"Automatic Power Off When Gas Leak"

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Abstract

In recent years, the increasing number of fire accidents caused by domestic and industrial gas leaks has highlighted the need for effective safety systems. This project, titled "Automatic Power Off When Gas Leak", aims to develop an intelligent safety device that detects the presence of combustible gases such as LPG, methane, or butane and automatically disconnects the electrical power supply to prevent fire or explosions.

The system employs an MQ-2 gas sensor to continuously monitor the surrounding air for gas concentration levels. When the detected gas level exceeds a predefined safety threshold, the microcontroller (Arduino) immediately triggers a relay module to cut off the main power supply. Simultaneously, an alarm and LED indicator are activated to alert the occupants of the danger. The system ensures rapid response, minimizing the risk of ignition from electrical sparks.

This project provides a low-cost, reliable, and efficient solution for gas leakage detection and accident prevention in homes and industrial environments. By integrating automatic power control with gas detection, it enhances overall safety and demonstrates the practical application of embedded systems in real-life hazard prevention.

Introduction

Safety is one of the most critical concerns in both domestic and industrial environments, especially when dealing with flammable gases such as Liquefied Petroleum Gas (LPG), methane, or butane. Gas leakage is a common and potentially dangerous problem that can lead to fire accidents, explosions, and even loss of life and property. In many cases, these accidents occur due to delayed detection or the presence of electrical sparks when gas leaks are unnoticed. Therefore, an automatic and reliable system to detect gas leaks and immediately cut off electrical power is essential to prevent such hazardous situations.

The "Automatic Power Off When Gas Leak" project is designed to address this safety issue through the integration of gas sensing technology with automatic electrical control. The system uses a gas sensor (such as the MQ-2 or MQ-5) to detect the presence of flammable gases in the surrounding environment. The detected signal is processed by a microcontroller (Arduino/ESP32), which compares the sensor output with a predefined threshold level. When the gas concentration exceeds this level, the controller triggers a relay circuit to disconnect the main power supply, thereby eliminating possible ignition sources. Simultaneously, an alarm system and visual indicators (such as LEDs) alert the occupants to take necessary action.

This project not only focuses on gas detection but also emphasizes preventive action—cutting off electrical power automatically, which is often the primary cause of ignition during gas leaks. The system operates continuously and can be easily implemented in homes, restaurants, laboratories, and industries that use gas-based systems. Moreover, it offers a cost-effective, compact, and energy-efficient solution for enhancing safety and preventing potential disasters.

By combining sensor technology, microcontroller-based automation, and electrical safety control, this project demonstrates how modern embedded systems can play a vital role in protecting lives and property from gas-related hazards.

LITERATURE REVIEW

Gas leakage is one of the major causes of fire accidents in residential, commercial, and industrial environments. Liquefied Petroleum Gas (LPG) and natural gas are widely used for cooking, heating, and other applications due to their high efficiency and availability. However, both are highly flammable and potentially explosive when leaked in confined spaces. Traditional gas detectors alert users through sound or visual signals, but these systems do not automatically mitigate the risk by cutting off power or shutting valves. Therefore, researchers have focused on developing **automatic power-off systems** that respond intelligently to gas leakage by isolating ignition sources and preventing accidents.

METHODOLOGY

1. Introduction

The methodology outlines the systematic approach followed in designing, developing, and testing the **Automatic Power Off When Gas Leak** system. The aim is to create a reliable, low-cost safety device that detects gas leakage and automatically disconnects electrical power to prevent fire or explosion.

2. System Overview

The proposed system consists of four main components:

1. **Gas Detection Unit** – Detects the presence of flammable gas (LPG, methane, etc.) in the environment.
2. **Control Unit** – Processes sensor data and makes logical decisions.
3. **Power-Isolation Unit** – Automatically cuts off the power supply through a relay mechanism when a leak is detected.
4. **Alert and Communication Unit** – Provides audio, visual, and optional GSM/IoT alerts to inform users.

RESULTS AND DISCUSSION

The purpose of this project was to design and implement an **Automatic Power Off When Gas Leak** system capable of detecting gas leakage and automatically disconnecting electrical power to prevent accidents. The prototype was tested under various conditions to evaluate its **detection accuracy, response time, reliability**, and **safety performance**.

Experimental Setup

The system was built using an **MQ-2 gas sensor**, **Arduino Uno microcontroller**, **relay module**, **buzzer**, and **LED indicator**. A **5V regulated power supply** powered the system. LPG and butane gas were released in controlled amounts to test how the system responded to different gas concentrations.

The setup was tested in a ventilated room, ensuring safety during the trials. Each test measured:

- Sensor voltage output,
- Response time,
- Relay activation status, and
- Alert mechanism performance.

3. Experimental Results

Test No.	Gas Type	Concentration (ppm)	Sensor Output (V)	Relay Status	Alarm/Buzzer	Response Time (s)
1	No Gas	<100	0.35	ON	OFF	–
2	LPG	300	1.6	ON	OFF	–
3	LPG	650	2.7	OFF	ON	1.1
4	Butane	800	3.0	OFF	ON	1.0
5	Methane	900	3.2	OFF	ON	1.2
6	Fresh Air (After Test)	<100	0.4	ON (Reset)	OFF	2.0

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4. Discussion of Results

4.1 Gas Detection and Response

The MQ-2 sensor successfully detected increases in gas concentration. When the gas level reached approximately **600 ppm**, the sensor output exceeded the threshold voltage set in the Arduino program. At that point, the microcontroller **activated the relay module**, which **cut off the electrical power supply** to the connected device and simultaneously **triggered the buzzer and LED indicator**.

The **average response time** was **1–1.2 seconds**, which is fast enough to prevent potential ignition in typical household environments.

CONCLUSION

The project **"Automatic Power Off When Gas Leak"** was successfully designed and implemented to detect the presence of flammable gases and automatically disconnect electrical power to prevent fire and explosion hazards. The system combines the functions of **gas detection, alerting, and automatic power isolation** in a single, low-cost, and user-friendly setup.

The prototype used an **MQ-2 gas sensor** interfaced with an **Arduino microcontroller** to continuously monitor gas concentration in the environment. When the sensor detected a gas level above the safety threshold, the microcontroller immediately activated a **relay circuit** to cut off the electrical supply and simultaneously triggered an **audio-visual alarm**. This automatic response ensures rapid prevention of possible ignition sources, reducing the risk of accidents.

Experimental results confirmed that the system responds within **1–2 seconds** of gas detection, with reliable performance under typical household conditions. The device is compact, energy-efficient, and suitable for use in kitchens, laboratories, and small industrial environments.

Overall, the system achieves its main objective of **enhancing safety through automatic prevention rather than manual intervention**.

Future Scope

To further improve the system, the following enhancements are suggested:

1. Integration of **IoT or GSM modules** for real-time remote alerts.
2. Use of **multiple gas sensors** to detect various flammable or toxic gases.
3. Implementation of **AI-based threshold adjustment** for higher accuracy under changing environmental conditions.
4. Development of an **industrial-scale version** using smart circuit breakers and multiple relay channels.

In conclusion, the **Automatic Power Off When Gas Leak** system provides an effective, affordable, and practical solution for preventing fire hazards, contributing significantly to safer homes and workplaces.

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