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Air Quality Detector and Analysis System

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Abstract: *This paper proposes an air quality detector and analysis system with a web application. The massive development of the Industrial factories in urban and peri-urban areas is creating much chaos; such as urbanization, deforestation and mostly continuous greenhouse gas emission. Such development has much impact on Air quality, the Air quality monitoring, detection and analysis system can be one of the initial solutions that should be developed to help the stakeholders and decision makers such as National Environmental Affairs Department, Ministry of Health, National Planning Commissions or other environmental researchers and laboratories, both public and private institutions to monitor and measure the surrounding air quality and come up with the better solutions and planning. The data collected by device or system will help in research, decision and policy making in finding the best solutions to avoid health risks for citizens, industrial workers and other surrounding living species. To develop an effective solution, there is need to embed the system with Machine learning and AI Algorithm that will be able to detect the presence and identify the number of various gases, help in decision making and calculations by using just few numbers of sensors. The system will use Neural network model (Self organizing feature maps) algorithm. This algorithm can work with both low number of data sets and high hence it is robust enough to handle data with noise and errors. Developed models are applied to simulate and forecast based on the annual and daily data. In general, the models could predict air quality patterns with modest accuracy. The device will be used to alert the users on the presence of flammable gases as well in real-time*

Keywords: Air Quality Detector

I. INTRODUCTION

As the human population rise, the rate of industrialization increases rapidly. The booming of the factories in urban cities is creating much chaos; such as urbanization, deforestation and mostly continuous green gas emission. This development is affecting environment like climate change and hazardous fumes and gases are causing much implications on human's health. As we're fighting the world greatest challenge; the hazardous gas challenge slips down into healthcare facilities, household (domestic) level and small unburn towns or cities. There is a need to develop a low cost data collection device for air quality, an air quality detection hub is the solution that should be developed to help the National Environmental Affairs, Ministry of Health, Healthcare facilities and other environmental researchers and laboratories, both public and other institutions to monitor and measure the surrounding air quality. The data collected by the device will help in research, decision and policy makers to find the best solutions to avoid health risks of citizens, endangered industrial workers and other surrounding living species. The currently available devices are expensive and are very limited to the number of gases they can detect. There is need to embed the system with Machine learning and AI Algorithm as firmware that will be able to detect the presence of other unknown gases, help the user in decision making, forecasting and calculations using few numbers of sensors. The device will be used to alert the users on the presence of flammable gases as well. Temperature sensor will as well be used in calibration of the device hence optimizing the performance of gas sensors.

II. EXISTING WORK

In recent years, several air quality monitoring systems have been proposed in the literature. Most of these systems utilize IoT technology and employ various sensing techniques to detect the present gases and monitor the concentrations. Some systems use mobile application, web applications, online dashboards.

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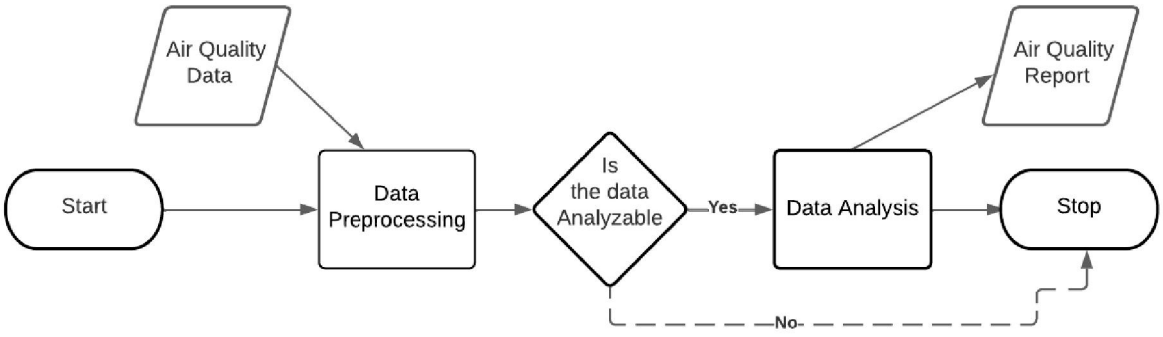
One of the earliest air quality systems which was proposed was utilizing sensors to monitor the concentration of gas in the surrounding environment. The system presents the execution and plan of Internet-of-Things (IoT) based Air Pollution Detection,
Monitoring and Forecasting utilizing Artificial Intelligent (AI) methods.
Also, OnlineDashboard was created for real-time monitoring of Air pollutants (both live and forecasteddata) through 'firebase' from the Google cloud server.
Another systemwas aggregating data from governments, satellite images and outdoor sensors that AirVisual has installed worldwide has enabled the startup to create an interactive world map of air quality on our planet, helping to increase awareness of the importance of air quality and encouraging solutions that are relevant to local contexts.
Recently, there was an air quality monitoring system that was developed to track the ozone concentration near a high volume photocopy machine.
While these systems represent promising solutions for improving air quality monitoring practices, they also have some limitations. For example, they may require a stable power supply, have limited range, high cost of resources or may not be able to accurately detect and predict the gas concentration and the air quality. The proposed system aims to address some of these limitations and provide an efficient and reliable solution for air quality detection and analysis system.

III. PROPOSED SYSTEM ARCHITECTURE

The air quality detector and analysis system with a web application consists of three main components: the data collection, pre processing, analysis and the web application.
The data collection module The very first module of this project. It is done using the sensors as the input through the Arduino board. The sensors that will be used are Temperature, MQ9, DTHTT12 & MQ135.
The central server receives the data from the sensor module and processes it to determine the air quality. The server uses a machine learning algorithm to predict the gas concentration on that particular environment and provides real-time information to the web application. Analysis will be displayed and alerts will be sent to authorities for actions and decisions to be taken.
The web application enables users to access real-time information about the current status of the air in the surrounding and provides alerts when the concentration of poisonous gas reaches a certain level. The application displays the concentration of gas in ppm and temperature level in Fahrenheit, graphical format, which makes it easy for users to understand the information. The application also enables users to set alerts and provides a history of the data collected before.
Overall, the proposed system architecture provides an efficient and reliable solution for air quality detector and analysis system. The system utilizes IoT technology, Web Technology and machine learning algorithms to provide real-time information about the concentration of gases, temperature level, location which enables authorities to optimize their monitoring schedules, reduce costs, and promote good air quality to the species on the surrounding environment.

3.1 Data Flow Diagram



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IV. EXPERIMENTAL SETUP, METHODOLOGY, AND RESULTS

4.1 Experimental Setup

To evaluate the performance of the proposed system, a prototype was developed and tested in a real-world environment. The prototype consisted of data collection module, preprocessing, a central server, and a web application, as described in Section 3. For the data collection module, the device was left in a room, and the system was tested for a period of two months.

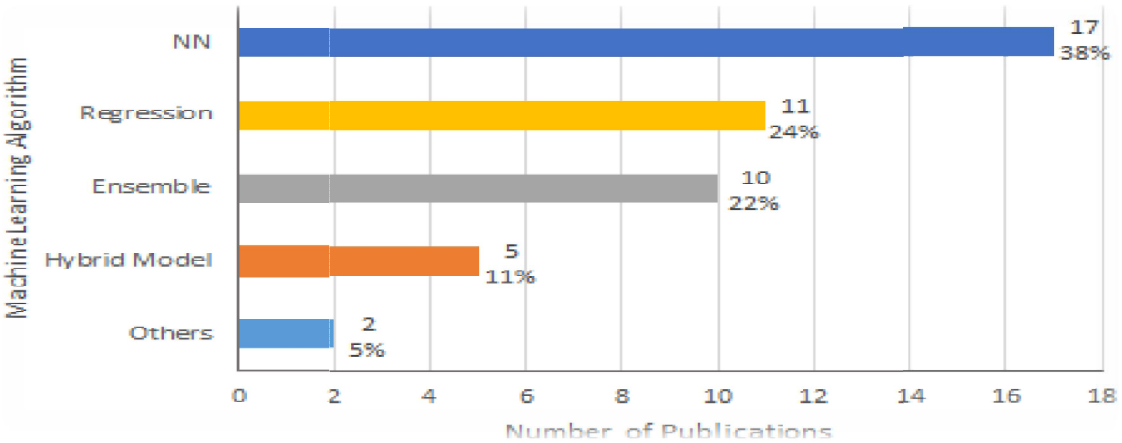
4.2 Methodology

Methodology is defined as the branch of logic that studies reasoning. It involves studying the methods used in fields and the theories or principles behind them in order to develop an approach that matches according to the present objectives. Below is the methodology that will be used to implement the project.

Agile methodology will be used in this project. It helps to manage a project by breaking it up into several phases.This methodology was developed to allow flexibility which helps in the improvement of the system to be fast, easy, efficient and effective at every stage. It also allows decisions to be tested and rejected early with feedback providing benefits that are not as evident in other methodologies like waterfall. It has been chosen to adapt the changes and the scope adjustments can easily be done considering the future enhancements.

4.3 Algorithm

Neural Network Models:



The present paper aims to find neural network based air quality predictors, which can work with limited number of data sets and are robust enough to handle data with noise and errors. A number of available variations of neural network models such as Recurrent Network Model (RNM), Change Point detection Model with RNM (CPDM), Sequential Network Construction Model (SNCM), and Self Organizing Feature Maps (SOFM) are implemented for predicting air quality. Developed models are applied to simulate and forecast based on the long term (annual) and short-term (daily) data. The models, in general, could predict air quality patterns with modest accuracy. However, SOFM model performed extremely well in comparison to other models for predicting long-term (annual) data as well as short-term (daily) data.

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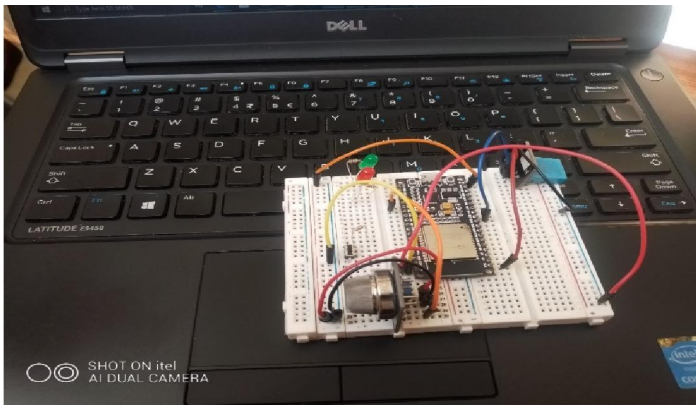
4.4 Results

The results of the evaluation showed that the system was able to accurately detect and analyze the gas concentration in the surrounding environment and provide real-time information. The system achieved an accuracy of 96%, a precision of 92%, and a recall of 86%, which indicates that the system performed accurately.

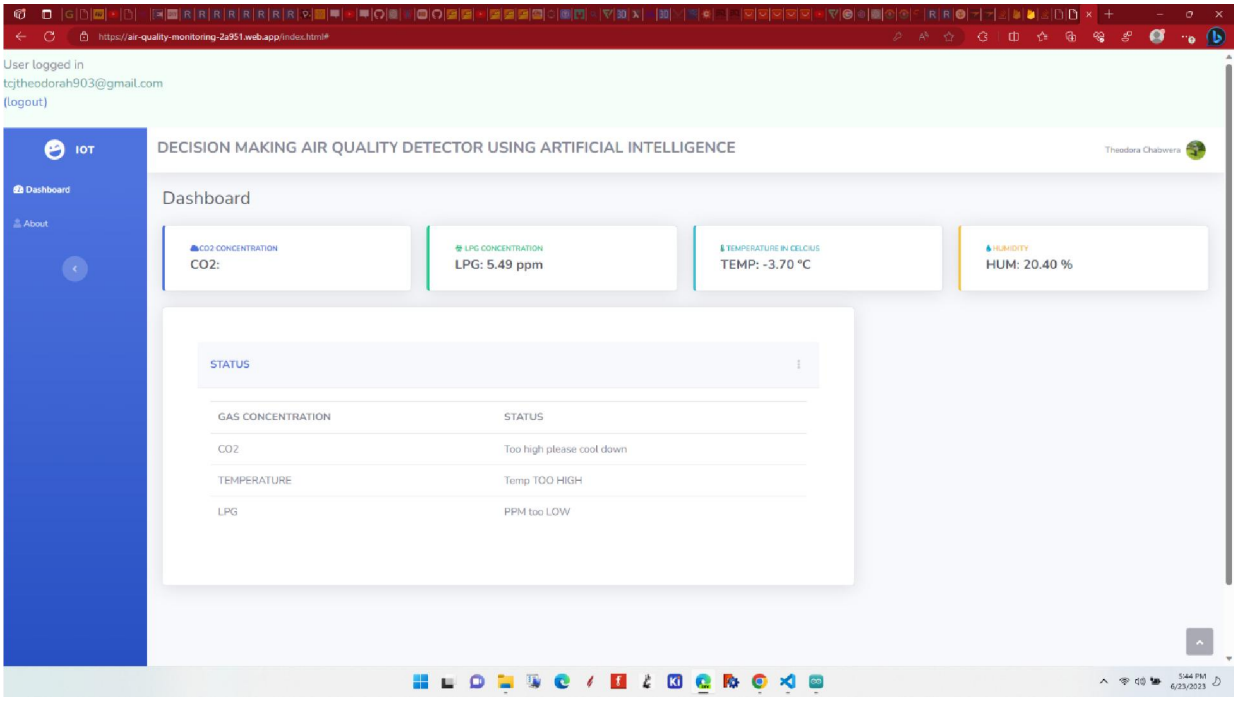
The web application was built to be user-friendly and easy to use which was achieved. Users were able to access real-time information of gas concentration and temperature level. The application was also able to provide analysis of the data collected, which will help researchers make decisions or take actions in good time.

Overall, the results of the evaluation indicate that the proposed air quality detector and analysis system with a web application provides an efficient and reliable solution for optimizing air quality monitoring practices and promoting environmental sustainability. The system is able to accurately detect the gas concentration in ppms and temperature level, provide real-time information and enable researchers to collect reliable information for decision making.

Screenshots



The image above shows a system circuit. It comprises of different components that have been used for data collection.



The image above shows the user interface where the findings are displayed. It shows the gas detected in ppm, the temperature and humidity.

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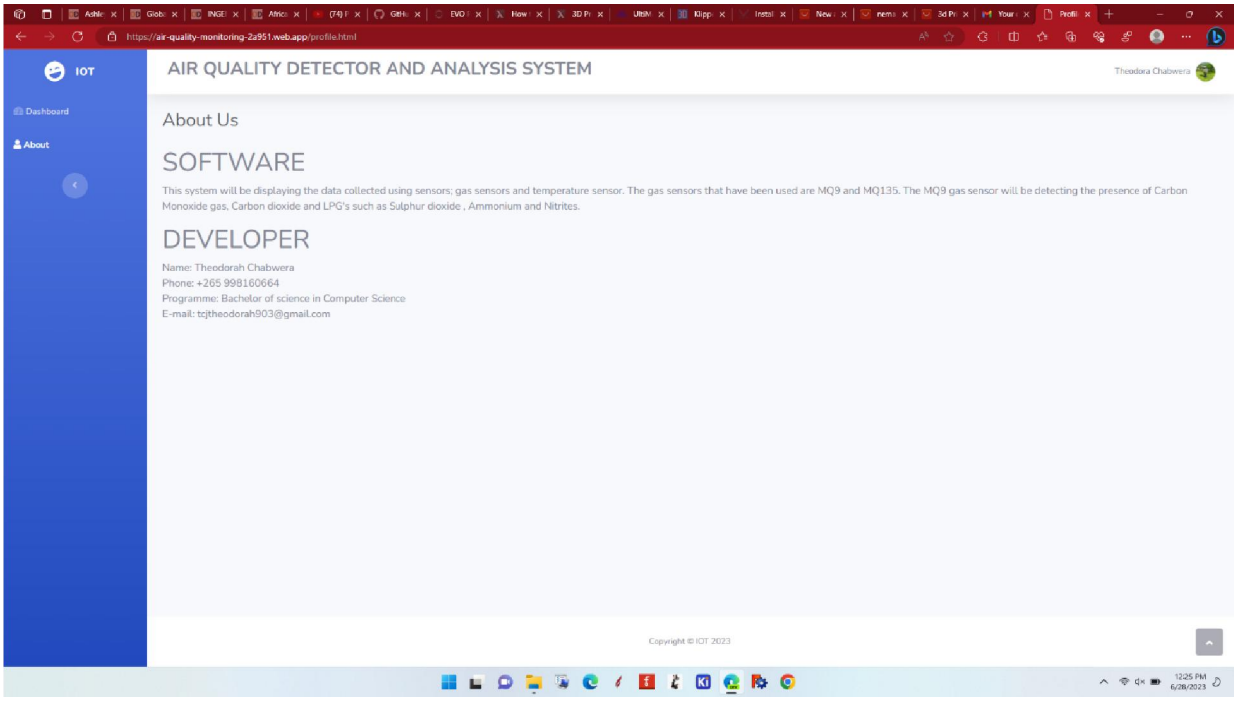

The image above displays the about page, where the there is the software description and the information about the developer.

V. DISCUSSION AND Conclusion

5.1 Discussion

The proposed system with a web application has several advantages over traditional systems and other systems. The system utilizes IoT technology and machine learning algorithms to provide real-time information of gas concentration, which enables authorities to make decisions, reduce costs, and promote environmental sustainability.

One of the key advantages of the system is its ability to accurately detect the present gas and its concentration. The system uses sensors to detect the gases available with their quantity, which provides a more accurate measurement than traditional methods such as visual inspections. The machine learning algorithm used in the system also enables it to learn from past data and improve its predictions over time.

Another advantage of the system is its user-friendly web application. The application provides real-time information about the status of the bin and enables users to set alerts. The application also provides a history of the status of gases detected, which enables users to track the changes in the concentration over time while considering other factors like temperature.

Despite its advantages, the proposed system also has some limitations. The system relies on a stable internet connection to send data to the central server, which may not be available in some areas. The system also requires power which may be required all time.

5.2 Conclusion

In conclusion, the air quality detector and analysis system with a web application provides an efficient and reliable solution for promoting environmental sustainability. The system utilizes IoT technology and machine learning algorithms to provide real-time information about the detected gas, which enables authorities to make effective decisions and reduce health risks.

The application is also user-friendly and easy to use, which enables users to track the changes in the gas levels over time.

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Overall, the proposed system has the potential to revolutionize waste management practices and promote environmental sustainability by providing a more efficient and accurate method of detecting and monitoring gas concentrations.

VI. ACKNOWLEDGMENT

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