Embedded Real-Time System for Gas Leakage Detection" involves deploying sensor nodes within households to communicate with a central node. In the event of a gas leak, an alarm is activated and relevant personnel are notified via text messages using the MAC address of each sensor unit's RF module. Additionally, this system integrates exhaust fans to expel leaked gas and mitigate risks. However, its primary focus is on minimizing potential disasters rather than preventing them entirely through gas supply shutdown mechanisms.

3. COMPONENTS

1.Microcontrollers Arduino Uno 2. Crystal 16 MHz 3.LCD 16X2 LCD 4. WIFI module ESP8266 5. Load cell ADC output 0-5V 6.Buzzer DC 5V 7.Fire sensor IR based 8. Smoke sensor MQ series 9. Power Source 12V, 1 amp DC adaptor 10. Gas sensor MQ series 11. Arduino IDE

3.1 Microcontrollers Arduino Uno: The Arduino Uno Rev. 3 Microcontroller Board is built around the ATmega328 8-bit Microcontroller from Microchip Technology. It features 14 digital input/output pins.

3.2 Crystal 16 MHz: This oscillator is widely used in various consumer electronics, including microprocessors and microcontrollers.

3.3 LCD: Liquid Crystal Displays (LCDs) control light passage through liquid crystals to create images when an electric current is applied.

3.4 WiFi Module ESP8266: The ESP8266 WiFi Module is a self-contained System on Chip (SOC) with an integrated TCP/IP protocol stack, enabling any microcontroller to connect to a WiFi network.

3.5 Load Cell ADC Output 0-5V: A load cell is an electro-mechanical sensor designed to measure force or weight, utilizing the relationship between applied force, material deformation, and electrical flow.

3.6 Buzzer DC 5V: A direct current buzzer that operates at 5V.

3.7 Fire Sensor IR-Based: This module detects flames within the 760–1100 nanometer wavelength range.

3.8 Smoke Sensor MQ Series: The MQ-2 sensor from Winsen can detect smoke and combustible gases in the range of 300–10,000 ppm.

3.9 Power Source 12V, 1 Amp DC Adaptor: This high-quality 12V 6A AC-DC switching power supply module operates within an input voltage range of 110–245VAC, providing a constant output of 12V and up to 6A of current.

3.10 Gas Sensor MQ Series: Gas sensors, or gas detectors, are electronic devices that detect and identify various types of gases, commonly used for detecting toxic or explosive gases and measuring gas concentrations.

3.11 Arduino IDE: The Arduino Integrated Development Environment (IDE) is a user-friendly and straightforward programming environment with a community-driven system, simplifying the coding of websites and applications.

4. PROPOSED SYSTEM

The Arduino system calculates the weight of the cylinder, which is directly proportional to the gas level—higher weight indicates a fuller cylinder and vice versa. Additionally, the Arduino monitors the status of gas and fire sensors. It displays all sensor data on an LCD and sends this information to an IoT cloud server at 30-second intervals. If the smoke or fire sensors are triggered, the data is also immediately transmitted to the server. The transmitted data includes the gas cylinder level, smoke sensor status, and fire sensor status, allowing for remote monitoring. If the gas cylinder level drops below 30 percent, a buzzer is activated to indicate that the cylinder is nearly empty. This project enhances kitchen safety by protecting against fire accidents.

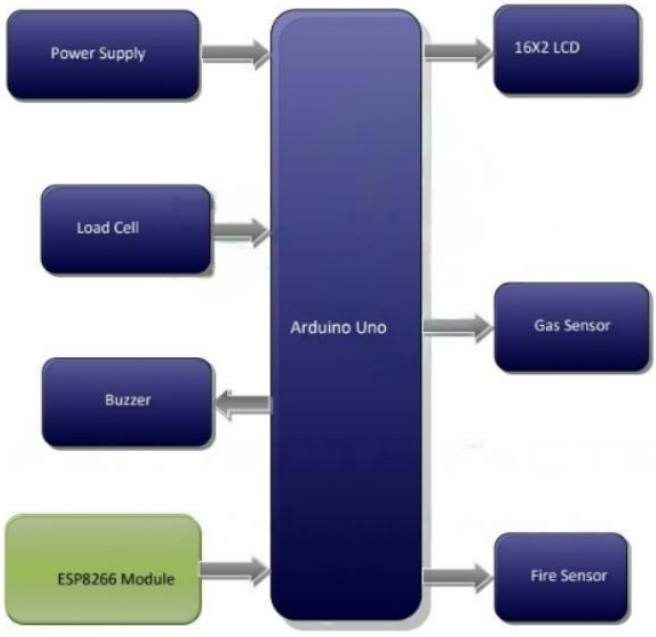

FIGURE 1: BLOCK DIAGRAM

FIGURE 2. POWERSUPPLY BLOCKDIAGRAM

5. USES

1. **Residential Use:**
   - Monitor the gas levels in household cylinders to avoid running out unexpectedly.
   - Ensure safety by detecting leaks and fire hazards early.
2. **Commercial Use**:
   - Used in restaurants and hotels to manage multiple gas cylinders efficiently.
   - Prevents disruptions in service by ensuring gas availability and safety.
3. **Industrial Use**:
   - Monitors gas levels in large-scale operations such as manufacturing plants and laboratories.
   - Enhances safety by detecting leaks and potential fire hazards in environments with high gas usage.
4. **Automotive Use**:
   - Monitors gas levels in vehicles that run on LPG or CNG.
   - Ensures timely refueling and safety during travel.
5. **Logistics and Supply Chain**:
   - Used by gas suppliers to track gas levels in cylinders distributed to various locations.
   - Helps in efficient supply chain management by predicting demand and scheduling refills.

6. ADVANTAGES

1. **Enhanced Safety**:
   - Early detection of gas leaks and fire hazards prevents accidents and ensures a safe environment.
   - Reduces the risk of explosions and fires by providing real-time alerts.
2. **Convenience**:
   - Remote monitoring allows users to keep track of gas levels from any location.
   - Alerts and notifications ensure timely refills, preventing interruptions in gas supply.
3. **Cost Savings**:
   - Prevents wastage of gas by accurately measuring usage and detecting leaks.
   - Reduces maintenance costs by identifying issues early and preventing damage to equipment.
4. **Efficiency**:
   - Automates the process of monitoring and managing gas cylinders, saving time and effort.
   - Streamlines operations in commercial and industrial settings by ensuring continuous gas supply.
5. **Environmental Benefits**:
   - Minimizes gas wastage and reduces carbon footprint by ensuring optimal usage.
   - Helps in the safe disposal and recycling of gas cylinders by monitoring their condition and usage.
6. **Data Analysis and Management**:
   - Provides valuable data on gas consumption patterns, helping in better inventory and resource management.
   - Enables predictive maintenance and efficient scheduling of refills based on usage trends.
7. **Emergency Response**:

- Immediate alerts and notifications allow for quick action in case of leaks or fire hazards.
- Enhances the ability to respond to emergencies, reducing potential damage and loss.

7. WARNING

While the gas cylinder monitoring system significantly enhances safety, users should be aware of the following:

1. **Regular Maintenance**: Ensure that all components, including sensors and the Arduino system, are regularly maintained and tested to function correctly.
2. **Proper Installation**: Install the system according to the manufacturer's guidelines to ensure optimal performance and safety.
3. **Awareness and Training**: Users should be educated on the importance of gas safety and trained on how to respond to alerts and notifications.
4. **Dependence on Technology**: While the system provides early warnings, it should not replace traditional safety measures. Always adhere to standard safety protocols when handling gas cylinders.
5. **Power Supply**: Ensure a stable power supply to the monitoring system to avoid disruptions in functionality.

8. CONCLUSION

The development and implementation of a gas cylinder monitoring system are vital in mitigating the risks associated with gas leaks and fire hazards. This system effectively detects gas leaks, monitors cylinder levels, and provides timely alerts, thereby enhancing safety in residential, commercial, and industrial settings. By integrating advanced sensors and IoT technology, this project ensures real-time monitoring and quick response to potential hazards. The ability to remotely monitor gas levels and receive immediate notifications greatly reduces the risk of accidents, ensuring the safety of human lives and property. This system represents a significant step forward in proactive safety management for gas cylinders.

9. FUTURE WORK

Future work on the gas cylinder monitoring system could focus on the following areas to enhance its functionality and effectiveness:

1. **Enhanced Connectivity**: Integrate more robust communication protocols such as 5G to improve the reliability and speed of data transmission.
2. **Battery Backup**: Develop a battery backup system to ensure continuous operation during power outages.
3. **Integration with Home Automation Systems**: Integrate the gas monitoring system with broader home automation systems for centralized control and monitoring.
4. **Machine Learning Algorithms**: Implement machine learning algorithms to predict potential gas leaks based on historical data and patterns.
5. **Mobile Application**: Develop a comprehensive mobile application to provide real-time monitoring, control, and alerts on the go.
6. **Scalability**: Design the system to be easily scalable for larger industrial applications, with the ability to monitor multiple cylinders and locations simultaneously.
7. **Improved Sensor Technology**: Research and integrate advanced sensor technologies to enhance the accuracy and reliability of gas detection.
8. **User Interface Improvements**: Enhance the user interface for better usability and easier interpretation of data and alerts.
9. **Regulatory Compliance**: Ensure the system complies with evolving safety regulations and standards for gas monitoring systems.

By addressing these areas, the gas cylinder monitoring system can become more efficient, reliable, and user-friendly, offering even greater safety and convenience to its users.

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