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IOT Based Gas Detection System by Using Arduino Uno

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ABSTRACT

In our daily lives, fuels and gases play crucial roles, powering various activities in households and industries. However, mishandling of these substances can lead to significant issues, potentially causing accidents and harm. This project aims to address such concerns by developing an IoT-based gas detection system capable of identifying gas leaks and preventing accidents by blocking leaks in vulnerable areas. Central to this system is the MQ6 gas sensor, chosen for its effectiveness in detecting a range of gases commonly found in homes and industries, including LPG, i-butane, hydrogen, methane, smoke, and alcohol. While the sensor provides valuable insights into gas presence, it does not offer precise gas concentration readings; instead, it indicates trends within an acceptable margin of error. Nevertheless, this device automatically initiates precautionary measures upon detecting a potential gas leak, such as shutting off the main gas supply after a designated period to mitigate the risk of accidents. Furthermore, the integration of a Wi-Fi module enhances the system's capabilities by enabling real-time alerts to be sent to the owner. In the event of a gas leak, immediate action can be taken, as the system promptly sends alert messages to notify the user, facilitating timely intervention and preventing potential hazards.

INTRODUCTION

Despite the availability of safety devices such as smoke detectors and fire extinguishers, conventional measures often fall short in protecting individuals from the harmful consequences of gas leakage incidents. Tragic events like the Bhopal gas tragedy in December 1984, claiming over 3,000 lives due to a methyl isocyanate leak, and the Nagaram incident in Andhra Pradesh in June 2014, where a rusty pipe resulted in a gas leak and explosion at Gas Authority of India Limited's plant, resulting in 29 fatalities, underscore the urgent need for technological advancements in gas leak detection and prevention.
The potential for catastrophic consequences underscores the importance of early gas leak detection. The MQ6 sensor represents a significant advancement in this regard, offering both detection and prevention capabilities. With its high sensitivity and rapid response time, the MQ6 sensor utilizes a sensitive SnO2 filament to maintain low electrical conductivity in clean air conditions. However, when exposed to combustible gases like LPG, the filament's conductivity increases, enabling prompt detection of gas leaks.

This project leverages the capabilities of the MQ6 sensor in conjunction with Arduino technology to create an efficient gas leakage detection system. By integrating the sensor with an ESP8266 Wi-Fi module, the system achieves connectivity to the internet, allowing for real-time monitoring and alerts. Parameters such as maximum and minimum gas concentration levels can be easily configured to suit specific requirements.

In the event of a gas leak detection, the system automatically triggers an alert mechanism, notifying the owner via SMS. This proactive approach enables swift intervention, minimizing the risk of accidents and ensuring the safety of individuals and property

LITERATURE REVIEW

Over the years, researchers and innovators have proposed various solutions aimed at preventing and detecting gas leakages, showcasing a diverse array of approaches and technologies. Malipatil, Shilpa, and Jayasudha [1] presented a comprehensive system incorporating components such as Arduino, LPG, GPS, MQ6 sensor, Load cell, and Signal amplifier. This setup continuously monitors the level of gas in cylinders, issuing timely alert SMS notifications to users when levels drop below a predefined threshold of 2 kilograms, while also adeptly detecting leakage levels.

Another noteworthy contribution by Siddharth, Rameswari, Keerthana Gayathri, and Kavin Sanjaya [2] resulted in the development of a Smart Gas Assistant designed for efficient kitchen operations. Their innovative system seamlessly integrated Arudino, Wi-Fi, GSM Module, Internet of Things (IoT), an Online Tool, and a Mobile Application. It not only accurately measures the quantity of LPG in cylinders but also automatically initiates bookings from registered numbers. Moreover, it delivers proactive alert messages to customers, providing real-time updates on the remaining volume of gas available in the cylinder.

Anusha, Nagesh, Venkata Sai, Srikanth, and Rupalin Nanda [3] contributed to the field with their IoT-Based LPG Leakage Detection and Booking System, featuring Customer SMS Alerts. This sophisticated system employed a combination of a GSM Modem, MQ2 Gas Sensor, Load Cell, and AWS server to autonomously identify instances of fuel leaks, promptly alerting users through SMS notifications. In scenarios where users are unable to respond promptly, the system takes proactive measures by automatically reserving LPG gas and updating reservation data on the server using AWS technology. These pioneering systems exemplify the ongoing efforts within the research community to enhance gas safety through technological innovation, showcasing the potential of IoT, GSM, and sensor technologies in mitigating risks associated with gas leakages and ensuring the safety and well-being of individuals and communities alike.

PROPOSED SYSTEM

The proposed system introduces a comprehensive approach to gas leak detection and prevention, leveraging cutting-edge components including the Arduino Uno, MQ9 gas sensor, 16x2 LCD display, SIM800L/900 GSM module, GPS module, and optionally, a WiFi module. This integrated setup addresses the limitations of conventional safety devices, providing an advanced solution for enhanced safety.

1. Gas Leak Detection Mechanism:

- The MQ9 gas sensor serves as the primary detector, continuously monitoring the gas level.
- Upon detecting a gas level increase of 30% or more, the sensor signals the Arduino Uno board.

2. Alert System:

- The Arduino Uno board processes the sensor data and activates the alert mechanism.
- The 16x2 LCD display provides visual feedback, indicating the detection of a gas leak.
- An exhaust fan and buzzer are activated to alert neighboring individuals to the potential danger.

3. SMS and Call Alerts:

- The integrated SIM800L/900 GSM module sends SMS alerts to pre-defined phone numbers upon gas leak detection.
- Additionally, the module initiates a call to the designated phone number, ensuring immediate attention to the alert.
- The SMS alert includes a notification stating "Gas Leak Detected" along with relevant information.

4. Image Capture:

- In case of a gas leak, the system captures images using an attached camera and includes them in the alert message sent to the owner.
- This feature provides crucial visual information to the owner, enabling remote assessment of the situation.

5. GPS Location Sharing:

- The system incorporates a GPS module to provide real-time location sharing.
- Upon detecting a gas leak, the system includes the GPS coordinates in the SMS alert, allowing recipients to pinpoint the exact location of the incident.

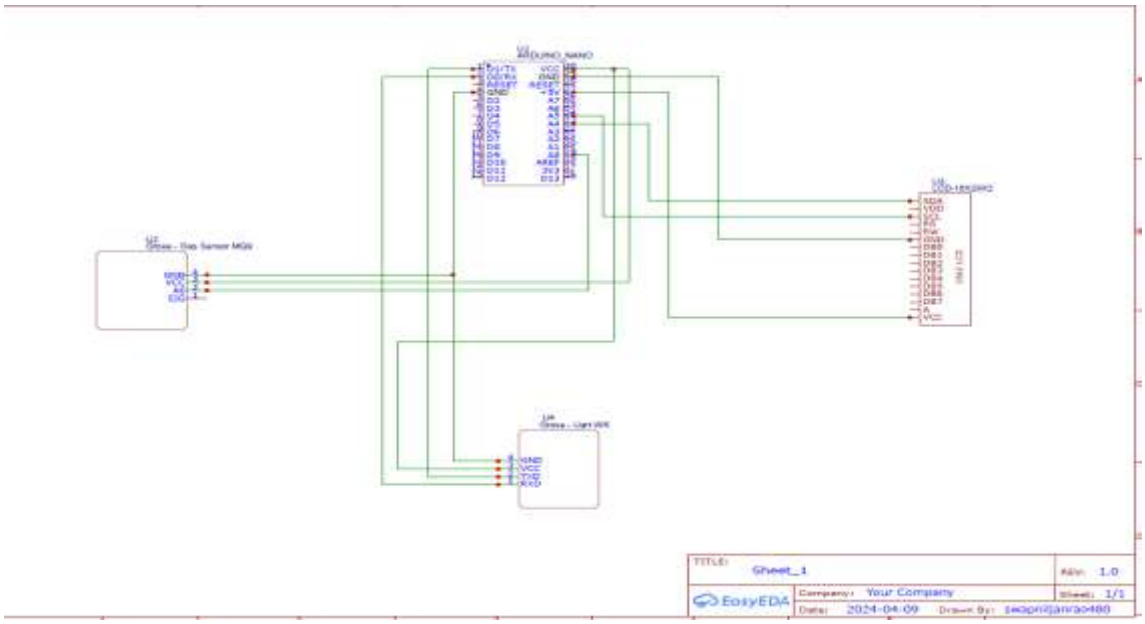
6. Wi-Fi Module Integration (if applicable):

- Optionally, a Wi-Fi module can be integrated into the system to enable additional connectivity options.

- This feature allows for real-time alerts, remote monitoring, and control via a web interface, providing an extra layer of security and oversight. This holistic approach to gas leak detection promises to revolutionize safety measures in both domestic and industrial settings, filling the critical gap in existing safety devices.

CIRCUIT CONNECTIONS

The proposed gas leak detection and alert system utilizes a combination of hardware components interconnected to achieve its functionality. The circuit connections are as follows:



(CIRCUIT DIAGRAM)

1. 16x2 LCD Display:

- The 16x2 LCD display is interfaced with the Arduino Uno microcontroller.
- The Ground (GND) pin of the LCD display is connected to the Ground (GND) pin of the power source to establish the common reference voltage.
- The Voltage Common Collector (VCC) pin of the LCD display is connected to the 5V output of the power source to provide power.
- The Serial Data (SDA) pin of the LCD display is connected to Analog pin A4 of the Arduino Uno for data transmission.
- The Serial Clock (SCL) pin of the LCD display is connected to Analog pin A5 of the Arduino Uno for clock synchronization.

2. MQ9 Gas Sensor:

- The MQ9 gas sensor is directly connected to the Arduino Uno microcontroller for gas detection.
- The Analog Output (A0) pin of the MQ9 gas sensor is connected to Analog pin A0 of the Arduino Uno for analog signal transmission.
- The VCC pin of the MQ9 gas sensor is connected to the VCC (ICSP) pin of the Arduino Uno to receive power.
- The Ground (GND) pin of the MQ9 gas sensor is connected to the Ground (GND) pin of the power source to establish the common reference voltage.

3. SIM800L GSM Module:

- The SIM800L GSM module is integrated with the Arduino Uno microcontroller for SMS alert functionality.

- The Ground (GND) pin of the SIM800L GSM module is connected to the Ground (GND) pin of the digital section of the Arduino Uno.
- The Transmit Data (TXD) pin of the SIM800L GSM module is connected to the Receive (RX) pin (e.g., pin 1) of the Arduino Uno for data transmission.
- The Receive Data (RXD) pin of the SIM800L GSM module is connected to the Transmit (TX) pin (e.g., pin 0) of the Arduino Uno for data reception.
- The Voltage Common Collector (VCC) pin of the SIM800L GSM module is connected to the 3.3V output of the power source to provide power. These connections establish the necessary communication pathways between the components, enabling the gas leak detection and alert system to function effectively.

ARDUINO HARDWARES

Arduino is an open-source hardware and software platform popularly used for creating interactive projects and prototypes. It consists of both physical hardware and a development environment for programming microcontroller-based devices. The hardware components typically include:

1. Arduino Uno:

- The Arduino Uno is a popular microcontroller board based on the ATmega328P chip, featuring a total of 14 digital input/output pins, 6 of which can be used as PWM (Pulse Width Modulation) outputs, allowing for precise control of analog peripherals such as LEDs and motors.
- Additionally, it includes 6 analog input pins for reading analog sensors, a 16 MHz quartz crystal oscillator for timing, a USB connection for programming and serial communication, a power jack for external power input, and an ICSP (In-Circuit Serial Programming) header for bootloader programming.

(Arduino uno board)

2. 16x2 LCD Display:

- The 16x2 LCD display is a commonly used alphanumeric display module consisting of two lines, each capable of displaying up to 16 characters.
- It operates on the principle of liquid crystal display (LCD) technology, providing a clear and easily readable interface for displaying text, numeric data, and basic symbols.
- The display can be backlighted for improved visibility in low-light conditions and is often used in Arduino projects for providing user feedback, status information, or menu navigation.

(16x2 Lcd display)

3. MQ9 Gas Sensor:

- The MQ9 gas sensor is a gas detection module equipped with a semiconductor gas sensor capable of detecting a wide range of gases, including carbon monoxide (CO), methane (CH4), and liquefied petroleum gas (LPG).
- It operates based on the principle of resistance change in the presence of target gases, with higher gas concentrations leading to greater resistance.
- The sensor's analog output can be interfaced with the Arduino Uno for real-time gas monitoring, making it suitable for applications such as gas leak detection systems in industrial and residential environments.

(MQ9 GAS SENSOR)

4. 12V Power Supply Charger:

- The 12V power supply charger is an external power source used to provide stable DC voltage to the Arduino Uno and other peripherals in the system.
- It typically accepts AC input voltage from a mains power source (e.g., 100-240V AC) and converts it to a regulated 12V DC output.
- The charger ensures reliable and uninterrupted power supply to the Arduino board, essential for continuous operation in standalone or portable applications.

(12V CHARGER FOR POWER SUPPLY)

5. SIM800L Module:

- The SIM800L module is a compact GSM/GPRS (Global System for Mobile Communications/General Packet Radio Service) module designed for wireless communication in Arduino projects.
- It integrates GSM and GPRS functionalities, allowing for SMS (Short Message Service) messaging, voice calls, data transmission, and internet connectivity over the cellular network.
- The module communicates with the Arduino Uno via UART (Universal Asynchronous Receiver-Transmitter) serial communication and is commonly used for remote monitoring, control, and communication in IoT (Internet of Things) applications.

(SIM800L MODULE)

Understanding the capabilities and functionalities of Arduino hardware components, including the Arduino Uno board, 16x2 LCD display, MQ9 gas sensor, 12V power supply charger, and SIM800L module, is essential for designing and implementing projects effectively in various application domains.

HARDWARE RESULTS

The hardware setup consisted of interconnected Arduino components powered by a 12V charger. Under normal conditions, the system displayed a baseline gas level of 14%. Upon simulating a gas leakage scenario using a body spray containing gas, the MQ9 gas sensor detected the increase, with gas levels reaching 60%. Upon surpassing the 30% threshold, the system immediately triggered a gas leakage alert. The display promptly indicated "Gas Leakage Detected," while the SIM800L module activated to send SMS alerts to the user's mobile phone. Additionally, the system initiated a phone call, ensuring immediate notification of the gas leak. These results demonstrate the system's effectiveness in promptly detecting and alerting users to gas leakage incidents.

(WORKING MODULE OF GAS DETECTION SYSTEM)

CONCLUSION

The successful implementation and testing of the Arduino-based gas leakage detection system underscores its efficacy in real-time monitoring and alerting. By leveraging interconnected hardware components and the MQ9 gas sensor, the system demonstrated robust performance in detecting gas leaks promptly. The results highlight its ability to accurately identify gas concentration changes, triggering timely alerts to mitigate potential hazards. The integration of SMS alerts and phone call notifications further enhances its usability and ensures immediate response to gas leakage incidents. Overall, the system's simplicity, reliability, and effectiveness make it a valuable tool for enhancing safety measures in various settings, from

homes to industrial environments, ultimately contributing to the prevention of gas-related accidents and protecting lives and property. Further refinements and optimizations could be explored to enhance its capabilities and broaden its applicability in addressing gas leakage challenges.

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