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Gas leakage deduction system with automatic on and off regulator

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Abstract

The use of LPG and other combustible gases in homes and industries poses serious safety risks due to potential gas leaks. This project presents an IoT-based Gas Leakage Detection System with an Automatic Regulator On/Off mechanism to prevent accidents caused by undetected leaks.
Using an MQ-5 sensor, the system detects gases like LPG and methane. An Arduino Uno controls safety responses: it shuts off the gas supply via a servo motor, activates an exhaust fan, and alerts users with a buzzer, LEDs, and an LCD display. Designed for energy efficiency and IoT expansion, the system offers a reliable, real-time solution to enhance gas safety in various settings.

Keywords: IoT (Internet of Things), Gas Leakage Detection, MQ-5 Gas Sensor, Arduino Uno, LPG and Methane

1. Introduction

This project introduces a smart safety system that detects LPG and methane leaks using the MQ-5 gas sensor. When a leak is detected, the Arduino Uno processes the signal and takes immediate action: it shuts off the gas regulator via a servo motor, activates an exhaust fan to ventilate the area, and triggers a buzzer, LED indicators, and an LCD display to alert users.

The system is designed to be energy-efficient, cost-effective, and easily expandable with IoT features like GSM or Wi-Fi for remote alerts. It ensures real-time response and enhanced safety in homes, kitchens, and industries by combining automation with sensor technology.

2. Purpose of the project

The primary goal of this project is to develop an IoT-based gas leakage detection system with an automatic gas regulator control, enhancing safety in homes, businesses, and small industries. It uses an MQ-5 sensor to detect gases like LPG and methane and takes immediate automated action-shutting off the gas supply, activating an exhaust fan, and alerting users via buzzer, LEDs, and LCD display.

The system aims to minimize human dependency by enabling real-time detection and response, improving both local and remote awareness through potential GSM/Wi-Fi integration. It's designed to be cost-effective, energy-efficient, scalable**,** and educational**,** offering students hands-on experience in embedded systems and IoT. Ultimately, the project promotes public safety and the practical use of smart technology to prevent gas-related hazards.

3. Existing System

Traditional gas leakage detection systems are commonly used in homes, industries, and labs, typically consisting of basic sensors like MQ-2 or MQ-5 with buzzers or LED indicators. While they can detect the presence of gas and alert nearby individuals, they lack automation and rely heavily on human intervention. These systems do not include features like automatic gas shut-off, remote notifications, or real-time monitoring displays. Most are fixed, non-scalable, and become inoperative during power outages due to the absence of backup power. Additionally, they offer minimal user interfaces and lack diagnostic capabilities, making maintenance difficult. Advanced industrial systems exist but are costly and complex, unsuitable for small-scale use. Overall, current systems are reactive and limited, underscoring the need for a smarter, automated IoT-based solution.

4. Proposed System

The proposed system introduces an IoT-based, smart, and automated gas leakage detection solution designed for enhanced safety, affordability, and real-time response. Centered around an Arduino Uno microcontroller and an MQ-5 gas sensor, it detects LPG leaks and initiates immediate corrective actions without human intervention. When a leak is detected, the system automatically shuts off the gas valve via a servo motor, activates a buzzer and LEDs for alerts, and powers an exhaust fan to disperse the gas. A 16x2 LCD display provides real-time status updates, while the entire setup runs on a DC power supply with battery backup. The system is compact, modular, and easy to install in various environments. It is energy-efficient, cost-effective, and designed for continuous autonomous operation. Additionally, its components are easy to maintain and upgrade. Though currently offline, the design supports future expansion with wireless modules, making it both practical and adaptable for
evolving safty needs

5. Software Requirements

Arduino Uno App & Arduino C++ (Short Version) The Arduino Uno is a widely-used microcontroller board based on the ATmega328P, ideal for building embedded and IoT systems. Paired with the Arduino IDE, it allows users to write, compile, and upload code easily using a simplified version of C++.

The Arduino IDE provides a beginner-friendly interface, supporting libraries that simplify the use of sensors, actuators, and other components. The Uno connects via USB for code upload and then runs independently, making it ideal for real-time applications like gas leak detection**.**

Core functions in Arduino C++ include setup() (runs once at startup) and loop() (runs continuously), which handle device initialization and ongoing monitoring or actions. Built-in functions like digitalWrite(), digitalRead(), analogRead(), and analogWrite() simplify hardware interaction.

Though not wireless by default, Arduino Uno can support mobile communication via modules like HC-05 (Bluetooth) or ESP8266 (Wi-Fi)**,** allowing remote control through mobile apps.

Arduino C++ offers modular coding with custom functions and library support, making it flexible, beginner-friendly, and suitable for everything from learning projects to safety-critical systems. It encourages experimentation and quick prototyping-perfect for educational and real-world applications like gas leakage detection.

6. Hardware Requirement

Fig 1: Arduino Uno

The core controller that processes sensor data and controls the servo motor, buzzer, exhaust fan, and LEDs to ensure safety during gas leaks.

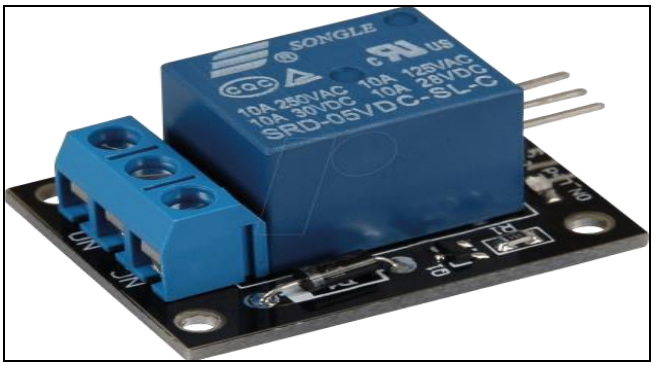

Fig 2: Relay Module

Allows the Arduino to control high-power devices like a water pump by switching them on/off based on sensor readings.

Fig 3: MQ-5 Gas Sensor

Detects gases like methane and LPG. Sends data to the Arduino, which triggers safety actions if a leak is detected.

Fig 4: Servo Motor

Automatically opens/closes the gas valve when a leak is detected, helping prevent further gas escape.

Fig 5: Buzzer

Alerts people with a loud sound when gas levels exceed safe limits, enabling quick evacuation or response.

Fig 6: Exhaust Fan

Ventilates the area by expelling leaked gases when high gas levels are detected, improving safety.

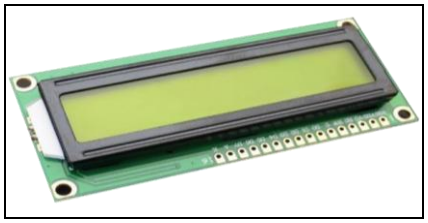

Fig 7: LCD Display (I2C)

Displays real-time gas levels and system status. The I2C module reduces wiring complexity by using fewer pins.

7. Implementation

System implementation involves assembling the hardware components and programming the Arduino Uno to detect gas leaks and respond automatically. The system consists of key components such as the Arduino Uno microcontroller, MQ-5 gas sensor, servo motor, exhaust fan, buzzer, LCD display, and LED indicators. The Arduino acts as the central unit that collects input from the gas sensor and controls the other components based on predefined conditions. Using Arduino C++, the system is programmed to continuously monitor gas levels. When a gas leak is detected, the servo motor automatically closes the gas valve, the buzzer sounds an alert to warn nearby individuals, the exhaust fan is activated to ventilate the area, and the LCD displays messages like "Gas Detected" or "Safe Environment." The entire system operates in a continuous loop, with initialization done in the setup function and repeated monitoring in the loop function. After hardware setup and programming, the system is thoroughly tested to ensure reliable performance. Issues such as incorrect wiring, coding bugs, or delayed responses are identified and resolved to guarantee that the system functions effectively in real-time. Once fully implemented, the system provides a dependable, automated solution to detect and respond to gas leaks, enhancing safety in residential or industrial environments.

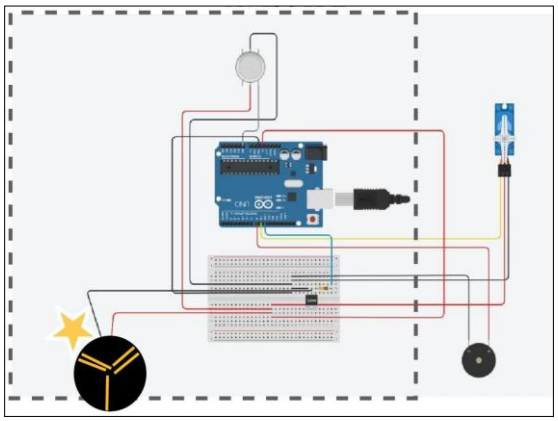

Fig 8: The circuit diagram for the gas leakage detection system illustrates how each component is connected and coordinated to perform its function

The circuit diagram for the gas leakage detection system illustrates how each component is connected and coordinated to perform its function. The Arduino Uno serves as the main controller, receiving input from the MQ-5 gas sensor and triggering outputs to various devices. The MQ-5 sensor detects the presence of gases like LPG or methane and sends an analog signal to the Arduino, which determines if the gas level exceeds a safe threshold. If a leak is detected, the Arduino sends a control signal to the servo motor, which closes the gas regulator to stop further leakage. At the same time, the Arduino activates the relay module connected to the exhaust fan, which helps disperse the gas from the environment. The LCD display with an I2C interface provides real-time feedback to the user about the system's status, while LED indicators offer a quick visual cue - green for safe and red when gas is detected. The buzzer provides an audible alert to ensure that nearby individuals are made aware of the danger even if they are not looking at the display. A suitable power source, such as a 12V DC adapter, powers the entire setup, with separate power provided to components like the servo motor if needed. Each component is carefully wired to specific pins on the Arduino to ensure smooth operation.

8. Conclusion

The IoT-based gas leakage detection system with an automatic regulator on/off mechanism offers an efficient and reliable safety solution for both residential and industrial settings. It uses the MQ-5 sensor to detect LPG and other combustible gases, triggering immediate actions such as shutting off the gas valve via a servo motor, activating an exhaust fan, and alerting users through a buzzer and LCD display. This automated response significantly reduces the risk of fires, explosions, and health hazards.

Designed for simplicity and affordability, the system is easy to install and operate, making it accessible to a wide audience. Its low power consumption supports continuous use, and while it currently lacks remote communication features, it is easily upgradable with modules like GSM or Wi-Fi for real-time mobile alerts. The integration of hardware and software through Arduino demonstrates core IoT principles and offers practical learning opportunities in embedded systems.

The system's adaptability allows it to detect multiple gases, making it suitable for diverse environments like homes, labs, and industrial sites. Its autonomous operation ensures safety even without user presence, providing peace of mind and reducing human error. Overall, the system is a scalable, cost-effective, and impactful solution for enhancing gas safety and preventing accidents.

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