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AI Sniff

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Abstract

In today's industrial landscape, leakages of toxic gases and undetected chemical emissions etc are some of the pressing issues that industries face. Current gas detection technologies are costly and impractical for wide deployment, causing delays in hazard detection. This project provides a scalable, cost-effective solution for faster and more efficient gas detection in industrial environments. By integrating machine learning to train the system on gas-specific sensor patterns, it is able to distinguish between gases like hydrogen sulphide, methane and carbon monoxide. This model can be used to detect other gases as per the industry requirements integrated with IoT capabilities it offers seamless connectivity to employee's devices, ensuring timely alerts and enhanced safety measures.

*Keywords:*Arduino Uno SMD ATmega 328, MQ4, MQ7, MQ136, Wifi Module, ESP-01

1. INTRODUCTION

Industries such as manufacturing, construction, and waste management frequently handle hazardous gases and chemicals that pose significant risks to human health and the environment. Undetected gas leaks, improper waste management, and chemical emissions can lead to severe accidents, health hazards, and environmental degradation.Traditional monitoring methods rely heavily on manual inspections, which are inefficient, time-consuming, and expose workers to potential dangers. There is a growing need for intelligent, automated solutions that provide real-time detection and alerts to prevent disasters.

This project introduces a smart detection system that can identify specific gases in the industrial environment. By integrating IoT devices, it facilitates seamless communication between the detection system and end users, ensuring that alarms and notifications reach the right individuals promptly. This innovative solution enhances workplace safety by continuously monitoring industrial environments, detecting hazardous substances, and providing timely alerts. Designed for applications in septic tanks, industrial facilities, and underground construction sites, AI Sniff ensures a proactive approach to risk management, reducing human exposure and improving overall operational efficiency.

2. RELATED WORK

As shown in the Fig. 1, The system comprises several key hardware components. The power supply provides the required voltage and current to run the Arduino UNO, sensors, and other connected modules. This power source can be either a battery or an external DC adapter. The system includes three gas sensors: the MQ4 sensor for detecting methane (CH_4), the MQ7 sensor for carbon monoxide (CO), and the MQ136 sensor for hydrogen sulphide (H2S). These sensors output analog signals proportional to the respective gas concentrations, which are fed into the analog input pins of the Arduino UNO.

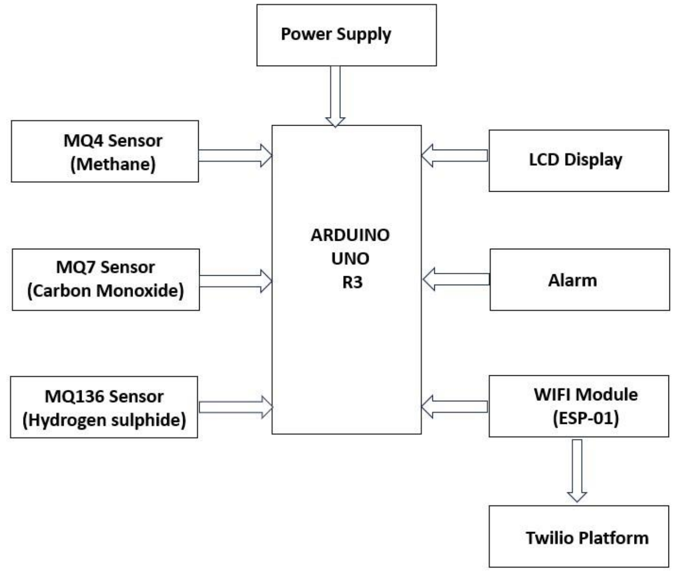

Figure 1: Block Diagram of the System

The Arduino UNO R3 acts as the central controller. It continuously reads the sensor values, processes the data, and triggers appropriate outputs based on predefined gas thresholds. An LCD display is used to show real-time gas concentration levels or status messages, and it is interfaced using an I2C module, which simplifies wiring and reduces the number of GPIO pins required. Two LEDs are used in the system: a red LED, which lights up when the gas level exceeds the safe threshold, and a green LED, which remains on under normal safe conditions, providing a quick visual status indication. Additionally, an alarm is activated in unsafe conditions to serve as an audible warning.

The Wi-Fi module (ESP-01) provides wireless connectiv ity, allowing the Arduino to send processed gas data. For emergency communication, Twilio is used to send SMS alerts directly to users and emergency responders. This ensures that in the event of a gas leak, necessary actions can be taken immediately based on real-time alerts.

3. METHODOLOGY

The workflow of the proposed design can be observed in Fig. 2 , which illustrates the operational process of the gas detection and alert system implemented in the project. The process begins with the sensor module continuously detecting the presence of gases in the environment. These detected values are then sent to the Arduino UNO, which acts as the central processing unit of the system.

Next, the Arduino transmits the data to the TWILIO for real time alerts via a Wi-Fi module (ESP-01). Simultaneously, the LCD display shows the current sensor readings in real time for local monitoring.

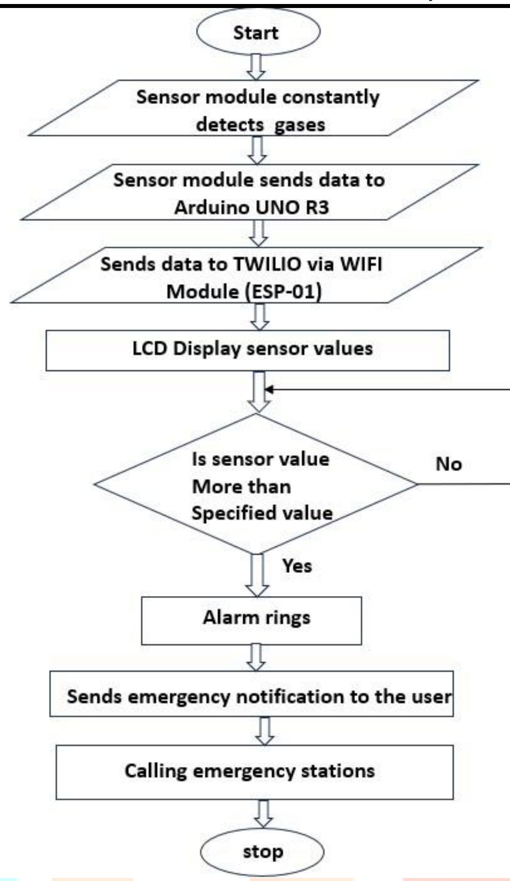

Figure 2: Process Flow Of System

The system then checks if the sensor value exceeds the predefined safety threshold. If the values are within safe limits, the system continues monitoring without any alert. However, if the value crosses the specified threshold, the system activates an alarm to alert nearby personnel.

An emergency notification is sent to the user through inte grated communication tools. In critical cases, the system also initiates contact with emergency response stations, ensuring timely intervention. The process concludes after completing these safety responses and continues to loop, thereby main taining continuous monitoring.

4. TRAINING USED

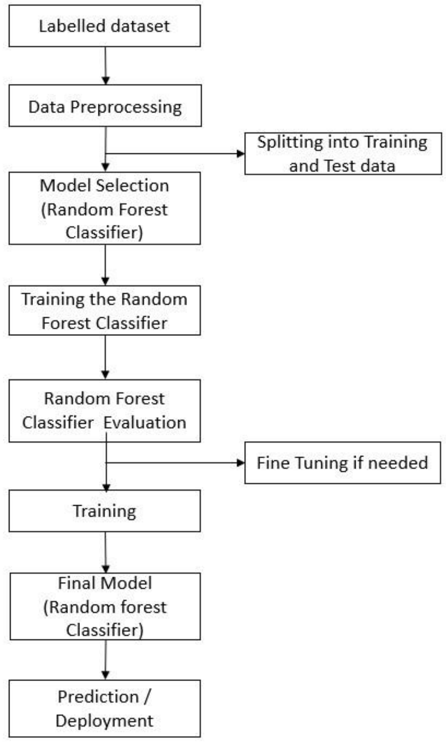

Figure 3: Training Flowchart

The flowchart in Fig. 3 illustrates the complete process of training the machine learning model for gas detection using a Random Forest Classifier. The training phase involved preparing a structured dataset containing labeled gas sensor readings corresponding to three industrial gases: Carbon Monoxide (CO), Methane (CH4), and Hydrogen Sulphide (H2S). Each instance in the dataset was annotated with a binary label indicating whether the gas concentration levels were within a safe range or exceeded predefined hazardous thresholds. Prior to training, the data underwent cleaning to remove inconsistencies and outliers, followed by feature standardization to ensure uniform scale across input variables.

A Random Forest Classifier was employed due to its robustness in handling high-dimensional, noisy sensor data and its ensemble-based decision-making approach, which reduces variance and enhances generalization. The implementation was carried out using Python on the Google Colab platform, leveraging libraries such as Pandas for data handling, and Scikitlearn for model construction, scaling, and validation. The dataset was split into training and testing subsets using an 80:20 ratio to ensure adequate evaluation post-training.

Hyperparameters such as the number of estimators and tree depth were tuned to optimize performance while minimizing overfitting. Furthermore, constraints like minimum samples per split and per leaf node were introduced to improve the model's stability. A 5-fold cross-validation strategy was incorporated during training to validate the model's consistency across different subsets and to obtain a more reliable performance estimate. The model's predictive capability was assessed using standard classification metrics including accuracy, precision, recall, and F1-score, confirming its suitability for real-time classification of gas levels in industrial environments.

5. TESTING RESULTS

As shown in Fig. 4, the final system integrates gas sensors, a microcontroller, and a communication module to enable real-time detection and alerting. To validate the accuracy of our sensor readings, a comparative calibration was conducted using an industrial-grade suction-based sensor operating in LEL units. By exposing both sensors to the same controlled gas environment, a correction factor was applied in software to align our readings with the reference output.

The test involved close placement of the prototype near the industrial sensor to ensure consistent exposure. Methane gas was introduced under controlled conditions, and outputs from both sensors were compared. The alignment confirmed that the developed system could reliably detect gas concentrations in practical settings.

Figure 4: Final Model Of the System

Fig. 5 and 6 demonstrate the successful detection of methane gas and the corresponding alert mechanism. During testing, the system effectively tracked rising gas concentrations in real time. When the sensor readings crossed the threshold of 50,000 PPM, the device promptly identified the leak and triggered the internal alert system.

At the same moment, an automated SMS alert was sent to a registered mobile number via the Twilio API, confirming seamless communication. A continuous monitoring phase was also carried out, during which consistent sensor performance and reliable alert generation were

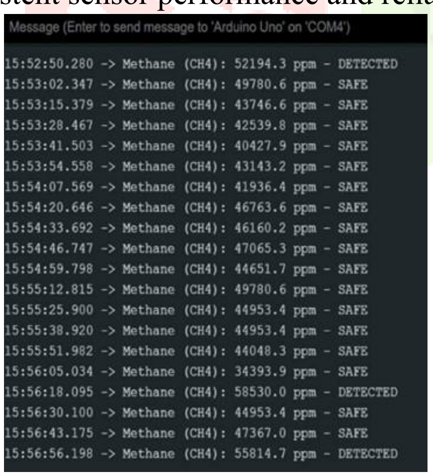

Figure 5: Model Result for Methane gas

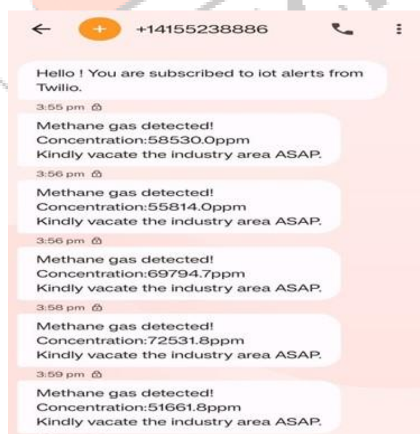

Figure 6: Twilio result

observed. These results validate the system’s capability to detect hazardous gas levels and provide timely warnings, supporting its use in safety-critical industrial environments.

6. CONCLUSION

This paper successfully developed an AI-based gas detection system that combines gas sensors with machine learning algorithms to detect and classify harmful gases in industrial environments. The system demonstrated high accuracy in identifying gases like Methane (CH4), Carbon Monoxide (CO), and Hydrogen Sulphide (H2S), and effectively predicted their concentration levels using real-time sensor data. Testing validated the system's reliability, cost-effectiveness, and potential for practical industrial applications, especially in environments requiring early leak detection. Its scalable and low-cost design makes it suitable for widespread use, highlighting how AI-driven solutions can significantly enhance environmental monitoring and industrial safety.

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