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AIR POLLUTION MONITORING SYSTEM USING IOT AND MACHINE LEARNING TECHNIQUES

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Abstract : Problem with the automobile engines continues to increase in a very large scale. Every vehicle has its own emission but problem arises when the emission occurs beyond standard values. Even though lot of changes has been made in the consumption of fuel, increasing urbanization and industrialization contribute for the poor air quality. With the technical advancements in machine learning, it's been possible to build predictive models for monitoring and controlling pollution based on the real-time data. With this, we are using IoT techniques for monitoring the emission rates of vehicles. A predictive model is built on the real-time data available, predicting the values of carbon monoxide. Sensors are embedded in the vehicles to measure the pollutants levels. By using the monitoring techniques, vehicle details such as location, owner is notified with the current situation of pollution in his location and his vehicle emission rate contributing to environment. Machine learning model is used for the prediction of pollution level in the vehicle location based on the previous data and the current data obtained by the sensors. Here the pollutants level can be controlled using smart emission surveillance

Keywords: Machine learning , Internet of things , Emission rate ,Air quality index

I. INTRODUCTION

Air pollution is one of the gravest problems faced by the environment especially by densely populated countries like India. The rapid growth of population has led to an increased usage of vehicles. These vehicles use fuels which undergoes incomplete combustion to emit toxins. The principal emissions from motor vehicles contains harmful gases which contributes to greenhouse effect. Automotive emissions include CO_2, carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides. The magnitude of each of these emissions relies on the mixture of vehicle/fuel, weather conditions, and driving patterns.

Under emission standards, the emission limits for a specific car differ depending on the vehicle's weight, its type of gas, and whether it is a passenger or a vehicle carrier. Diesel cars have a greater nitrogen oxide emission limit, while petrol cars have a greater carbon monoxide emission limit.

II. LITERATURE SURVEY

1. A Machine Learning-Based Air Quality Monitoring System Using IoT and Big Data Analytics," by J. Zhang et al. (2020):
This paper proposes a machine learning-based air quality monitoring system that utilizes IoT and big data analytics to improve the accuracy of air quality predictions. The system includes a set of sensors that measure pollutants in the air, and a machine learning algorithm that uses the collected data to predict future air quality levels. The system also includes a cloud-based server for data storage and processing, and a mobile app for users to access real-time air quality data.

2. "An Intelligent Air Pollution Monitoring System Based on IoT and Machine Learning," by S. S. Rathod et al. (2021):
This paper presents an intelligent air pollution monitoring system that combines IoT and machine learning techniques to monitor and predict air quality levels. The system includes a set of sensors that measure pollutants in the air, and a machine learning algorithm that uses the collected data to predict future air quality levels. The system can also send alerts and notifications to users based on the severity of air pollution levels.

3. "IoT-Based Air Pollution Monitoring System Using Machine Learning Techniques," by F. A. M. A. Rahman et al. (2021):
This paper proposes an IoT-based air pollution monitoring system that utilizes machine learning algorithms for data analysis and prediction of air quality levels. The system includes sensors that collect real-time data on air pollutants such as particulate matter, carbon monoxide, and nitrogen dioxide. The collected data is transmitted to a cloud-based server for processing and analysis using machine learning algorithms.

4. "Air Quality Monitoring System Using IoT and Machine Learning: A Review," by P. Sharma and V. Goyal (2020):
This paper provides a comprehensive review of air quality monitoring systems that use IoT and machine learning techniques. The review covers the current state of the art in air quality monitoring, including the various types of sensors used, the data processing techniques employed, and the machine learning algorithms utilized.

5. "A Hybrid IoT-Machine Learning Approach for Real-Time Air Quality Monitoring in Smart Cities," by A. Ghosal et al. (2021):
This paper proposes a hybrid IoT-machine learning approach for real-time air quality monitoring in smart cities. The system includes a set of sensors that measure air pollutants, and a machine learning algorithm that uses the collected data to predict future air quality levels. The authors conducted experiments to evaluate the performance of the system, and the results showed that it was able to accurately predict air quality levels with a high degree of accuracy.

6. "An IoT-Based Air Pollution Monitoring System Using Deep Learning," by S. Das and S. Mandal (2020):
This paper proposes an IoT-based air pollution monitoring system that utilizes deep learning techniques for data analysis and prediction of air quality levels. The system includes sensors that collect real-time data on air pollutants, and a deep learning algorithm that uses the collected data to predict future air quality levels. The authors conducted experiments to evaluate the performance of the system, and the results showed that it was able to accurately predict air quality levels with a high degree of accuracy.

7. "A Real-Time Air Pollution Monitoring System Using IoT and Machine Learning," by S. K. Reddy et al. (2019):
This paper proposes a real-time air pollution monitoring system that combines IoT and machine learning techniques to monitor and predict air quality levels. The system includes a set of sensors that measure air pollutants, and a machine learning algorithm that uses the collected data to predict future air quality levels. The authors conducted experiments to evaluate the performance of the system, and the results showed that it was able to accurately predict air quality levels with a high degree of accuracy.

[8] "Internet of Things for Smart Air Pollution Monitoring" by B. Gupta et al. (2018):
This paper provides a comprehensive review of IoT-based air pollution monitoring systems and discusses their potential applications in air pollution control in automobiles.

[9] "A Review of Machine Learning Approaches for Air Pollution Modeling" by M. Kumar et al. (2018):
This paper presents a review of various machine learning algorithms used in air pollution modeling and discusses their strengths and weaknesses.

[10] "A Survey of IoT Applications in Air Pollution Monitoring" by S. Khakpour et al. (2018):
This paper provides a survey of IoT-based air pollution monitoring systems and discusses their potential for improving air quality in urban areas.

[11] "An IoT-based Smart Air Pollution Monitoring System for Smart Cities" by S. Joshi et al. (2018): This paper presents an IoT-based air pollution monitoring system for smart cities and discusses its potential applications in air pollution control in automobiles.

[12] "A Review of Deep Learning Techniques for Air Pollution Detection and Monitoring" by A. Agrawal et al. (2018): This paper provides a review of deep learning techniques used in air pollution detection and monitoring and discusses their potential applications in air pollution control in automobiles.

III. METHODOLOGY

Module 1

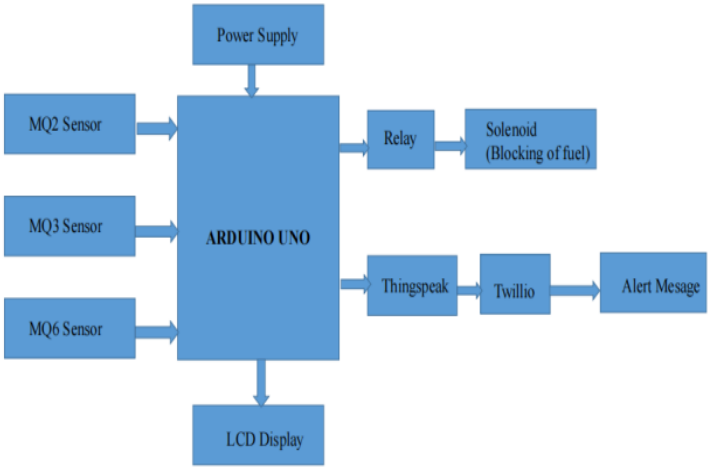


Fig 1 Block diagram of IOT module

The air pollution monitoring model utilizes three different types of sensors – MQ2, MQ3, and MQ6 - to detect various types of pollutants released by vehicles. These sensors detect carbon monoxide, carbon dioxide, Hydrocarbons. The sensor data is collected by an Arduino, which compares the collected data with standard values to determine if the pollutant levels are within safe limits.

The system uses LCD display to display the current status of different pollutants. Then the Arduino uno sends the collected data to the thingspeak (cloud based platform) for storage and analysis purposes. If the collected data is more than the standard values then using Twillio it sends alert message to the owner. If the pollution level doesnot reduce within specific time then the fuel to the engine is blocked using solenoid.

Module 2

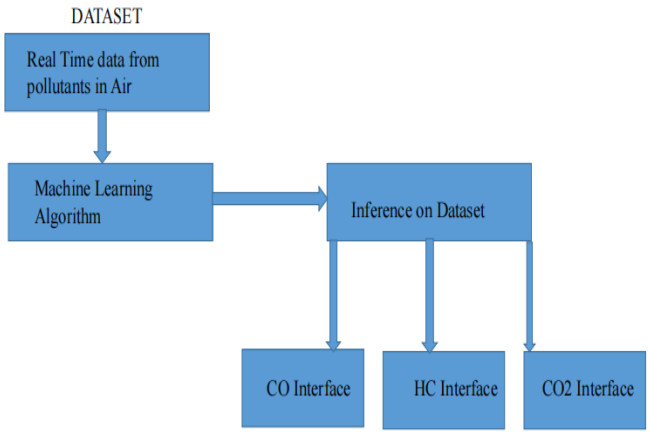
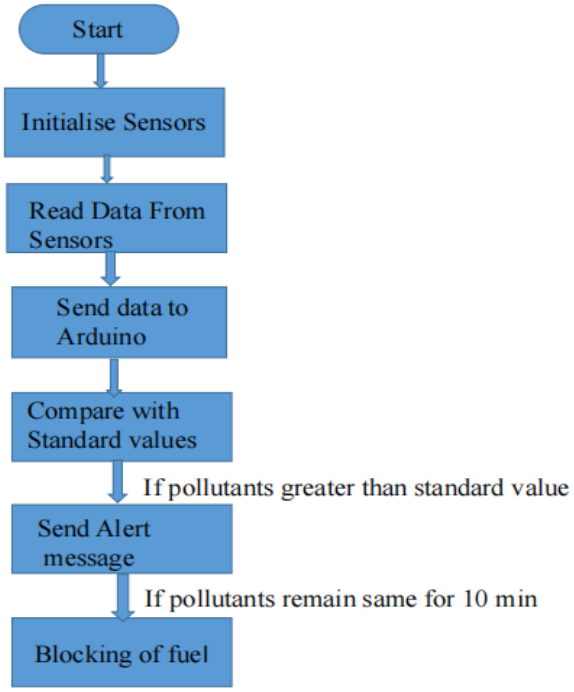


Figure 2 Block diagram of machine learning module

The Arduino collects data from various sensors, which is stored in a dataset to monitor changes over time. When enough data is gathered, machine learning algorithms can be used to analyze and make predictions based on the dataset. This model uses real-time data from the sensors as input. The model uses a specific type of mathematical process to learn and understand the patterns and relationships within a set of data. Once it has learned from this data, it can make predictions and draw conclusions about different factors related to air pollution, such as the types of pollutants present and the level of pollution that may be expected in the future.

IV. FLOWCHART



V. ADVANTAGES

1. The measurements of pollution concentrations are the best characterization of a given pollutant at a given time and location.
2. The data are supported by comprehensive quality assurance program, ensuring good data of known quality

VI. DISADVANTAGES

1. For both gases and particulate matter , if several identical low cost system are co-located, the user should expect a high level of repeatability [R2 >0.9] and should expect to be able to adjust accuracy by 'calibrating' – adjusting slope and offset – against a co=located reference /equivalent station.
2. Ozone is monitored daily, but mostly during the ozone season (the warmer months, approximately April through October).

VII. APPLICATIONS

1. It is used to measure of how air pollution affects one's health within a short time period.
2. Come to know about the pollution at hospitals and public places to avoid the breathability.
3. Air quality prediction is mainly used for asthma patients to be precautioned.
4. AQI prediction will overcome by planting trees and controlling human if it is unhealthy.
5. Roadside pollution monitoring.
6. Site selection for reference monitoring stations.
7. Indoor Air Quality Monitoring.
8. To make this data available to common man.

III. RESULT

Using different sensors connected to Arduino the pollutant levels are measured and if the pollutant level is greater than standard value the alert message is sent to the user.If pollutants remain same for 10min the fuel to the engine is blocked using solenoid.

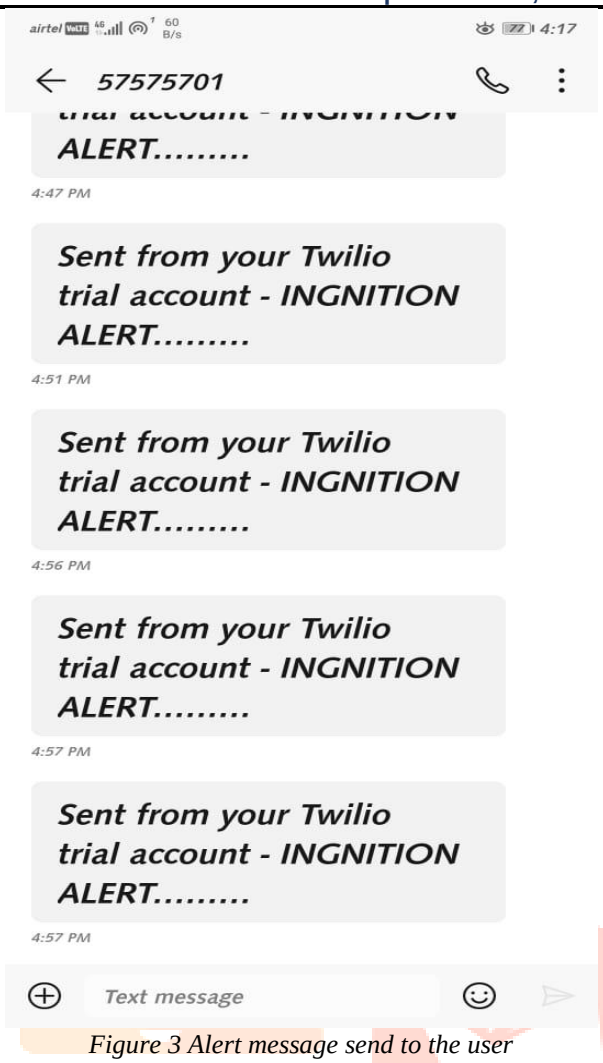


Figure 3 Alert message send to the user

IX. CONCLUSION AND FUTURE WORK

Over the past few decades, there has been a significant increase in pollution rates, leading to several environmental issues. Unfortunately, many people do not take the pollution caused by their vehicles seriously, resulting in problems such as ozone depletion. To tackle this issue, a new scheme called the smart emission surveillance system has been proposed. This system aims to be more innovative, user-friendly, time-saving, and effective than the current system. Using smart systems not only helps improve environmental quality, but it also allows car owners to avoid unnecessary problems compared to traditional emission testing methods. The idea behind this system is to identify and indicate the pollution level to the driver. The scheme only monitors three parameters at present, but it can be extended to consider more parameters that contribute to vehicle pollution.

This system provides the ability to view the sensor outputs through the internet, allowing orders to be given from a distance to regulate emissions. However, constructing detectors for distinct parameters can be a challenging task due to their high cost. The fact that this system is just an add-on and does not change the engine's configuration in any way makes it easier to implement in existing vehicles. Furthermore, this concept can also be extended to industries. In summary, the smart emission surveillance system is a promising scheme that can help curb pollution caused by vehicles. It is a step forward in environmental quality and can save car owners from unnecessary problems. With the ability to view sensor outputs through the internet and regulate emissions from a distance, this system could be a game-changer in reducing pollution levels.

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