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LPG Gas Detection and Alerting System using IOT

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SUMMARY

In today's world, safety is of utmost importance, both in educational institutions and workplaces. It is crucial to have effective safety systems in place, not only in industries but also in homes and businesses. One specific safety measure is the installation of gas leakage detectors in vulnerable areas. These detectors are devices that can identify the presence of gases, forming part of a safety system. When a leak occurs, the gas detector can sound an alarm, alerting individuals in the vicinity to take appropriate action. This is essential because certain gases can be harmful to living beings, such as humans and animals.

This paper introduces a novel approach to detect leaks of liquefied petroleum gas (LPG) using a microcontroller-based Node MCU. The goal is to detect and prevent LPG leaks, ensuring the safety of individuals and avoiding potential accidents. The proposed device continuously monitors the area using gas sensors. The data from these sensors is then transmitted to the Node MCU, which displays the results as a warning on an Android-based smartphone. Additionally, apart from LPG gas, the device can also detect leaked gases from air conditioners and refrigerators, which are equally harmful when released in a home environment. By utilizing this device, users can effectively prevent accidents caused by gas leaks, thereby ensuring their safety.

I. INTRODUCTION

LPG, short for liquefied petroleum gas, is a non-renewable energy source derived from fossil oil and gas. It primarily consists of propane and butane and is odorless in its natural state. However, an odorant called ethyl mercaptan is added to LPG to make it detectable. Detecting the presence of natural gases is not as quick for humans as it is for gas sensors. Therefore, a gas sensing system is essential for real-time monitoring of gas systems.

Gas leaks can lead to fires that pose a significant threat to human life and property. Delayed information about the occurrence of fire can further exacerbate the situation. Existing products in the market mainly function as fire extinguishers. However, our project aims to not only detect gas leaks but also trigger an alarm. In case of a fire, a water sprinkler system is activated, and an exhaust fan is utilized to remove any lingering gas from the kitchen area.

The primary objective of this paper is to detect gas leakage in residential areas such as homes, hotels, and schools, and provide alert messages to people in the vicinity. Gas sensors, like the MQ-6 gas sensor used in our implementation, are widely employed for detecting gas leaks in various applications. The MQ-6 sensor measures gas concentration in parts per million (ppm) and outputs an analog signal that can be converted into a digital format. By comparing intensity values with predefined thresholds for gas, smoke, and fire, the system makes appropriate decisions. Additionally, we incorporate a GSM module to upload the data to the cloud using Wi-Fi, allowing responsible individuals to monitor the system effectively.

II. LITERATURE SURVEY

In this proposed system, we have developed an innovative solution for detecting and alerting gas leakage, specifically focusing on economic fuels such as petroleum, liquid petroleum gas (LPG), and alcohol. The primary objective is to ensure safety by promptly identifying gas leaks and providing a mechanism for automatic valve closure to control the leakage.

To achieve this, the system incorporates sensors that effectively detect any leaked gas. These sensors are connected to a microcontroller, which acts as the central processing unit. Upon receiving the signal from the sensors, the microcontroller analyzes the data based on pre-programmed logic. In response to a detected gas leak, the microcontroller triggers various components, including water sprinklers, buzzers, and exhaust fans, to mitigate the hazard.

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Furthermore, the system leverages Internet of Things (IOT) technology to enable remote control and monitoring.This functionality is facilitated by a servo motor, which is responsible for rotating the regulator by 180 degrees, effectively shutting off the gas cylinder valve.

By implementing this gas leakage detection and alerting system, the issue of gas wastage can be significantly reduced, promoting resource efficiency. Moreover, the system serves as an important safety feature by providing timely alerts to consumers. For instance, if a burner is accidentally left on, the system promptly notifies the user about the potential danger.

In the literature survey conducted for this system, various sources were explored to gather relevant information on gas leakage detection and safety systems. Existing research and practical implementations were analyzed to identify the most suitable components and techniques for our proposed system. By carefully reviewing and synthesizing the literature, we have developed a robust solution that addresses the challenges associated with gas leaks and enhances overall safety in domestic and commercial environments.

III. SYSTEM ARCHITECTURE

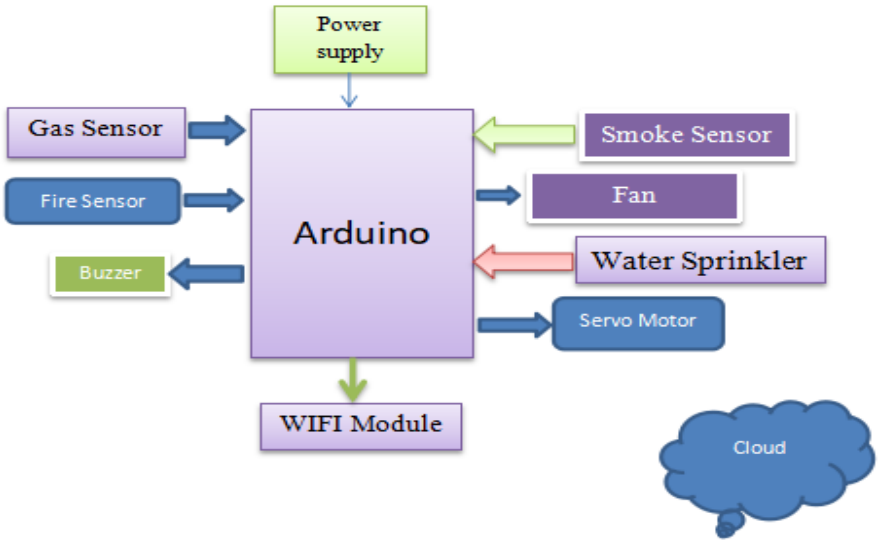

Figure 1 : System Architecture

In the event of a gas leakage, the sensors incorporated in this project are responsible for detecting the presence of gas and triggering the activation of various components. Firstly, the buzzer is turned on immediately to provide a clear and audible indication of the gas leakage. Simultaneously, a servo motor, acting as the gas regulator, rotates by 180 degrees to effectively halt any further gas leakage.

To address the potential dangers associated with gas leaks, the exhaust fan, which is a DC motor, is activated to expel the gas outside. This preventive measure significantly reduces the risk of major fire accidents. In the unfortunate event of a fire, a water sprinkler system is triggered, ensuring that the fire is extinguished promptly.

Furthermore, all the relevant data collected from the LPG gas sensor, smoke sensor, and fire sensor is transmitted and uploaded to the cloud using Wi-Fi devices. This allows for real-time monitoring and remote access to the system's information.

The provided block diagram visually represents a comprehensive system for detecting gas levels using IOT. Additionally, it includes the capability to identify gas leaks. When a gas leak is detected, the relevant information is displayed on an LCD screen for immediate visibility. Simultaneously, the system utilizes IoT technology to transmit this crucial information to the cloud, enabling remote monitoring and triggering alerts as necessary.

Components of System Architecture

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Gas Sensor :

Figure 2 : Gas Sensor

The gas sensor module, specifically the MQ-6 sensor, proves to be highly valuable in detecting gas leaks. Its sensitivity can be adjusted using a potentiometer, allowing for customization based on specific requirements. The MQ-6 sensor utilizes a sensitive material called SnO2, which exhibits low electrical conductivity in clean air. However, when flammable gas is present, the electrical conductivity of the sensing element increases significantly. This change in conductivity leads to a variation in the sensor's resistance, resulting in a corresponding voltage change. By connecting the sensor to a microcontroller, this voltage change can be accurately measured and analyzed. It is important to note that different gaseous elements exhibit varying sensitivity values, which further enhances the sensor's versatility and effectiveness in detecting specific types of gases.

Relay :

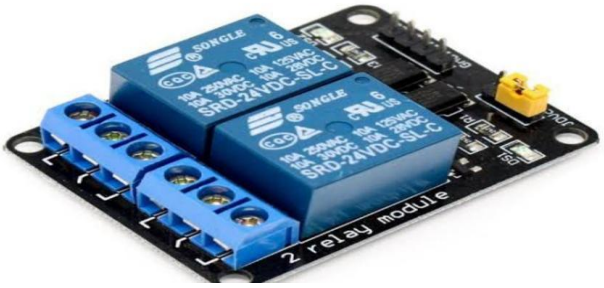

Figure 3 : Relay

A relay is an electrical switch that can be controlled by an Arduino or any other microcontroller. Its purpose is to enable the programmable control of devices that operate using high voltage and/or high current. By utilizing a relay, the microcontroller can effectively turn these devices on or off according to the desired program or logic. The relay acts as a mediator, allowing the low-voltage control signal from the microcontroller to safely control the higher voltage or current required by the connected devices. This provides a convenient and reliable method for automating the operation of various electrical devices in a programmable manner.

Arduino :

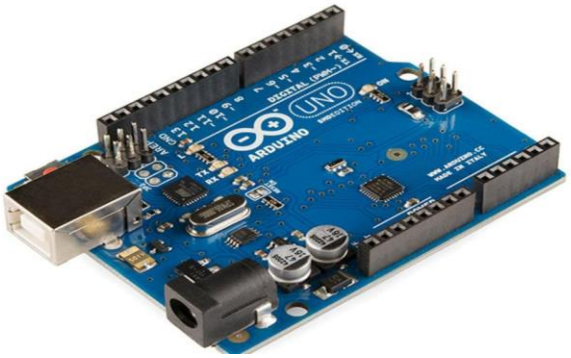

Figure 4 : Arduino Board

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The Arduino Uno board is a microcontroller that utilizes the ATmega328 as its core component. It offers a range of features and capabilities to support various applications. These include 14 digital input/output pins, with six of them functioning as pulse width modulation (PWM) outputs. The board is equipped with a 16-megahertz ceramic resonator, an ICSP (In-Circuit Serial Programming) header, a USB connection, six analog inputs, a power jack, and a button. These components provide the necessary support and functionality required for the microcontroller.

To get started, the Arduino Uno board can be connected to a computer using a USB cable, or it can be powered using an AC-to-DC adapter or battery. Unlike other boards, it does not require the use of a USB-to-serial driver chip. Instead, it distinguishes itself by incorporating the Atmega16U2 (or Atmega8U2 in earlier versions) as a dedicated USB-to-serial device. This feature enables easy communication between the Arduino board and the computer.

ThingSpeak : ThingSpeak is a freely available Internet of Things (IoT) platform that offers both an application and an API. Its primary purpose is to facilitate the storage and retrieval of data from various devices or "things" through the use of the HTTP protocol. This communication occurs either over the Internet or within a Local Area Network (LAN). ThingSpeak provides a versatile platform for creating a wide range of applications, including those focused on sensor logging, tracking the location of devices, and establishing a social network of connected things where status updates can be shared and accessed.

Fire Sensor :

Figure 5 : Fire Sensor

Fire detectors operate by detecting the presence of smoke and/or heat. Their function is to respond to the indications of a fire, such as the presence of smoke particles or abnormally high temperatures. Once triggered, these devices send a signal to the alarm system, which in turn activates the pre-programmed response specific to the corresponding area or zone. By promptly detecting and alerting the system to a potential fire, fire detectors play a crucial role in safeguarding against fire-related hazards.

DC Motor :

Figure 6 : DC Motor

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The DC motor, also known as a Direct Current motor, is the widely used motor type in various applications. Typically, DC motors possess two leads: one positive and one negative. When these leads are directly connected to a battery, the motor initiates rotation. By reversing the connection of these leads, the motor changes its rotation direction accordingly. This fundamental principle allows for the control and manipulation of DC motors to suit specific requirements and desired outcomes.

Servo Motor :

Figure 7 : Servo Motor

A Servo Motor is a compact device equipped with an output shaft that allows precise positioning to specific angles. This positioning is achieved by sending a coded signal to the servo. Once the servo receives the coded signal, it maintains the current angular position of its shaft. However, if the coded signal is altered, the angular position of the shaft will correspondingly change. In practical applications, servos find use in controlling the position of various surfaces, such as elevators and rudders in radio-controlled airplanes. They are also commonly employed in radio-controlled cars, puppets, and, of course, robots. The versatility and accuracy of servo motors make them a valuable component in numerous fields requiring precise angular control.

Buzzer :

Figure 8 : Buzzer

The Arduino buzzer, also known as a piezo buzzer, is a compact device that functions as a miniature speaker and can be directly connected to an Arduino board. It has the capability to generate sound by producing a tone at a specific frequency. The operation of the buzzer relies on the reverse phenomenon of the piezoelectric effect. When an electric voltage is applied to the piezo element, it undergoes mechanical vibrations, resulting in the production of audible sound. This allows the Arduino to control and emit tones or sounds through the buzzer, enabling various applications such as generating alarms, notifications, or musical tones. The piezo buzzer's simplicity and compatibility with Arduino boards make it a popular choice for sound generation in electronic projects.

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IV. PROPOSED SYSTEM

The proposed system aims to detect gas leaks, specifically focusing on substances like Methane, Butane, and LPG using the MQ-6 gas sensor. These gases, which are commonly used in cooking and industrial processes, pose a high risk due to their flammability. Traditional methods of gas leak detection heavily rely on human perception, which may not always be reliable, especially for individuals with a weak sense of smell. To address this issue, our system leverages the MQ-6 gas sensor to detect gas leaks accurately.
The system incorporates an IOT-based approach, allowing the gathered data on gas leakage to be transmitted to a cloud platform. This enables real-time monitoring and immediate action when a gas leak is detected. By uploading the leakage details to the cloud, the system ensures that users receive timely notifications about potential gas leaks, even if they are not physically present in the vicinity. This proactive approach mitigates the risks associated with gas leaks and allows for prompt response and intervention.

Overall, the proposed system provides an efficient and reliable solution for detecting gas leaks, particularly focusing on substances like Methane, Butane, and LPG. By combining the capabilities of the MQ-6 gas sensor with IOT technology, the system enables continuous monitoring and timely alerts, contributing to enhanced safety and the prevention of potential hazards caused by gas leaks.

V. IMPLEMENTATION

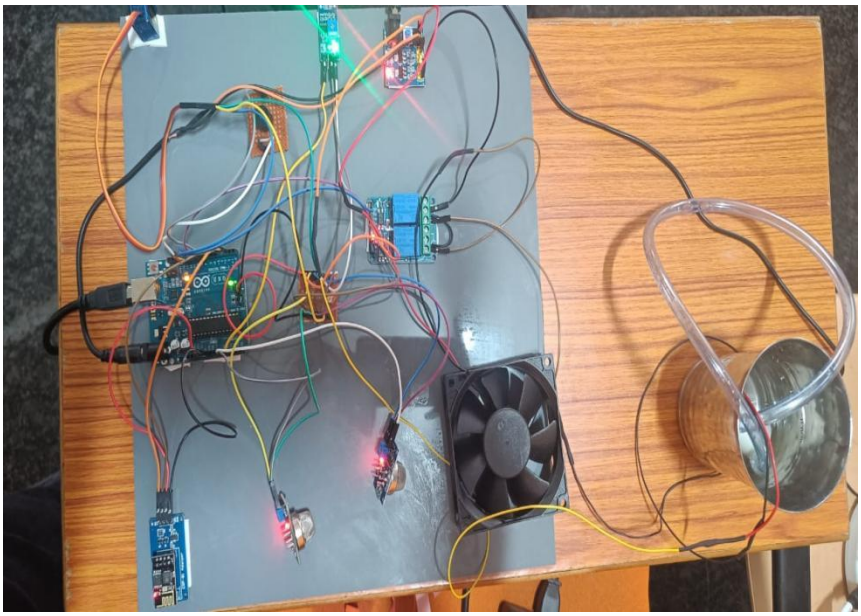

Figure 9 : Hardware Connections

The implementation of the proposed system involves several key steps to ensure the effective detection and monitoring of gas leaks. These implementation details are outlined below:

Hardware Setup: Begin by assembling the required hardware components, including the Arduino UNO board, MQ-6 gas sensor, LCD display, and WiFi module. We have Connect the components as per the circuit diagram .

Sensor Calibration: We have Calibrated the MQ-6 gas sensor to ensure accurate detection of Methane, Butane, and LPG leaks.

Coding and Programming: We have Written the code in Arduino IDE to interface the MQ-6 gas sensor , Fire Sensor and all other hardware's with the Arduino UNO board. The code includes functions to read sensor data, compare it with predefined thresholds, and trigger appropriate actions such as activating the buzzer, displaying alerts on the LCD, and transmitting data to the cloud.

Cloud Integration: We did Set up of the cloud platform using ThingSpeak to receive and store the gas leakage data from the Arduino board. There we can visualize and analyze the collected data.

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VI. RESULTS AND DISCUSSIONS

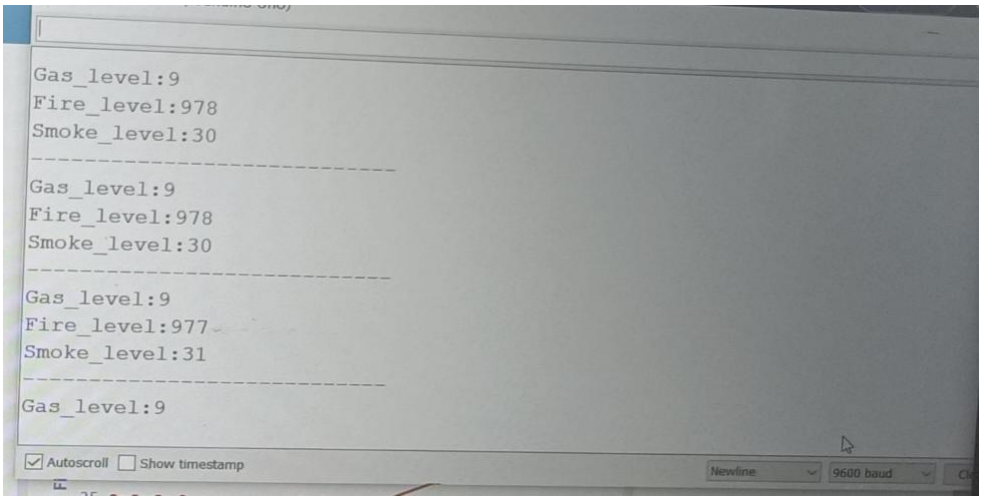

Figure 10: Serial monitor output when gas leakage detected

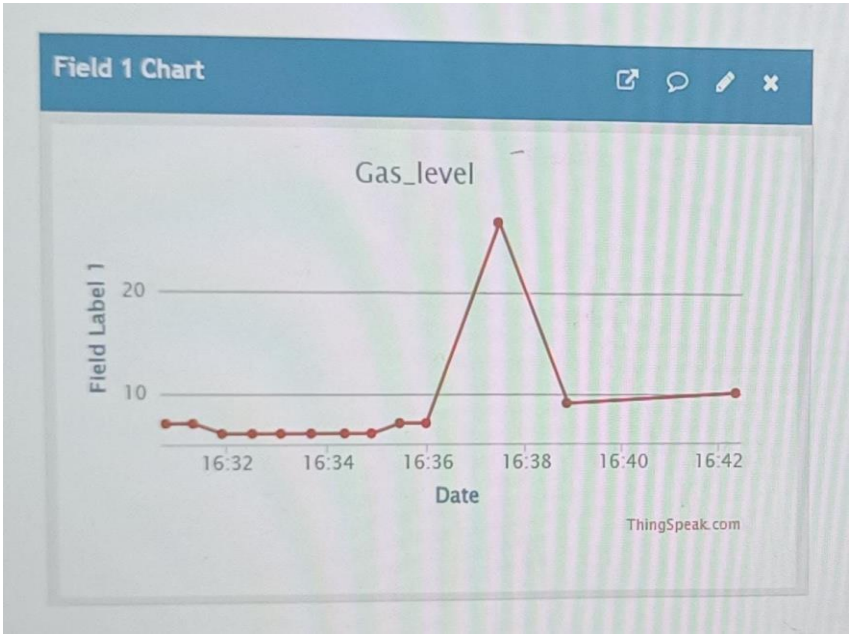

Figure 11 **:** Monitor Thing Speak Channel Output

The proposed solution can be implemented using the fundamentals of Internet of Things (IOT) and leveraging the capabilities of the ThinkSpeak platform. By utilizing ThinkSpeak, the collected data can be securely stored and analyzed. The data can be visualized in the form of graphical representations, enabling easy monitoring of gas levels and detection of any leakage incidents. The ThinkSpeak platform acts as a cloud infrastructure that allows remote access to the sensor data, enabling users to monitor the gas sensors from any location and at any time. The data collected by the sensors is transmitted to ThinkSpeak through a Wi-Fi module, and the platform generates an API key that can be incorporated into the source code. To establish a connection between the Wi-Fi module and ThinkSpeak, the SSID and Password of the Wi-Fi network are provided. This integration enables seamless data transfer and visualization through field graphs, providing a comprehensive understanding of gas sensor levels and facilitating the identification of gas leaks. By presenting the information in a graphical format, ThinkSpeak empowers users to effectively analyze and respond to potential gas leakage incidents.

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VII. CONCLUSION AND FUTURE ENHANCEMENT

Gas leakage incidents can have severe consequences, resulting in property damage and endangering human lives. These incidents often occur due to inadequate equipment maintenance and a lack of awareness among individuals. Therefore, it is crucial to develop a reliable system for detecting and alerting gas leaks, specifically focusing on LPG (liquefied petroleum gas). The presented research paper introduces a straightforward yet reliable approach to detect LPG leaks and promptly notify individuals about their severity. When an LPG leak is detected, the system triggers a buzzer and displays relevant information to alert users. This system operates using a 5V battery, and future improvements could include using a larger, rechargeable battery to prolong the gas detection module's lifespan and provide alerts when the battery runs low. By incorporating additional enhancements such as gas concentration detection and refining the system's design, it can become more user-friendly and cost-effective. These improvements will contribute to a more efficient system that helps prevent accidents and save lives.

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