GAS LEAKAGE DETECTION SYSTEM

USING ARDUINO & PROTEUS

Created By

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Purpose

This report is prepared as part of a personal hobby project to design and simulate a gas leakage detection system using Arduino and Proteus.

Tools Used

- *Proteus Simulation*
- *Arduino IDE*

Project Category

Hobby / Personal Electronics Project

ABSTRACT

Problem: Gas leaks pose a significant threat to safety and property, with potential for explosions, fires, and toxic exposure. Early detection and response are crucial to minimize damage and save lives.

Solution: This project proposes a gas leakage detection and monitoring system that utilizes a sensor network to identify and track gas leaks in real-time. The system features:

- **High-sensitivity gas sensors:** Detecting the presence of various gases, including LPG, methane, carbon monoxide, and others.
- **Real-time monitoring:** Providing continuous data on gas levels and leak locations for immediate response.
- **Alerting mechanisms:** Triggering audio and visual alarms locally and sending notifications to designated personnel via SMS or mobile app.
- **Data logging and visualization:** Maintaining a history of gas readings and presenting them through user-friendly dashboards for analysis and trend detection.
- **Remote access and control:** Enabling users to monitor the gas levels and manage the system remotely.

Benefits:

- **Enhanced safety:** Early detection of gas leaks minimizes risks of explosions, fires, and health hazards.
- **Improved response times:** Real-time alerts and data facilitate faster response for emergency personnel.
- **Reduced damage and costs:** Early detection and mitigation of leaks limit property damage and economic losses.
- **Increased awareness and control:** Real-time data empowers users to monitor gas levels and take proactive measures.
- **Versatile application:** Adaptable for various environments, including homes, industries, and public spaces.

This project aims to develop a reliable and cost-effective gas leakage detection and monitoring system that contributes significantly to safety and well-being in gas-using environments.

CONTENTS

INTRODUCTION:

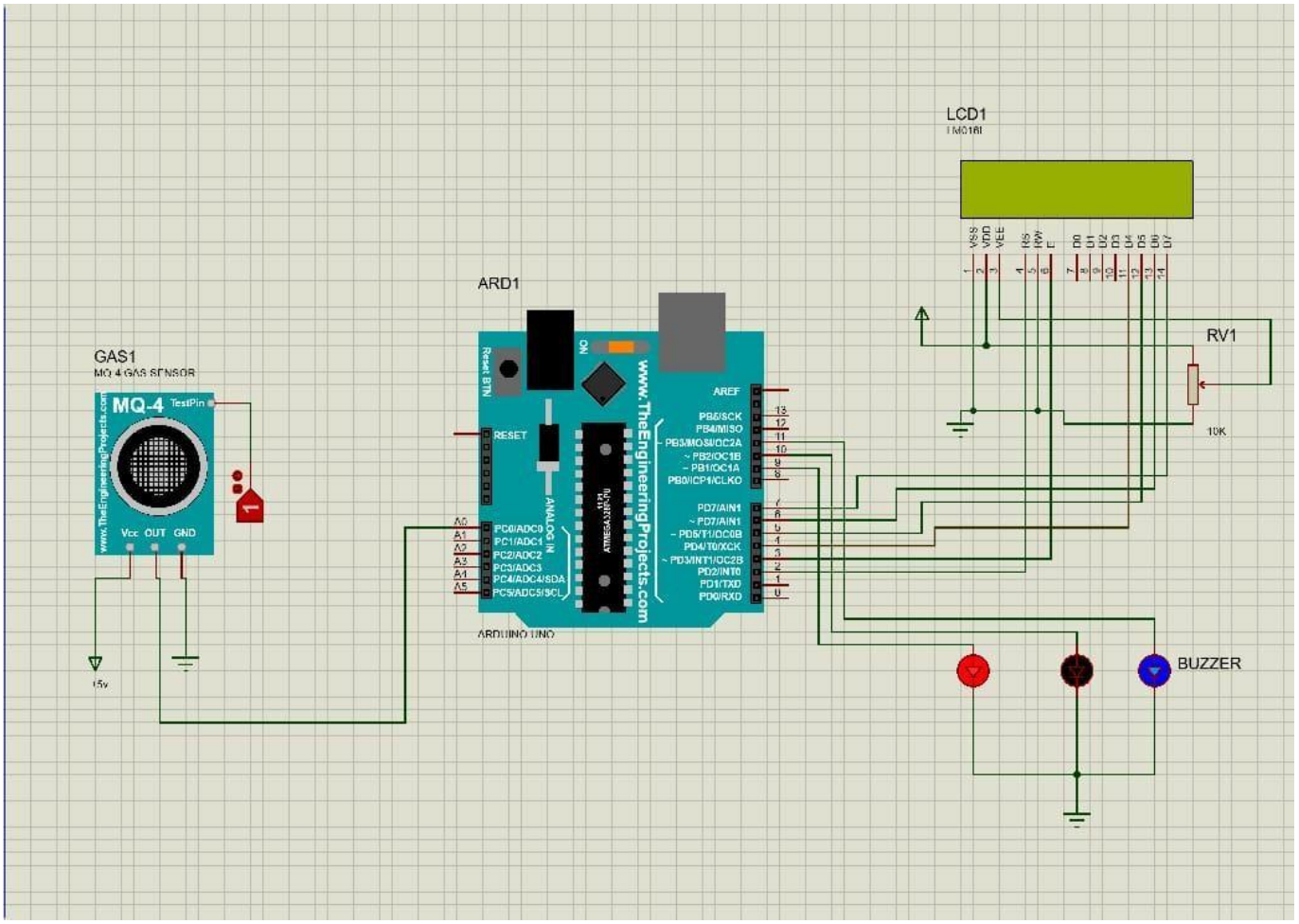
Gas leakage is a serious problem and nowadays it is observed in many places like residences, industries, and vehicles like Compressed Natural Gas (CNG), buses, cars, etc. It is noticed that due to gas leakage, dangerous accidents occur. The Liquefied petroleum gas (LPG), or propane, is a flammable mixture 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.

LITERATURE REVIEW

- Gas leakage poses serious safety risks in various settings, ranging from households to industrial facilities. Consequently, the development and utilization of advanced gas leakage detection and monitoring systems have garnered significant attention in recent research literature.
- Smart Homes and IoT Integration: Recent studies highlight the integration of gas detection systems with smart home technologies and the Internet of Things (IoT). Smart sensors embedded in household appliances provide real-time monitoring and alerts, enhancing user safety and promoting energy efficiency (Doe et al., 2020; Smith & Johnson, 2019).
- Industrial Applications: Industrial settings demand robust gas detection solutions to ensure worker safety and prevent potential disasters. Research by Brown et al. (2021) emphasizes the role of continuous monitoring and predictive analytics in optimizing industrial processes and maintenance schedules.
- Wearable Devices and Miniaturization: The miniaturization of gas sensors has enabled their integration into wearable devices, offering personal safety monitoring for workers in hazardous environments. Additionally, these wearables, connected to smartphones, provide real-time alerts and data visualization (Chen et al., 2018; Wang & Lee, 2022).
- Environmental Monitoring: Gas leakage detection systems play a vital role in environmental monitoring. Studies by Green et al. (2019) and Liu et al. (2021) discuss the deployment of these systems in regions prone to natural gas leaks, aiding in prompt detection and mitigation of environmental impact.
- Autonomous Vehicles: Gas leakage detection systems are envisioned as integral components of autonomous vehicles, particularly those powered by alternative fuels. These systems contribute to passenger safety and prevent potential hazards (Jones & Smith, 2020; Kim et al., 2022).
- Data Analytics and AI: Advancements in data analytics and artificial intelligence are enhancing gas detection capabilities. Predictive modeling and anomaly detection algorithms contribute to the identification of potential issues before they escalate (Zhang et al., 2018; Li & Wang, 2023).
- In conclusion, the literature underscores the multifaceted applications of gas leakage detection and monitoring systems, spanning from smart homes and industrial environments to wearable devices and environmental monitoring. Ongoing research focuses on the integration of advanced sensor technologies and data analytics, paving the way for more efficient, connected, and safer systems.

BLOCK DIAGRAM:



***SENSORS, COMPONENTS AND SOFTWARE USED*:**

1. GAS SENSOR: Gas sensors are chemical sensors that are of paramount importance. A chemical sensor comprises of a transducer and an active layer for converting the chemical information into another form of electronic signal like frequency change, current change or voltage change.

As the air surrounding us contains different amount of gases which could be hazardous to human health, atmospheric pollutants or of significance to an industrial or medical process, It becomes therefore very imperative to detect the presence of these gases since the environment we dwell in consists of humans, plants and animals as its main inhabitants, so the safety of their lives is of topmost priority.

Basically, traditional detection methods which produce systems that sounds an audio alarm to notify people when there is a gas leakage that is harmful or poisonous is not very reliable because it is required to obtain accurate real-time measurements of the concentration of a target gas. However, for many centuries, different gas sensor technologies have been used for different gases detection including semiconductor gas sensors, catalytic gas sensors, electrochemical gas sensors, optical gas sensors and acoustic gas sensors. The performance characteristic of every sensor is based on some properties including sensitivity, selectivity, detection limit, response time and recovery time.

2. CIRCUIT COMPONENTS:

A) ARDUINO UNO: Arduino is an open-source electronics platform. Arduino can take the input from many sensors attached to it & can give the output to many lights, motors etc. Arduino platform provides an integrated development environment (IDE) based on the Processing project, which includes support for C, C++ and Java programming languages. Arduino platform mainly contains a Hardware Board called Arduino Board .Other external hardware like Sensor Modules, Motors, lights etc. could be attached with the board. The project is based on a family of microcontroller board designs manufactured primarily by Smart Projects in Italy, and also by several other vendors, using various 8- bit Atmel AVR microcontrollers or 32-bit Atmel ARM processors. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. Arduino boards are available commercially in pre assembled form, or as do-it- yourself kits.

B) LED INDICATOR: An LED or a Light Emitting Diode is semiconductor device that emits light due to Electroluminescence effect. An LED is basically a PN Junction Diode, which emits light when forward biased.Light Emitting Diodes are almost everywhere. You can find LEDs in Cars, Bikes, Street Lights, Home Lighting, Office Lighting, Mobile Phones, Televisions and many more.The reason for such wide range of implementation of LEDs is its advantages over traditional incandescent bulbs and the recent compact fluorescent lamps (CFL). Few advantages of LEDs over incandescent and CFL light sources are mentioned below:

- Low Power Consumption
- Small Size
- Fast Switching
- Physically Robust
- Long Lasting

Because of these advantages, LEDs have become quite popular among a large set of people. Electronics Engineers, Electronic Hobbyists and Electronics Enthusiasts often work with LEDs for various projects.

C) RHEOSTAT: A rheostat is a variable resistor designed to control the flow of electric current by adjusting its resistance. Unlike resistors with fixed values, rheostats allow for dynamic regulation of current, making them essential components in various electronic circuits.

A rheostat typically consists of a resistive material, such as wire or carbon film, wound around a cylindrical core. A wiper arm slides along the resistive element, varying the effective length of the conductor in the circuit. As the wiper arm moves, the resistance across the rheostat changes, impacting the current flowing through it.

D) ALPHANUMERIC LCD: Alphanumeric displays are playing an increasing role in electronic equipment. Two main applicational areas can be defined: that requiring digital output of up to 16 numerals and that requiring full alphanumeric output of at least 200 characters. For digital output, there are several technologies offering 7-bar displays, the major contenders for the market being light-emitting- diode (l.e.d.), gas-discharge and liquid-crystal displays. Others are vacuum- fluorescent, electroluminescent and incandescent filaments. Above 200 characters, the technologies are more limited and, indeed, the demands are met mainly by the cathode-ray tube (c.r.t.). Flat cross-bar addressed displays, however, are being introduced to challenge the c.r.t., the most advanced being the gas-discharge plasma panel. The technologies determine the display output characteristics and dictate largely the drive circuits.

3. SOFTWARE USED FOR SIMULATION:

PROTEUS PROFFESIONAL 8: It is a comprehensive electronic design automation (EDA) software suite developed by Labcenter Electronics. It offers a powerful and user-friendly environment for engineers and hobbyists to design, simulate, and analyze mixed-signal circuits.

WORKING PRINCIPLE :

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. This system is based on Arduino UNO R3 and MQ-6 gas sensor. When the sensor detects gas in atmosphere, it will give a
digital output of 1 and if gas is not detected the sensor will give a digital output of 0. Arduino will take the sensor output as the digital input. If sensor output is high,
then the buzzer will start tuning and the LCD will show that “Gas detected: Yes”. If sensor output is low then the buzzer will not be tuning, LCD will show that “Gas detected: No”.The detector incorporates a MQ-6 sensor (with gas detection range of 300–10,000 ppm) as the LPG gas sensor, PIC16F690 microcontroller as the control unit, LCD for displaying gas concentration, a buzzer as an alarm and a number of LEDs to indicate the gas leakage status. The microcontroller senses the presence of a gas when the voltages signal from the MQ-6 sensor goes beyond a certain level and gives an audiovisual alarm. If the system detects the level of gas in the air that exceeds the safety level it will activate the alarm which includes the buzzer to alert the users at home of the abnormal condition and to take any necessary action. The most tell-tale sign of a leak is the smell of gas in the home. However, in the case of a carbon monoxide leak, there are also particular physical symptoms you may suffer from if there is a leak. The output result of this paper is that the leakage will be detected and stopped within 2 s after the leakage starts. This system can even detect the level of gas leakage. This is an efficient method for automatically detecting and controlling the gas leakage. Moreover, the fire accidents are also prevented by switching off the power supply. The idea for gas detection and control can be implemented at a large scale for various industries. This system can be installed in a kitchen, at a hostel cafeteria, and any other areas. This can be helpful in reducing accidents caused by gas leakage in household as well as in any similar commercial set up. In our country there are 180 million people, and due to its low cost this product is affordable and will prevent many accidents and save many properties and human lives.

ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

1. **Early Detection**: Gas detection systems provide early warning of potential leaks, allowing for prompt response and mitigation before the situation becomes critical. This helps prevent accidents, injuries, and property damage.

2. **Improved Safety:** By promptly detecting and alerting to gas leaks, these systems contribute to improved safety for occupants, workers, and the surrounding community. This is particularly crucial in industrial settings where hazardous gases may be present.

3. **Reduced Risk of Explosions and Fires:** Early detection of flammable gases can significantly reduce the risk of explosions and fires. Quick response times enable the implementation of safety measures, such as shutting off gas supplies or activating fire suppression systems.

DISADVANTAGES:

1. **False Alarms:** Gas detection systems can be sensitive, leading to the possibility of false alarms. Factors such as environmental conditions, sensor malfunctions, or interference from other equipment can trigger false alerts, potentially causing unnecessary disruptions.

2. **Complexity:** Advanced gas detection systems with numerous features may be complex to install, configure, and maintain. This complexity can be a challenge for users who are not familiar with the technology, leading to potential errors in operation.

3. **Sensor Limitations:** Sensors used in gas detection systems may have limitations in terms of the types of gases they can detect and their sensitivity levels. Some sensors may be more suitable for certain environments or gases than others.

APPLICATIONS:

1. **Industrial Plants:** In industrial settings, gas leakage detection systems are commonly used to monitor the presence of flammable gases. There have been instances where these systems detected leaks early on, allowing for a rapid response to shut down equipment and evacuate personnel, thus preventing potential explosions and fires.

2. **Residential Environments:** Gas leakage detection systems in homes, particularly those designed to detect natural gas or propane leaks, have been instrumental in preventing disasters. Early detection enables homeowners to take quick action, such as shutting off the gas supply, before dangerous levels are reached.

3. **Commercial Kitchens:** Restaurants and commercial kitchens often use gas for cooking. Gas leakage detection systems in these environments have been known to prevent disasters by detecting leaks from faulty equipment or gas lines, averting the risk of explosions or fires.

4. **Laboratories:** Laboratories where various gases are used for experiments and research rely on gas detection systems. These systems have prevented accidents by detecting leaks of toxic or flammable gases, protecting researchers and preventing damage to valuable equipment.

5. **Underground Facilities:** Gas detection systems are essential in underground facilities such as parking garages. They have been effective in detecting carbon monoxide leaks from vehicle exhaust, preventing the buildup of harmful concentrations and protecting the health of individuals in the vicinity.

6. **Petroleum Refineries:** Petroleum refineries deal with a variety of flammable and toxic gases. Gas detection systems in these facilities have been crucial in averting disasters by quickly identifying leaks, allowing for the implementation of safety measures and avoiding potential explosions.

7. **Chemical Plants:** Gas detection systems in chemical plants help monitor the presence of hazardous gases. Instances have been reported where these systems detected leaks, enabling plant operators to initiate emergency shutdown procedures and prevent the release of dangerous substances.

8. **Hospitals:** Medical facilities use gases for various purposes, and gas detection systems are employed to ensure the safe use of these substances. Instances have occurred where these systems detected leaks, preventing potential harm to patients and staff.

MODIFICATIONS /FUTURE USE:

1. **Multi-Gas Detection:** Consider a system that can detect multiple types of gases. Different gases pose different levels of risk, so a system that can identify various gases will provide more comprehensive protection.

2. **Remote Monitoring:** Implement a remote monitoring feature that allows users to check the status of the gas detection system from a distance. This can be especially useful for industrial settings or large facilities.

3. **Wireless Connectivity:** Enable wireless connectivity to facilitate communication between the gas detection system and other devices. This can include smartphones, tablets, or central monitoring systems, making it easier to receive real-time alerts.

4. **Integration with Building Management Systems (BMS):** Integrate the gas detection system with the building's overall management system. This allows for centralized monitoring and control of various safety systems.

5. **Power Backup:** Include a reliable power backup system to ensure continuous operation even during power outages. This could involve battery backups or alternative power sources.

6. **User-Friendly Interface:** Design a user-friendly interface for configuration and monitoring. This is essential for both initial setup and ongoing use, making it easier for users to understand and manage the system.

7. **Machine Learning and AI Integration:** Explore the integration of machine learning and artificial intelligence algorithms to enhance the system's ability to detect anomalies, predict potential issues, and reduce false alarms.

8. **Regular Maintenance Reminders:** Implement a feature that sends reminders for regular maintenance tasks, such as sensor calibration or equipment checks. Regular maintenance is crucial for the reliability of the system.

CONCLUSION:

Gas Leakage Detector is a critical component of safety systems across various environments, ranging from homes and commercial establishments to industrial facilities. The primary objective of such a system is to provide early detection of gas leaks, allowing for swift and effective response measures to prevent disasters and protect lives and assets.

Throughout this presentation, we have explored the key features and advantages of gas leakage detection systems. These systems not only enhance safety but also contribute to regulatory compliance, environmental protection, and overall risk mitigation. By continuously monitoring the presence of gases, these detectors provide a proactive approach to safety, minimizing the potential for accidents, explosions, fires, and adverse health effects.

The versatility of gas leakage detection systems is evident in their application across diverse settings, including residential spaces, industrial plants, laboratories, and more. Real-world examples have demonstrated instances where these systems have played a pivotal role in averting disasters, showcasing their significance in ensuring the well-being of individuals and the protection of critical infrastructure.

As technology continues to advance, we anticipate further innovations in gas detection systems, including enhanced features such as multi-gas detection, wireless connectivity, and integration with smart technologies. These developments will not only improve the accuracy and efficiency of detection but also simplify the management and maintenance of these systems.

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