HAZARDOUS GAS DETECTION SYSTEM WITH AN ALERTING MECHANISM

Sudeep sagar[1], Tanuja N G[2], Akanksha K A [3] and Harshitha S[4]

Students, Dayananda Sagar Academy Of Technology And Management, Bengaluru, India

Dr. Rama Abirami K, Associate Professor, Dayananda Sagar Academy Of Technology And Management, Bengaluru, India

sudeepsagar448@gmail.com[1], tanujang082002@gmail.com[2] , akankshaka692@gmail.com[3], harshithasomashekar527@gmail.com[4]

Abstract- Several head-ways are made with technological advancement in our day-to-day lives providing us with improved living standards, safety, and security. One such development is the IoT. This paper proposes a detection setup for harmful gas emission with an alert system using IoT. Harmful gas leakage in industrial plants and oil refineries, can lead to devastating consequences, including death. To prevent all these, this paper lays out a system that can pass an alert, whenever a gas discharge occurs. Arduino is used in this setup, along with various Gas Sensors (MQ-2, MQ-3, MQ-6, MQ-135), which identifies gasses such as Carbon Monoxide, LPG, propane and many more. It also detects power outages and smoke/fire in the work environment. The Arduino is in coalition with a Wifi module. An alert is sent to the person by calling or sending an alert SMS. If a gas leakage occurs, the system would detect it and automatically generate an alert signal.

Keywords – Gas sensors, alarm, hazardous, Arduino, Artificial Intelligence, IOT.

1. Introduction

Industrial safety is a critical concern in our daily lives and it is everyone's responsibility to ensure a safe working environment. The primary objective is to use IoT to eliminate hazardous gases from industrial sites. Human bodies are vulnerable to various toxic gases and hazardous chemicals or elements in the atmosphere. If the level of hazardous gases surpasses the human body's tolerance limit, it can lead to serious danger or even death. To ensure Safety in industrial areas, a gas detection system is essential to detect the levels of toxic gases present. These areas often contain high concentrations of

Hazardous gases, such as carbon monoxide (CO), methane (CH4), butane, and more, increase the risk of accidents. To mitigate this risk and protect human life, a gas detection system is necessary. From this point of view, our project offers several advantages:

- A practical, cost-effective, and sensible project with real-world applications
- Accurate information
- A less complex circuit

2. Literature survey

Tanvira Ismail et al. [2] explored the potential of a gas leakage system based on GSM. Their notion was when the gas sensor detects some gas, a signal will be delivered to a microcontroller's ADC unit, which activates integrated external devices, such as an exhaust fan, buzzer and GSM module. In a separate study, the aim was developing an automatic cylinder booking system and gas inspection device for domestic use, utilizing a MQ-4 gas sensor to detect

gas efflux and recording the data using an LCD monitor, buzzer, and sending SMS via a GSM module. In an automated cylinder booking system [3] , a load cell was utilized to detect hazardous gas and send alerts via email smartly. Pavithraa et al. [5] debated LPG gas booking and monitoring system using IoT, which incorporated a GPS and load cell. Mahalingam et al. [6] explored the implementation and design of an economical hazardous gas detector. They developed a unique circuit to sense gas and established a threshold for gas accumulation. If that value exceeded the set threshold, the circuit detected it and provoked an alarm, sending a signal to the RF receiver. Faisal et al. [8] established a system where several gas detectors were used to sense the hazardous gasses in the atmosphere and send messages to few recorded phone numbers, an LCD display, and trigger a buzzer. Salhi et al. [13] implemented a hazardous gas detection and smoke detection devices for early threat sensing in smart homes using machine learning algorithms. This model was unique because it utilized a separate centralized Machine-to-Machine method to detect gas and smoke very early in its initial stages where the threat is minimum to zero. It also housed data mining techniques to detect irregular changes in the atmosphere.
The following table summarizes all the reviewed literature papers by categorizing the identical features. .

TABLE I
SUMMERY OF THE RELATED WORKS

Reviewed Paper	IoT	Call Service	Machine Learning
[2]	No	No	No
[3]	No	No	No
[4]	Yes	No	No
[5]	Yes	No	No
[6]	No	No	No
[7]	No	No	No
[8]	No	No	No
[9]	No	No	No
[13]	Yes	No	Yes

Table I demonstrates that none of the literature reviewed covers IoT-based gas, smoke, or fire detection, inspiring us to develop our own network. In our proposed method, we have primarily focused on the implementation of an alerting system using multiple sensors which cover almost all bases of gases. We have endeavoured to achieve accurate output and have incorporated call facilities and IoT to effectively detect gas, smoke, and fire occurrences.

3. Background and Research Methodology

A. Block Diagram:

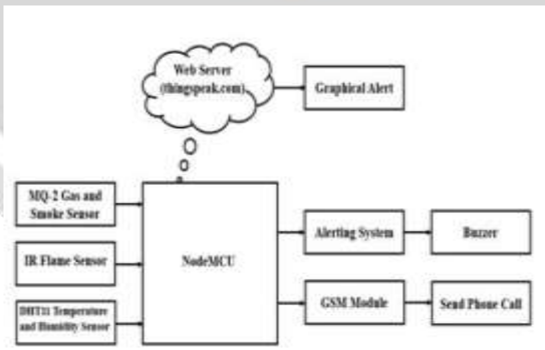

Fig. 3.1 - Overall working diagram of the proposed system.

Figure 1 illustrates the operational flowchart of the proposed system, and provides a comprehensive overview of the system's functioning.

B. Logic Diagram:

Fig. 3. 2 - Gas, smoke and fire leakage detection processing steps.

Figure 2 illustrates a flowchart of the proposed system. This flowchart provides a comprehensive overview of the system's structure and functionality.

Proposed System

It consists of automated modules which accomplish the following functions:

- This system is designed to replace human beings in dangerous areas. It is capable of identifying bombs and various gases in the war field.
- The system is able to sense the presence of hazardous gasses in our environment, and with the help of machine learning algorithms and technology; it can automatically identify and classify them.
- It can also predict the level of harm caused by the gasses with a high degree of accuracy.
- The read values from the hardware are displayed on an LCD monitor for reference, and are also automatically stored in an Excel sheet or CSV file for future reference

4. Proposed Approach

I. Hardware Design:

Arduino UNO microcontroller

A microcontroller board called Arduino UNO is based on the ATmega328P. It contains 6 analogue inputs, a 16 MHz ceramic resonator, 14 digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button.

Figure 4.1 – Arduino Microcontroller

Humidity and Temperature Sensor

Temperature sensors are electronic IoT devices used to measure the temperature of our environment. They take input data and convert it into electronic data for recording, monitoring, and signalling temperature changes in the environment. Similarly, humidity sensors are electronic devices used to monitor and measure the humidity of the environment.
They also take input and convert it into electronic data for recording and monitoring purposes.

Figure 4.2 – Temperature Sensor

MQ2 Gas Sensor
The MQ2 sensor is an IoT device used to sense a variety of gases in the air, such as liquid petroleum gas, alcohol, chlorine, and propane. This versatile device is an invaluable tool for monitoring air quality and ensuring safety in a variety of environments.

Figure 4.3 – MQ2 Gas Sensor

MQ3 Gas Sensor
The MQ-3 gas sensor boasts high sensitivity to alcohol vapors and is resistant to interference from smoke, gasoline and vapor. This sensor is cost-effective compared to the MQ-2 gas sensor, making it suitable for a variety of applications that require the detection of alcohol at varying concentrations.

Figure 4.4 – MQ3 Gas Sensor

MQ6 Gas Sensor
The MQ6 gas sensor is used to sense LPG. It is also suitable for a variety of industrial applications, making it an ideal choice for sensing gases such as LPG, propane, iso-butane, and LNG. This sensor is capable of providing reliable and accurate readings, making it an invaluable tool for ensuring the safety of the environment.

Figure 4.5 – MQ6 Gas Sensor

MQ135 Gas Sensor

The MQ-135 Gas Sensor can identify dangerous gases and smoke, including ammonia (NH_3), sulphur (S), benzene (C_6H_6), and CO_2. This sensor, like the others in the MQ series of gas sensors, has a pin for both digital and analogue output.

Figure 4.6 – MQ135 Gas Sensor

Flame Detector

Flame Detector detects the presence of a flame or fire in the surrounding environment. Depending on the scenario, possible actions to a fire detection may include turning off a fuel line (such as a propane or a natural gas line), sounding a buzzer, and turning on a fire extinguishing system in the work place.

Figure 4.7 – Flame detector

LDR Sensor

LDRs, often called light-dependent resistors, are tiny light-sensing devices. An LDR is a resistor whose resistance alters in response to fluctuations in the quantity of light particles hitting it. When light intensity is increased, the LDR's resistance goes down.

Figure 4.8 – LDR sensor

WiFi Module

ESP8266 is an WiFi Module with a 1MB Flash capacity. It is a self-contained SOC with an integrated TCP/IP protocol, this WiFi Module allows any microcontroller to access your WiFi network. The ESP8266 is capable of offloading all Wi-Fi dependant networking tasks from another application processor or also to host a new an application.

Figure 4.9 – WiFi Module

Buzzers

Piezo buzzers are inexpensive gadgets that can produce standard beeps and tones. Utilising a piezo crystal, a unique substance that transforms into a different shape when exposed to electricity, they function. The crystal can produce a pressure wave that the human ear perceives as sound if it presses on a diaphragm, similar to a miniature speaker cone.

II. Software Design:

In this project, software plays a critical role. To this end, an Arduino microcontroller code is employed. The NodeMCU is programmed with the necessary code to ensure proper operation. The code contains some complexity in order to obtain accurate information. Additionally, a string API key is used to establish a connection with the webserver.

The isnan() function is also utilized. The AT function is employed to make phone calls via the GSM module. Furthermore, delay() functions are employed to keep the program running in a fixed loop to ensure accurate results.

III. Machine Learning Algorithms:

We utilize machine learning algorithms for data splitting, training, and testing purposes. Logistic Regression and K Nearest Neighbour algorithms are two of the most popular algorithms used to predict the toxicity of gases. These algorithms are powerful tools for analyzing data and making predictions about the environment.

Logistic regression provides a consistent output which helps to predict the output based on real-time data. We are testing and training the data to ensure accuracy. By utilizing logistic regression, we can gain valuable insights into the data and make more informed decisions.

5. Results and Discussion

This section discusses the performance of the developed framework. The potential of the developed model is evaluated below, utilizing regression and KNN algorithms, and the results are compared. These methodologies provide a fast response rate and the diffusion can be created quicker than manual strategies. Furthermore, the framework has been proven to be more efficient than traditional approaches, allowing for faster and more accurate results.

The following are the data set which are distinguished as raw data and the acquired real time tested data respectively.

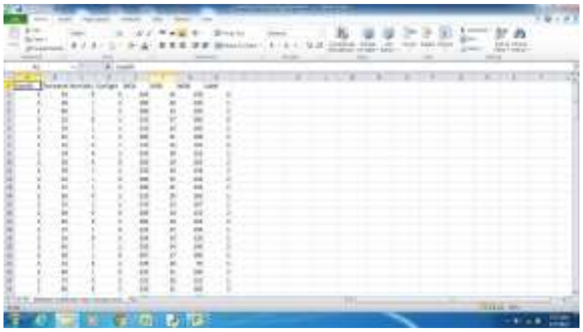

Figure 5.1 – Raw data

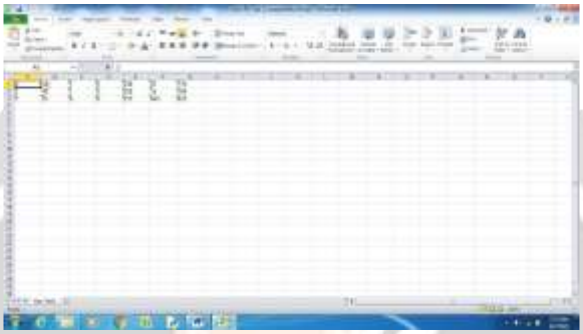

Figure 5.2 – Hardware real time tested data

6. Future works

Future enhancement of this research will involve data science techniques applied to improve the system's services and accuracy using cloud. Additionally, several gas and fire sensors will be used to detect fire and gas vapour emission in industries, who’s output can be monitored from a database. Furthermore, a centralized database will be developed to enable calling or messaging multiple users. GSM data can be gathered in the database and transmitted to distributed users. Finally, a gas and smoke detecting AI could be assembled to detect the harmful gases.

7. Conclusion

The primary objective of this research is to develop a low-cost and straightforward system that can be operated in three modes:

- Gas leakage detection mode
- Fire leakage detection mode
- Temperature detection mode

A message alert system is used when gas, smoke, or fire residues escape, sending a message to the user's device. However, we have implemented an alarm system, which provides users with several advantages. Additionally, we have deployed a system with various sensors, making it user-friendly and cost-effective.

Furthermore, it not only provides a call alert, but also a graphical alert on the web server. To further enhance the system's accuracy and prediction ability in critical situations, we have applied machine learning algorithms.

Future work of this research will include data analytics applied to the cloud to improve the system's services and accuracy. Additionally, multiple gas and fire sensors will be used to detect gas and fire leakage in industries and a database will be created to store the sensors' output. Furthermore, a database will be developed to enable calling or messaging multiple users. GSM data will be stored in the database and transmitted to multiple users. Finally, a gas and fire sensing robot could be constructed to detect gas leakage through pipelines.

8. References

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