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 by also monitoring the data, plotting a graph using ThingSpeak

Keywords – Gas sensors, alarm, hazardous, Artificial Intelligence, IOT, ThingSpeak

I. 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 surpass 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

Existing System Drawbacks:

1. *Cost and Accessibility:* Some existing systems are expensive, making them less accessible to individuals from economically disadvantaged backgrounds. This can result in poor or in extreme cases no real monitoring services.

2. *Lack of Portability:* Traditional monitoring systems and industrial devices are often stationary and not easily portable. This restricts the ability to monitor hazardous gases outside of manufacturing facilities or in remote areas.

3. *Limited Connectivity and Real-time Monitoring:* Some devices rely on manual data recording or require wired connections, hindering real-time monitoring

capabilities. This can lead to delays in data analysis and timely interventions.

4. *Limited Integration:* Many existing systems focus on monitoring individual parameters, leading to a fragmented approach to gas monitoring. This can make it challenging to obtain a holistic view of environmental dangers.

Advantages of our proposed system:

1. *Real-time Monitoring and Alerts:* The system provides real time monitoring of the measured parameters, allowing enforcers to access up-to-date information about the gas leakage status. This enables prompt interventions in case of any critical situation or emergencies. Additionally, the system can generate alerts and notifications when certain thresholds or abnormal readings are detected, ensuring timely security protocols to be acted upon.

2. *User-friendly Interface:* The system is designed with a user friendly interface, making it easy for users to interact with the device. Additionally, the inclusion of access control through user credentials ensures data security and privacy.

3. *Improved Efficiency and Time Saving:* The automation and integration of the various sensors and data transmission mechanisms streamline the data monitoring process. Users can access real-time data, eliminating the need for manual data entry and reducing the chances of human errors. The system also allows multiple users to monitor data simultaneously, enhancing collaboration and efficiency

4. *Remote Monitoring*: One of the key advantages of the proposed system is its capability for remote monitoring. Through the integration of audio and message notifications, enforcers can remotely access the workplace leakage levels and monitor from any location. This feature is particularly beneficial in scenarios where physical visits to facilities are challenging, such as during critical leakage or potential explosion dangers.

5. *Comprehensive Data Monitoring:* Our device offers a comprehensive approach to gas monitoring by integrating multiple sensors to measure multiple ranges of gases. This holistic view of the environment with potential toxic gases allows for a more accurate assessment of safety and enables early detection of abnormalities/potential explosion risks.

6. *Cost-effective Solution:* The use of Arduino Uno as the master controller and cost-effective sensors makes the system a cost effective solution compared to traditional monitoring devices. This affordability increases accessibility, making the system suitable for a wide range of detection possibilities. It reduces the financial barrier on small startups or industries while ensuring quality monitoring. .

7. *Potential for Early Diagnostics and Prevention:* The continuous monitoring and early detection capabilities of the system enable users to identify potential risks at an early stage. This facilitates proactive interventions, prevention strategies, and timely arrival, ultimately improving safety outcomes and reducing the burden on after-math solutions.

II. RELATED WORKS

After analyzing several models and prototypes, the following table summarizes all the reviewed literature papers by categorizing the identical features.

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

The above table 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 endeavoured to achieve accurate output and have incorporated audio-alerting facilities along with IoT to effectively detect gas, smoke, and fire occurrences.

III. METHODOLOGY

Some of the tools and techniques/Algorithm used in the implementation of hazardous Gas detection System is as follows:

A. K-nearest neighbors Algorithm

The k-nearest neighbors algorithm, sometimes referred to as KNN or k-NN, is a supervised learning classifier that employs proximity to produce classifications or predictions about the grouping of a single data point.KNN is a simple classifier in which samples are categorized according to the class of their closest neighbor. High volume is a characteristic of medical databases. Classification may result in less accurate results if the data collection contains redundant and unnecessary properties.

B. Random forest Algorithm

The Random Forest Algorithm is a machine learning technique that uses multiple decision trees to improve the accuracy of predictions for classification and regression problems. The more trees in the algorithm, the better its problem-solving ability. It is based on the concept of ensemble learning, which combines multiple classifiers to improve model performance.

C. Decision Tree Algorithm

A decision tree is a method for predicting a response to data using categorization or regression. Regression is used when the data is continuous, while classification is used when the characteristics are clustered. One of the key techniques for data mining is the decision tree. A root node, branches, and leaf nodes make up a decision tree. Follow the path from the root node to a leaf node to assess the data

D. Support Vector Machine Algorithm

SVM is a supervised machine learning algorithm used for both classification and regression. Though we say regression problems as well it's best suited for classification. The objective of the SVM algorithm is to find a hyperplane in an N-dimensional space that distinctly classifies the data points. The dimension of the hyperplane depends upon the number of features. If the number of input features is two, then the hyperplane is just a line. If the number of input features is three, then the hyperplane becomes a 2-D plane. It becomes difficult to imagine when the number of features exceeds three.

E. ThingSpeak

With the help of the IoT analytics tool ThingSpeak, you can gather, visualize, and examine real-time data streams online. Data sent by your devices to ThingSpeak is instantly visualized by ThingSpeak. You can perform online analysis and analyze data as it comes in with the option to run MATLAB code in ThingSpeak. ThingSpeak is frequently used for prototyping and proof-of-concept systems.

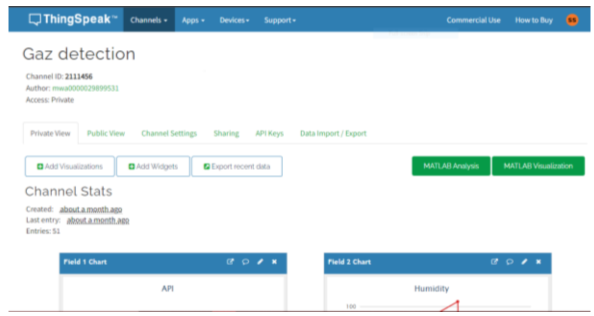

***Fig. 3.1 -** Thingspeak project channel*

IV. WORKING PROCEDURE

The basic structure of a Gas detection system distinguishes four basic steps in the performance analysis process: Sensor Data Collection, Data Processing and Display, Remote Viewing, and Data Transfer via telegram.

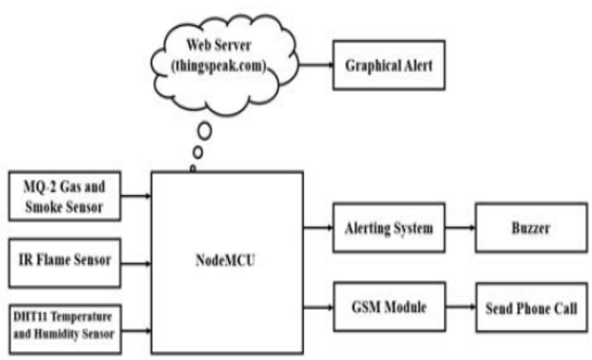

***Fig. 4.1 -** Overall working procedure of the proposed system.*

Figure 4.1 illustrates the operational features of the proposed system, and provides a comprehensive overview of the system's functioning.

The IoT-based Gas Monitoring System utilizes advanced data processing techniques to handle the data collected by the sensors and present it in a meaningful manner on the monitor connected to the Arduino Uno. Once the sensor data is received by the Arduino Uno controller, it undergoes a series of processing steps to extract relevant chemical parameters.

1. *Data Acquisition:* The sensor data, including temperature, humidity, LDR and flame sensor data is acquired by the Arduino Uno from the respective sensor modules. The data is collected in real-time and stored in the system memory for further processing.

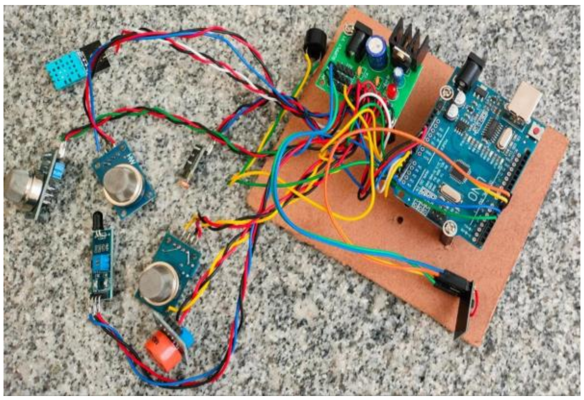

***Fig. 4.2** - Multiple sensors connected to system*

2. *Data Filtering and Calibration:* To ensure data accuracy and reliability, the collected sensor data undergoes filtering and calibration process. Filtering techniques such as SVM and KNN algorithms are applied to eliminate any unwanted redundancies in the data. Calibration procedures are performed to compensate for any sensor-specific biases and ensure accurate measurements.

3. *Parameter Calculation:* Once the sensor data is filtered and calibrated, the system performs the necessary calculations to derive the desired thresholds. It then classifies if the present gas levels in the atmosphere is safe or unsafe depending on the user-set values.

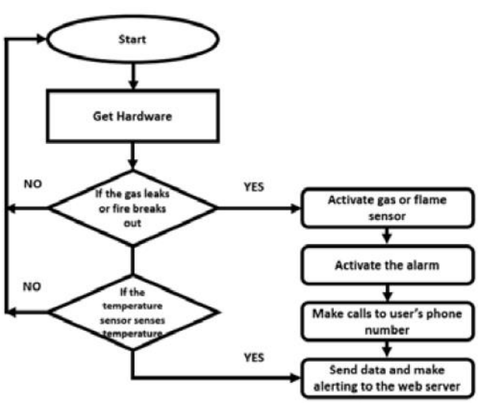

***Fig. 4.3** - parameter calculation and analysis*

4. *Real-time Display:* The Processed chemical parameters are then displayed in real-time on the monitor connected to the system. A graphical user interface (GUI) provides a user-friendly presentation of the parameters, allowing users to easily monitor their surroundings for dangers. The GUI includes visual indicators, numerical values, graphical representations, as well as Audio, enabling users to interpret the data at a glance.

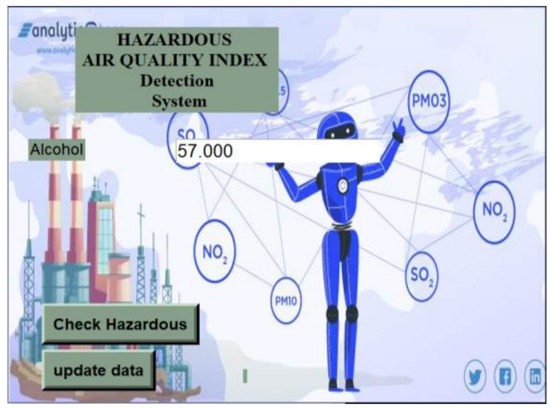

***Fig. 4.4** - User GUI*

Notification via Audio and Bot:

Upon successful measurement of all the chemical data parameters, the system generates an audio message containing the parameter values and relevant information about safety level classification. The Bot facilitates the secure delivery of these messages to the specified user addresses of concerned individuals, such as Industry owners or employees. This telegram notification feature allows for immediate awareness of any significant changes or abnormalities in the environment and is helpful for taking adjacent safety measures.

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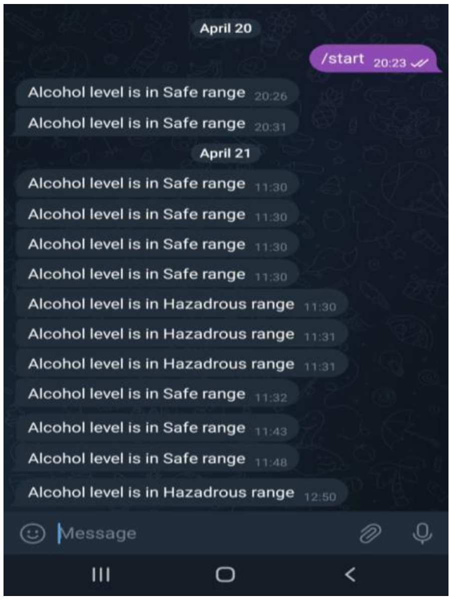

Fig. 4.5 *- Telegram message describing the alcohol levels in the environment*

Remote Viewing via Thingspeak:

The system utilizes Thingspeak to enable remote access and viewing of the data parameters. With the Thingspeak account accessibility through remote devices connected to the network with the monitoring system, authorized individuals can securely access and monitor the parameters from anywhere. This remote viewing feature facilitates plotting a graph providing real-time values and recording the data, enhancing the accessibility and reach of the system.

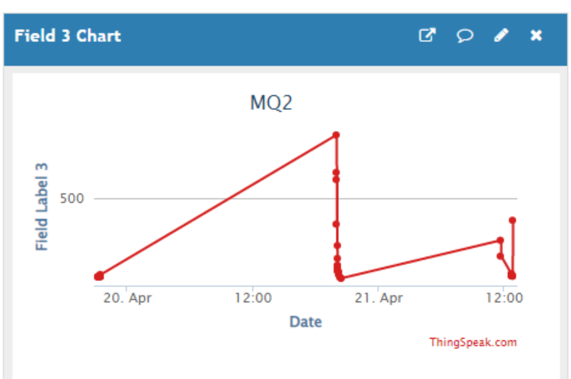

Fig. 4.6 *- Thingspeak visualization for MQ2 sensor through a plotted graph*

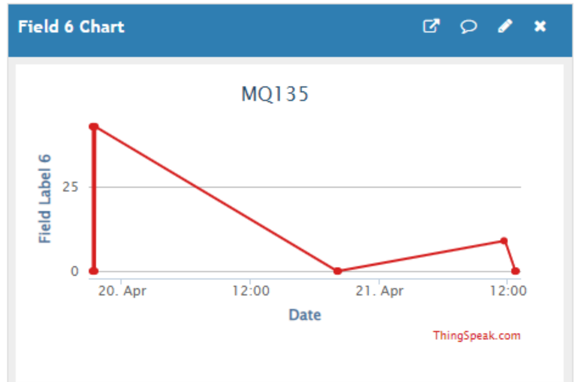

Fig. 4.7 *- Thingspeak visualization for MQ135 sensor through a plotted graph*

The combination of remote viewing via Thingspeak and notifications through Audio and Bot service enhances the usability and accessibility of the IoT-based Gas Detection System. Users can conveniently monitor their surroundings for gas leakage remotely and pursue safety acts before any casualties occur.

V. Future works

While the current implementations of the IoT-based Gas Monitoring System have proven successful, there are several areas for future improvement and enhancement. These include:

1. *Expansion of Sensor Capabilities:* Integrating additional sensors to measure more comprehensive chemical parameters. This would provide a more holistic view of various identical gases and enable better monitoring and management of toxic conditions.
2. *Enhanced Data Analysis:* Advanced data analysis techniques, such as advanced machine learning algorithms can be implemented, to derive more meaningful insights from the collected sensor data. This would enable the system to detect patterns, trends, and anomalies, leading to more accurate diagnosis and safeguarding.

3. Integration with Cloud Services: Integration of cloud-based storage and analysis platforms can be explored to store and process large volumes of data

securely. This would facilitate long-term data management, hazardous gas analysis, and support for research studies.

4. *Mobile Application Development:* A dedicated mobile application can be developed to provide a more user-friendly interface for individuals to access and monitor their workplace environment.

VI. 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..

VII. References

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