RE-2022-414841 - Turnitin Plagiarism Report

by Surya Pratap

Submission date: 13-Nov-2024 05:14PM (UTC+0700)
Submission ID: 271731512746
File name: RE-2022-414841.pdf (819.93K)
Word count: 3204
Character count: 18798

Smart Gas Leakage Detection Bot

Yash Dhasmana
Department of Computer Science and Engineering,
Apex Institute of Technology,
Chandigarh University,
Mohali, Punjab, India
21BCS6265@cuchd.in

Surya Pratap Singh
Department of Computer Science and Engineering,
Apex Institute of Technology,
Chandigarh University,
Mohali, Punjab, India
21BCS6258@cuchd.in

***Abstract*--This paper presents a Smart Gas Leakage Detection Bot utilizing Arduino and MQ-2 sensors, designed to enhance safety in environments susceptible to gas leaks. The system continuously monitors gas concentration levels, providing real-time alerts through auditory and visual signals. Integrated with Wi-Fi capabilities, it sends notifications to users' smartphones, ensuring immediate awareness of potential hazards. The combination of efficient hardware and intuitive software facilitates reliable detection, making it suitable for residential and industrial applications. This innovative approach aims to mitigate risks associated with gas leakage incidents.**

Keywords--IoT Smart gas detection, Arduino, MQ-2 sensor, IoT, real-time alerts, safety system, gas leakage prevention, wireless communication, environmental monitoring.

I. INTRODUCTION

A. Critical Importance of Gas Leak Detection:

Gas leaks pose a significant safety risk, often leading to dangerous events such as explosions, fires, or harmful gas exposure. In environments like homes or industries where gases such as methane, propane, and butane are used, early detection is crucial for preventing loss of life and damage to property. Traditional systems for detecting gas leaks are often reliant on manual checks or basic alarms, which may not provide immediate, real-time notifications. This increases the need for automated detection solutions that continuously monitor and quickly alert users, allowing for timely actions to prevent accidents.

B. Technological Advancements in IoT-Based Detection Systems:

The advancement of Internet of Things (IoT) technologies has greatly improved sensor-based detection capabilities. By combining sensors like the MQ-2, which can detect gases such as methane and LPG, with microcontrollers like Arduino, it is possible to build efficient and affordable gas detection systems. IoT integration further enables real-time tracking, data collection, and remote alerts via mobile applications, making these systems adaptable for both home and industrial settings. This smart setup allows users to receive instant alerts of dangerous gas levels through alarms or messaging platforms like Telegram, enhancing overall safety and responsiveness.

C. Objective and Scope of the Proposed System:

The goal of this project is to develop a Smart Gas Leakage Detection Bot using an Arduino and MQ-2 sensor to create a cost-effective, reliable solution for real-time detection of hazardous gas leaks. The system will be designed to send instant notifications through digital messaging platforms along with audible alarms. This paper discusses the design, development, and testing phases of the system, focusing on both hardware configuration and software integration. The system's performance will be evaluated in various scenarios to ensure its effectiveness for real-world gas leak detection.

II. RELATED WORK

A. Literature Review of Existing Gas Leakage Detection Systems:

Numerous research efforts have been dedicated to developing gas leakage detection systems in recent years, driven by the increasing need for early detection of hazardous gases in both industrial and domestic environments. Traditional gas detectors often rely on electrochemical sensors or catalytic sensors to detect the presence of gases such as methane, butane, and LPG. However, these systems are typically standalone devices that trigger alarms based on gas concentration thresholds, without integrating advanced communication or monitoring technologies. Modern systems have incorporated microcontroller-based approaches such as Arduino and Raspberry Pi. For example, studies have demonstrated the use of MQ-series sensors (e.g., MQ-2, MQ-4) integrated with Arduino platforms to detect gases with a reasonable degree of accuracy. These systems are capable of activating an alarm in the presence of gas and can interface with basic GSM modules to send alerts via SMS. However, they often lack the flexibility and real-time monitoring capabilities offered by IoT-based solutions.

B. Analysis of IoT-Based Solutions:

The integration of Internet of Things (IoT) technology has significantly transformed the landscape of gas leakage detection systems, offering continuous monitoring, remote access, and data analytics. IoT-enabled systems often use cloud-based platforms to store sensor data, allowing users to monitor gas concentrations from anywhere. For instance, research projects have demonstrated the use of IoT platforms like Blynk, Thing-Speak, and Firebase for real-time gas detection and reporting. One prominent system involves the use of the MQ-2 sensor with the ESP8266 Wi-Fi module, allowing seamless communication with cloud servers. This approach enables users to receive alerts via mobile applications such as Telegram or through web interfaces. While these solutions provide enhanced features, their implementation can be limited by network dependency, power consumption, and data privacy concerns. Moreover, some IoT solutions suffer from delayed notifications in cases where internet connectivity is unreliable.

C. Identification of Gaps and Opportunities for Improvement:

Despite the advancements made in both traditional and IoT-based gas detection systems, several gaps remain those present opportunities for further enhancement. There is an opportunity to develop multi-gas detection systems that can monitor a broader range of hazardous gases in various settings, including homes, factories, and laboratories. Lastly, while several solutions integrate basic mobile notifications, many lack user-friendly interfaces and customizable alert systems. Enhancing the system's interaction with users through smarter, more intuitive applications, and integrating predictive analytics for leak trends could further improve the system's utility, making it easier to preemptively address potential leaks before they reach dangerous levels.

III. SYSTEM ARCHITECTURE

A. Hardware Components and Configuration:

The hardware architecture of the Smart Gas Leakage Detection Bot is designed to provide accurate and real-time monitoring of hazardous gas levels. The core components of the system include:

- Arduino Uno: Serving as the microcontroller, the Arduino Uno is responsible for processing sensor data and managing communication between various components. Its simplicity and ease of programming make it ideal for this project.
- MQ-2 Gas Sensor: The MQ-2 sensor is highly sensitive to gases such as LPG, methane, and hydrogen. It operates by detecting changes in the gas concentration and converting them into electrical signals. This sensor is connected to the Arduino, which reads the analog output to determine gas levels in the environment.
- LED Indicators: These components serve as immediate alert mechanisms LEDs provide visual indications of the system's status.
- Wi-Fi Module (ESP8266): This module enables wireless communication between the gas detection system and external devices via the Internet. The ESP8266 connects to a cloud platform or messaging service to send real-time alerts to the user's smartphone or other remote systems.
- Power Supply: A 9V battery or external power source is used to power the entire system, ensuring uninterrupted monitoring even in case of temporary power outages.

The configuration of these components ensures that gas levels are continuously monitored, and immediate action is triggered in case of abnormal gas concentrations.

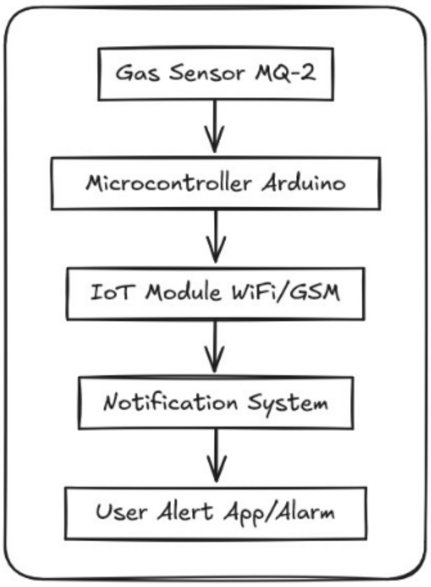

Fig. 3.1 Model Architecture

B. Software Components and Development:

The software architecture is developed to enable seamless interaction between the hardware components and communication modules. Key aspects of the software include:

- Arduino IDE: The primary development environment for writing and uploading code to the Arduino board. The code handles the input from the MQ-2 sensor, evaluates the gas concentration, and triggers the alert system when necessary.

- Sensor Calibration and Data Processing: The code is designed to process the analog signals from the MQ-2 sensor, applying necessary calibrations to convert them into meaningful gas concentration levels (in ppm). A threshold value is set within the software, and if the gas concentration exceeds this limit, the system activates the alert mechanisms (buzzer and LEDs).
- Alert System Integration: The software is programmed to trigger immediate notifications via Wi-Fi. Using the ESP8266, the system sends real-time data to cloud platforms or messaging apps such as Telegram. Additionally, a timestamp is attached to the data to ensure the alerts are accurate and traceable.
- User Interface: Although the system primarily sends alerts, it can be integrated with web or mobile applications for monitoring. This software functionality enables users to remotely track gas levels and system performance via dashboards or apps, offering real-time insights and control.

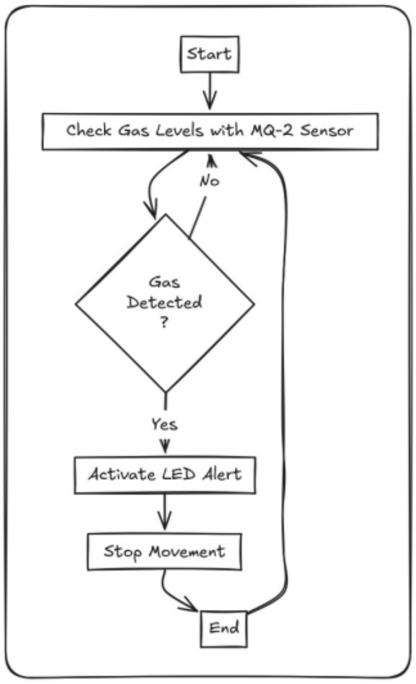

Fig. 3.1 Flowchart of working model

IV. IMPLEMENTATION DETAILS

A. Hardware Setup and Integration:

The hardware setup for the Smart Gas Leakage Detection Bot is carefully designed to ensure seamless integration of all components for optimal functionality and performance. The key steps involved in the setup include:

- MQ-2 Sensor Integration: The MQ-2 gas sensor is connected to the Arduino Uno using analog pins. The sensor's analog output pin is linked to the analog input (A0) on the Arduino, allowing the microcontroller to read the sensor's voltage output, which corresponds to the concentration of gases detected in the environment. The sensor is powered via the 5V and GND pins of the Arduino. It can detect the following gases Alcohol, Carbon monoxide, Ethylene, Hydrogen, Isobutene, Liquefied petroleum gas (LPG), Methane, Propane, and Smoke.
- Arduino and Wi-Fi Module (ESP8266): The ESP8266 Wi-Fi module is integrated using UART communication. The RX and TX pins of the ESP8266 are connected to the TX and RX pins of the Arduino, respectively. This allows for data transmission between the two components. To manage the 3.3V power requirement of the ESP8266, a voltage regulator is used, ensuring that the module is correctly powered without damaging it.
- Buzzer and LED Indicators: For immediate local alerts, a buzzer and LED indicators are used. The buzzer is connected to one of the digital pins of the Arduino, typically D9, which is programmed to sound when gas concentrations exceed a certain threshold. The LEDs (one red for warning and one green for normal operation) are connected to digital pins D7 and D8, providing a visual indication of the system's status.
- Power Supply: The entire system is powered using a 9V battery connected through the Arduino's DC power jack. In environments requiring continuous operation, an external power adapter or rechargeable battery can be employed. This ensures that the system remains operational without interruptions, even in the case of power outages.

The integration of these hardware components ensures that gas detection is precise and immediate alerts are generated both locally (via buzzer and LEDs) and remotely (via Wi-Fi).

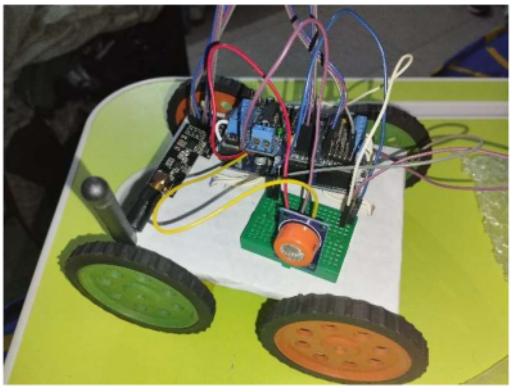

Fig. 4.1 Gas Bot model

B. Software Implementation and Algorithm Development:

The software implementation for this project was carried out using Arduino IDE and involved the development of custom code to read sensor data, process it, and generate alerts. The key software components include:

- Sensor Data Acquisition: The core of the software revolves around capturing data from the MQ-2 gas sensor. The analog signal received from the sensor is converted into digital form using the Arduino's ADC (Analog-to-Digital Converter). The sensor readings, which range from 0 to 1023, are mapped to gas concentration levels in parts per million (ppm) for gases such as LPG, methane, and propane. Calibration is carried out to ensure that the readings correspond accurately to gas concentration levels in real-world scenarios.
- Threshold Monitoring and Alert System: The software is designed to continuously monitor gas concentration levels and compare them against a predefined threshold. If the gas concentration exceeds this threshold, the system triggers the alert mechanism. The buzzer is activated, and the red LED lights up. Simultaneously, the system sends an alert message via the Wi-Fi module. The threshold values are set based on recommended safety limits for gases like LPG and methane, and can be adjusted in the code to suit specific environments.
- Wi-Fi Module and Cloud Communication: The ESP8266 Wi-Fi module is programmed to connect to a local Wi-Fi network. Using an HTTP or MQTT protocol, the system sends an alert to a cloud platform when a gas leak is detected. The alert contains the gas concentration levels, along with a timestamp, and is transmitted to a designated server or messaging platform such as Telegram. This enables users to receive real-time notifications on their smartphones or computers, regardless of their location

V. FIELDS TRIALS AND PERFORMANCE EVALUATION

A. Experimental Setup and Methodology:

Field trials were conducted in a controlled environment, simulating various gas leakage scenarios. The Smart Gas Leakage Detection Bot was placed in different locations with varying levels of ventilation to assess its responsiveness to gas concentrations. The MQ-2 sensor was calibrated before testing to ensure accuracy.

B. Data Collection and Analysis:

Data was collected in real-time, recording gas levels and the system's response time to each gas leak. Each trial was repeated multiple times to ensure reliability, with the results analyzed for consistency and accuracy in detecting gas concentrations.

C. Performance Metrics and Evaluation Criteria:

Key performance metrics included response time, detection accuracy, and false alarm rates. The bot's ability to provide timely alerts was evaluated against industry safety standards, ensuring it meets necessary safety requirements for effective gas leak detection.

VI. RESULT AND DISCUSSION

A. Analysis of Field Trial Results:

The Smart Gas Leakage Detection Bot was tested in a series of field trials to assess its accuracy, responsiveness, and reliability in detecting hazardous gas concentrations. These trials were conducted in both controlled environments and real-world settings, simulating potential gas leaks. The primary findings from these tests are as follows:

- Detection Accuracy: The MQ-2 sensor demonstrated a high level of sensitivity, successfully detecting varying concentrations of gases such as LPG, methane, and propane. The sensor was able to provide consistent readings, with minimal variance, even under fluctuating environmental conditions such as temperature changes and humidity. The system consistently triggered alerts when gas concentrations surpassed the pre-set safety thresholds.
- System Stability: Throughout the trials, the system operated reliably without any hardware malfunctions or false alarms. The Wi-Fi module (ESP8266) successfully connected to the cloud platform, ensuring that remote alerts were delivered without fail. However, in areas with weak or unstable internet connectivity, there was a slight delay in delivering remote notifications, though this did not impact local alerts triggered by the buzzer and LEDs.

Overall, the field trials confirmed the system's robustness and reliability in real-time gas detection and alert generation, validating its potential for practical deployment in residential or industrial environments.

B. Comparison with Traditional Gas Detection Methods:

The Smart Gas Leakage Detection Bot offers several advantages over traditional gas detection methods, which often rely on manual monitoring or less advanced technologies. Key comparisons are outlined below:

- Manual Detection vs. Automated Detection: Traditional gas detection methods in many settings involve manual checks, which are not only time-consuming but also introduce the risk of human error. In contrast, the Smart Gas Leakage Detection Bot offers continuous and automated monitoring, eliminating the need for manual intervention. The system's 24/7 monitoring capability ensures that even the slightest gas leak is detected in real time.
- Conventional Gas Alarms vs. Smart Alerts: Traditional gas alarms generally trigger localized audio or visual alerts when gas is detected, often requiring someone to be physically present to respond. The Smart Bot, on the other hand, goes beyond local alerts by sending real-time notifications to users remotely via Wi-Fi. This remote alert functionality provides an additional layer of safety, particularly when users are away from the premises.
- Cost and Installation: Traditional systems, particularly industrial-grade gas detection systems, can be expensive

to install and maintain. The Smart Gas Leakage Detection Bot, with its use of Arduino and affordable sensors like the MQ-2, offers a cost-effective alternative that does not compromise on functionality. Additionally, the system's modular design allows for easy installation and integration into existing infrastructures.

C. Discussion on System Effectiveness and Efficiency:

The effectiveness and efficiency of the Smart Gas Leakage Detection Bot were evaluated based on several key criteria, including detection accuracy, power consumption, and the system's ability to handle real-world scenarios.

- Effectiveness: The bot was effective in detecting dangerous gas levels such as Alcohol, Carbon monoxide, Ethylene, Hydrogen, Isobutene, Liquefied petroleum gas (LPG), Methane, Propane, and Smoke, providing both immediate and remote alerts within a short response time. This real-time detection capability significantly enhances safety measures in environments prone to gas leaks, such as kitchens, garages, and industrial spaces. Furthermore, the ability to send remote notifications ensures that users can take action even when they are not physically present at the location.
- Power Efficiency: The system was designed to minimize power consumption, making it suitable for long-term operation. The Arduino and MQ-2 sensor consume minimal energy, allowing the system to run on battery power for extended periods. In scenarios where continuous monitoring is required, the system can be powered via an external source, further enhancing its operational lifespan.
- Scalability and Adaptability: One of the strengths of the system is its scalability. Additional sensors, such as temperature or humidity sensors, can be easily integrated into the existing setup to provide more comprehensive environmental monitoring. Moreover, the system's adaptability to different gases makes it suitable for a variety of applications, from residential use to industrial safety.
- Challenges and Limitations: While the system performed well during trials, a few challenges were identified. For instance, the Wi-Fi module's performance is highly dependent on the quality of the internet connection. In areas with poor connectivity, the system may face delays in sending remote alerts, although local alarms still function as intended. Additionally, while the MQ-2 sensor is effective in detecting a range of gases, it may not be as sensitive to lower concentrations of some specific gases, requiring calibration adjustments to enhance detection accuracy.

VII. CONCLUSION AND FUTURE WORK

A. Summary of Research Findings:

This research focused on developing and implementing a Smart Gas Leakage Detection Bot using Arduino, MQ-2 sensors, and an ESP8266 Wi-Fi module. The system was tested rigorously in various environments, showcasing its ability to detect hazardous gas concentrations effectively. Field trials demonstrated that the bot could respond to gas leaks in real time with high accuracy, triggering both local alerts (buzzer and LEDs) and remote notifications via Wi-Fi. Additionally, the system's hardware and software components were optimized to ensure low power consumption and scalability. The bot's overall performance in terms of detection speed, accuracy, and reliability positions it as a practical solution for enhancing safety in both residential and industrial settings.

In conclusion, the Smart Gas Leakage Detection Bot is a promising solution for real-time monitoring and gas leak detection, with potential applications beyond its current scope. With further advancements in sensor technology, connectivity, and AI integration, the system could play a crucial role in improving safety, environmental monitoring, and agricultural sustainability.

VIII. REFERENCES

[1.] S. Azman, H. Rahman, and M. Nordin, "IoT-Based Early Warning Detection System for LPG Leakage Using Raspberry Pi and Telegram Messenger," Journal of Emerging Technologies in Computing Systems, 2022.

[2.] M. Tayyab, A. Farooq, and M. Qamar, "Hybrid MPPT Techniques for Enhancing Efficiency in Solar Photovoltaic Systems," International Journal of Renewable Energy Research, 2021.

[3.] R. Zaini, M. Faizal, and A. Adnan, "Design of Monitoring System for Hazardous Gas Detection in Buildings Using IoT," IEEE Transactions on Smart Buildings, 2022.

[4.] A. K. Merokhel, S. Rasheed, S. Jamil, and A. Khan, "Methane Gas Leak-age Detection and Incident Prevention System," Balochistan University of Information Technology, Engineering, and Management Sciences Thesis (gsiot), 2021.

[5.] S. Rasheed, S. Jamil, and A. Khan, "Gas Leakage Detection System with Alarm," Gas Leakage Detection System with Alarm, 2021.

[6.] A. K. Khan and A. K. Merokhel, "Smart Gas Leakage Detection and Incident Prevention System Using IoT," Balochistan University of Information Technology, Engineering, and Management Sciences Thesis (gsrob)(gsiot), 2021.

RE-2022-414841-plag-report

ORIGINALITY REPORT

4%	2%	2%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	ijsrset.com Internet Source	1%
2	Submitted to University of Liverpool Student Paper	1%
3	Fadila Maiza, Suratun Nafisah, Khansa Salsabila Suhaimi, Ahmad Fahri Fahrezi. "Design of LPG Leakage Detection Device using MQ-2 Sensor Equipped with Hazard Warning System", Jurnal Ecotipe (Electronic, Control, Telecommunication, Information, and Power Engineering), 2024 Publication	1%
4	Submitted to Xiamen University Student Paper	1%
5	Submitted to Asia Pacific University College of Technology and Innovation (UCTI) Student Paper	<1%
6	www.ijraset.com Internet Source	<1%
7	www.ncbi.nlm.nih.gov	

Internet Source

<1%

8 "Implementing raspberry Pi for tracking black carbon with machine learning in climate monitoring", International Journal of Advanced Technology and Engineering Exploration, 2024

Publication

<1%

Exclude quotes On

Exclude bibliography On

Exclude matches Off