Advanced Gas Leakage Detection System

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Abstract: *The Liquefied Petroleum Gas (LPG) is a main source of fuel, especially in urban areas because it is clean compared to firewood and charcoal. Gas leakage is a major problem in the industrial sector, residential premises, etc. Nowadays, home security has become a major issue because of increasing gas leakage. Gas leakage is a source of great anxiety with ateliers, residential areas and vehicles like Compressed Natural Gas (CNG), buses, and cars which are run on gas power. One of the preventive methods to stop accidents associated with the gas leakage is to install a gas leakage detection kit at vulnerable places. The aim of this paper is to propose and discuss a design of a gas leakage detection system that can automatically detect, alert and control gas leakage. This proposed system also includes an alerting system for the users. The system is based on a sensor that easily detects a gas leakage.*

I. Introduction

Today Gas leakage is a serious problem and nowadays it is observed in many places like residences, industries, and vehicles like Compressed Natural Gas (CNG), buses, cars, etc. It is noticed that due to gas leakage, dangerous accidents occur. The Liquefied petroleum gas (LPG), or propane, is a flammable mixture of hydrocarbon gases used as fuel in many applications like homes, hostels, industries, automobiles, and vehicles because of its desirable properties which include high calorific value, less smoke, less soot, and meager harm to the environment. Liquid petroleum gas (LPG) is highly inflammable and can burn even at some distance from the source of leakage. This energy source is primarily composed of propane and butane which are highly flammable chemical compounds. These gases can catch fire easily.

In homes, LPG is used mainly for cooking purposes. When a leak occurs, the leaked gases may lead to an explosion. Gas leakage leads to various accidents resulting in both material loss and human injuries. Home fires have been occurring frequently and the threat to human lives and properties has been growing in recent years. The risks of explosion, fire, suffocation are based on their physical properties such toxicity, flammability, etc. The number of deaths due to the explosion of gas cylinders has been increasing in recent years.

The Bhopal gas tragedy is an example of accidents due to gas leakage. The reason for such explosions is due to substandard cylinders, old valves, no regular checking of gas cylinders, worn out regulators and a lack of awareness of handling gas cylinders. Therefore, the gas leakage should be detected and controlled to protect people from danger. An odorant such as ethane thiol is added to LPG, so that leaks can be detected easily by most people. However, some people who have a reduced sense of smell may not be able to rely upon this inherent safety mechanism. A gas leakage detector becomes vital and helps to protect people from the dangers of gas leakage There are different gas detection techniques used . In this paper a low cost advanced sensor-based gas leakage detector, alert and control system is

proposed and discussed. The system is very efficient, user friendly, portable, small in size and cost effective.

II. Literature Survey

Gas detection devices are widely used in industries, homes, and vehicles to prevent accidents caused by gas leaks. Dr. Walter Snelling introduced LPG in 1910, a highly flammable blend of butane and propane, which often leads to accidents due to leaks. Gas detectors identify leaks and help prevent explosions or health risks like suffocation. These detectors vary based on the gas they detect and the technologies they use, such as semiconductors or infrared sensors. Since it's hard for humans to constantly monitor gas concentrations, these detectors play a crucial role.

The proposed system by the authors uses MQ-5 sensors to detect LPG gas. When a leak is detected, a buzzer sounds, and an alert is displayed on an LCD screen. Additionally, a load sensor monitors the gas cylinder's weight, sending alerts to the owner if the gas level is low. The system uses the Pushbullet app for rapid data transmission via Wi-Fi, connected to an Arduino UNO. Different sensors are used for different gases: MQ-6 for LPG, MQ-4 for methane, and MQ-135 for benzene, all giving output in parts per million (PPM).

The system also employs ESP32 for sending and receiving messages and Node MCU for powering sensors that monitor cylinder weight. If the gas level is low, it's displayed using the Ubidots platform. The system is designed to be cost-effective and also measures temperature and humidity for enhanced monitoring.

III. System Design

3.1 Components

- **Gas Sensor (MQ-6)**: The MQ-6 sensor is highly sensitive to LPG and other combustible gases. It detects gas leaks at low concentrations and triggers the safety system.
- **Microcontroller (Arduino/ESP32)**: The microcontroller processes the signals from the gas sensor and controls the shut-off valve.
- **Solenoid Valve**: This is an electromechanical valve that opens and closes the gas supply line based on instructions from the microcontroller.
- **Alarm System**: An audible and visual alarm is integrated to alert users in case of a gas leak.
- **Auto Cut-Off Regulator**: A regulator attached to the gas cylinder that automatically shuts off the gas supply in the event of leakage.

3.2 Working Principle

The system operates in the following sequence:

1. **Gas Detection**: The MQ-6 sensor continuously monitors the environment for the presence of LPG. Once the gas concentration exceeds a pre-defined threshold, the sensor sends a signal to the microcontroller.
2. **Processing and Decision Making**: The microcontroller processes the sensor data in real-time. If a gas leak

is confirmed, it activates both the alarm system and the solenoid valve to shut off the gas supply.

3. **Auto Shut-Off**: The solenoid valve cuts off the gas flow, preventing further leakage. Simultaneously, the auto cut-off regulator on the gas cylinder is triggered to ensure there is no gas supply even if the primary valve is faulty.
4. **Alert Mechanism**: The alarm system alerts people in the vicinity, ensuring swift evacuation or further action.

IV. Advantages and Limitations

4.1 Advantages

- Early Detection and Prevention: The system provides an early warning of gas leaks and automatically shuts off the gas supply, significantly reducing the likelihood of accidents.
- Cost-Effective: The components used in the system are affordable and readily available, making it feasible for large-scale implementation in educational institutions.
- Automated Response: The system eliminates the need for manual intervention, thereby improving response time and ensuring swift action in case of emergencies.

4.2 Limitations

- Power Dependency: The system relies on electrical power, and a power outage could render it ineffective. Installing a backup power system, such as an uninterruptible power supply (UPS), could mitigate this issue.
- Sensor Reliability: Gas sensors may degrade over time, necessitating regular calibration and replacement to ensure accurate detection.

V. Future Scope

Future work could focus on the integration of wireless communication systems to enable remote monitoring of gas levels and system status. Moreover, integrating artificial intelligence (AI) to predict potential gas leaks based on environmental conditions or usage patterns could further improve the system's efficiency and reliability.

VI. Conclusion

The design of a sensor-based automatic gas leakage detector with an alert and control system has been proposed and discussed in this paper. This is a low-cost, low power, lightweight, portable, safe, user friendly, efficient, multi featured and simple system device for detecting gas. Gas leakage detection will not only provide us with significance in the health department but it will also lead to raise our economy, because when gas leaks it not only contaminates the atmosphere but also wastage of gases will hurt our economy. The proposed system will cost only USD 10 which is easily affordable even for poor people. In the open literatures it is noticed that much work has not been done for a smart gas detection system. In future, more advanced features will be integrated with this system which will provide users with more safety and relaxation. The

proliferation of handheld devices has led to developments in the field of smart gas sensors, which has considerably widened their scope of application. The need for ensuring safety in workplaces is expected to be the key driving force for the market over the coming years.

VII. Reference

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