Air Pollution Monitoring and Prediction System

Meghana H Prabhu, K Sridevi Rao, Navya Nagaraj Vidyavathi Poojary ,Nikhitha J, Nagaraj Bhat, Ramya D Shetty

ABSTRACT--- Environmental Air Pollution Monitoring System is used for monitoring the concentrations of major air pollutants using gas sensors. The main target of this project is to monitor the air quality using sensors and analyze the existing trends in air pollution and make prediction about future. The major objective is to inform the public about the quality of air, raise the awareness and also to develop warning systems for the prevention of undesired air pollution episodes and to create awareness in order to reduce the amount of air pollution caused due to various sources. The system is also used to get the approximate quantity of pollutants present in air thereby giving awareness to the people of that specific region. Thus, the amount of pollution caused due to various sources can be reduced, leading a healthier and safer environment.

Index Terms: Air pollutants, Gas sensors, Warning System

I. INTRODUCTION

Air pollution is one of the major environmental problem in our country. Mostly, it is caused by human activities such as construction, mining, transportation, etc. However, natural disasters such as volcanic eruptions and forest fires may also pollute the air, but their occurrence is rare and they usually have less effect, unlike human activities that are important causes of air pollution.

Poor air quality has harmful effects on human health.

Therefore, reducing pollutants in the air is important for human health and the environment. Pollutants can also damage plants and buildings.

Major Pollutants taken into consideration:

Carbon monoxide (CO) is a colorless, odorless gas that is produced by the incomplete burning of carbon based fuels including petrol, diesel, and wood. Combustion of natural and synthetic products also causes the production of CO. It also lowers the amount of oxygen that enters our blood.

Nitrogen dioxide (NO_2) causes smog and acid rain Burning the fuels such as petrol, diesel, kerosene and coal leads to the production of NO_2.

Sulphur dioxide (SO_2) is produced from burning coal. Some industrial processes can also produce Sulphur dioxide.

In past decades, due to civilization and urbanization, there is a major growth in Polluting industries, large quantities of construction waste, drastic loss of forests and vehicles on roads which has increased the level of pollution. Therefore, it is necessary to constantly monitor and report the harmful impacts from air pollution.

II. LITERATURE REVIEW

In order to monitor the air quality, a new framework has been put forth that monitors the concentration of gases and analyze the current trends in air pollution and make prediction about future.

In [1], Internet of Things has been introduced and a kind of real time Air Pollution Monitoring and Forecasting System is being designed. In monitoring points, environmental sensors including nitrogen dioxide, smog, inhalable particles, carbon monoxide, chlorine, hydrogen chloride and hydrogen fluoride sensors are installed.

In [2], Two low cost gas sensors namely MQ7 (to detect CO) and MQ135 (to detect NH3CO2 etc.) with Wi-Fi module have being used. Raspberry Pi 3 B model is used. Their sensor will gather the data of various environmental parameters and provide it to Raspberry Pi which acts as a base station.

In [3], Auto regression algorithm is used to predict future value of PM2.5 based on the previous PM2.5 reading. Here they are only predicting the level of PM2.5.Logistic regression algorithm is employed to detect whether a data sample is polluted or not.

In [4], Two gas sensors namely CO and NO2 are used. They have used Arduino platform to communicate the data quickly. WSN (Wireless sensor network) acts as the transceiver. Output is in terms of concentration of gases i.e. in ppm. The values of sensors are sent to the mobile using IOT central server and then displayed on the screen.

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Meghana H Prabhu, Department of Computer Science, Shri Madhwa Vadiraja Institute of Technology and Management, Udupi, Karnataka, India. (meghanahprabhu@gmail.com)

K Sridevi Rao, Department of Computer Science, Shri Madhwa Vadiraja Institute of Technology and Management, Udupi, Karnataka,India, (sridevirao.sr79@gmail.com)

Navya Nagaraj Vidyavathi Poojary, Department of Computer Science, Shri Madhwa Vadiraja Institute of Technology and Management, Udupi, Karnataka,India, (navyanagaraj29@gmail.com)

Nikhitha J, Department of Computer Science, Shri Madhwa Vadiraja Institute of Technology and Management, Udupi, Karnataka, India. (nikhithajayakar@gmail.com)

Nagaraj Bhat, Assistant Professor Department of Computer Science, Shri Madhwa Vadiraja Institute of Technology and Management, Udupi, Karnataka India. (nagarajbhat.cs@sode-edu.in)

Ramya D Shetty, Assistant Professor Department of Computer Science, Shri Madhwa Vadiraja Institute of Technology and Management, Udupi, Karnataka ,India,(ramyashetty.cs@sode-edu.in)

In [5], Focuses on how a sensor network is used in wide range to monitor the level of air pollutants (CO, NO_2, PM) present in urban ambient area. Here they have considered metro city, Bangalore as a real time example. They have used WSN to forecast and send the warning messages to the public.

In [6], Time series analysis method is used for analyzing the pollution trends in Delhi and making prediction about the future. The time series method includes two techniques. One is Multilayer Perceptron and the other is Linear Regression. The data is taken from Central Pollution Control Board to predict the concentration of pollutants such as CO, SO2, PM10 and O3 from the year 2011-2015.Their main agenda was not only to bring awareness but also to minimize level of pollution by taking proper measure and ensuring that the vehicles emit the pollutants within the permissible range.

In [7], A Multilayer Perceptron Neural Network is used as a tool for air pollution prediction. Their main focus is on the prediction of SO_2 contents.

In [8], The technologies like WSN and GSM are used. With the help of a GSM module, a text message is been sent to base station when the volume of dangerous gases crosses a particular safe limit.

In [9], Gas sensors namely CO and CO2 are used. Other parameters like temperature and humidity are also sensed along with gas concentrations to enable data analysis through data fusion techniques. Energia, an open source electronics prototyping platform is used.

III. COMPONENTS USED

A. Arduino Uno R3 Microcontroller

It is a hardware platform which is very flexible and it can be programmed based on the function for which it is used. It is an open source microcontroller device with easily accessible hardware/software platform and is compatible with most of the sensors. The Arduino UNO R3 Microcontroller is shown in Figure1.

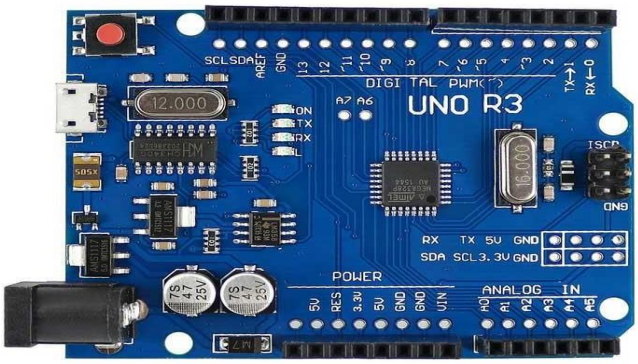


Figure 1: Arduino Uno R3 Microcontroller

B. Sensors Used

MQ135 Sensor: It is an air quality sensor which senses gases like ammonium, nitrogen, oxygen, alcohol, aromatic compounds, sulfide and smoke.

I. MQ7 Sensor: It suitable for sensing Carbon Monoxide in air.

II. MiCS-2714 Sensor: This is a robust sensor for detection of nitrogen dioxide.

III. SO_2 B4 Sensor: It is capable of detecting Sulphur Dioxide in Air.

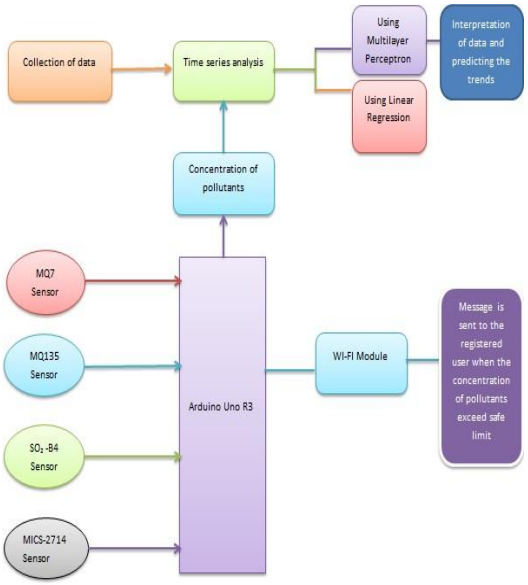
C. Wi-Fi Module

ESP8266 is Wi-Fi enabled system on chip module .It is capable of hosting applications.

IV. METHODLOGY

A. Dataset Considered

The dataset collected consist of four attributes namely time in month, concentration of carbon monoxide, Sulphur dioxide and nitrogen dioxide. The dataset is being collected from Pollution Control Board. To this dataset we have appended the data collected from sensor via CoolTerm application.



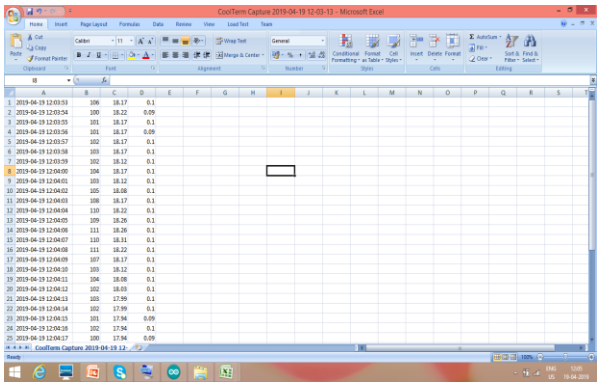


Figure 3: Data Collection

C. Method Used

The method used here is time series analysis [6]. This method is used for analyzing the time series data. A model is trained using the previously observed values using this method. Once after it is trained it can predict the future values.

D. Techniques Used

(i)Multilayer Perceptron

A Multilayer Perceptron [6] is a feedforward artificial neural network that generates a set of outputs for a given set of inputs. It consists of atleast 3 layers: Input Layer, Hidden Layer and Output Layer. Each node apart from the input node has nonlinear activation. A Multilayer Perceptron uses supervised learning technique called as Backpropagation. They train the network on a set of input-output pairs and learn to model the dependency between inputs and outputs.

(ii)Linear Regression

Linear regression [6] is used to model the **RELATIONSHIP** between the response *y* and the input variable *x*. mathematically, we can write a linear relationship as,

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots + \beta_n x_n$$

Figure 2: Architectural Design

B. Architectural Design

Architectural design of the model is shown in Figure 2.

Four sensors namely MQ7, MQ135, SO_2-B4 and MiCS

-2714 are used. All sensors are powered with 5V. Outp

put of the sensors is voltage which is proportional to the concentration of gas in air. Alert message regarding quality of air is sent to registered mobile number when the concentration of pollutant exceeds the certain limit. IFTTT is a web based service using which the message will be sent to the registered mobile number when the event is triggered. The data collected from sensor is stored in the .csv file using Coolterm application. The snapshot of data collection is shown in Figure 3.The data considered is preprocessed inorder to eliminate noise. The missing values in the dataset are filled up. For analyzing the data time series analysis method is used.

Linear Regression is a very simple algorithm. If goal is prediction linear regression can be used to fit a predictive model to an unobserved dataset of values of the response and explanatory variables.

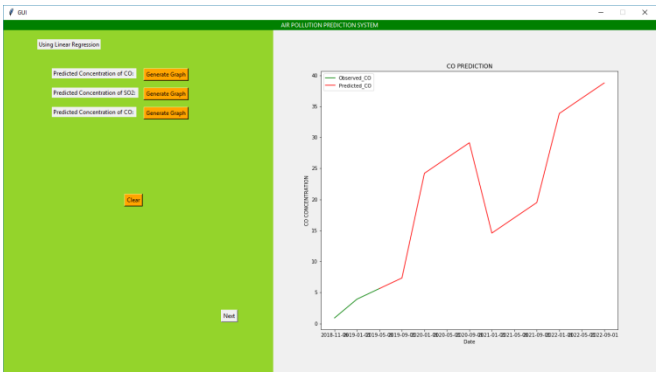


Figure 4: GUI for Air Pollution Prediction

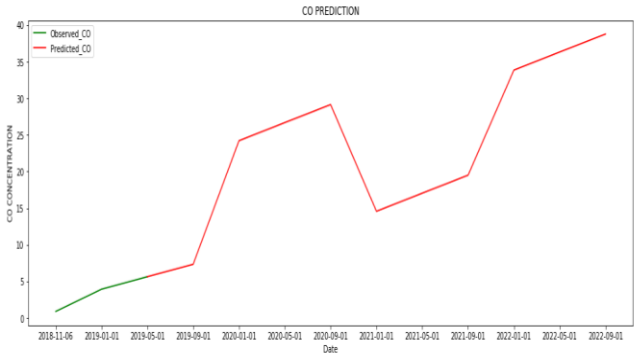


Figure 5: Graph showing Predicted CO

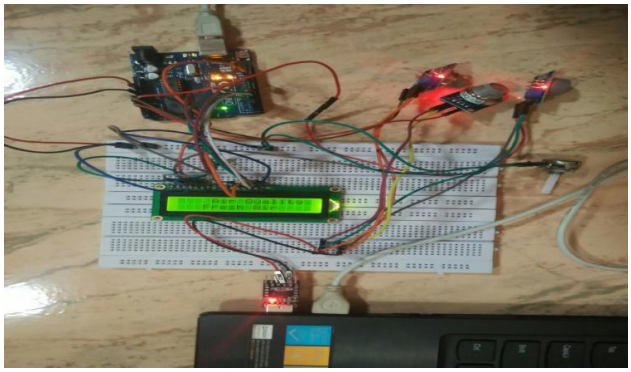


Figure 8: Hardware Setup

V. RESULT

The Figure 4 is a GUI using which graph showing variation in concentration of pollutant such as CO, SO_2 and NO_2 can be generated for a particular day. The snapshots from Figure 5 to Figure 7 are the results obtained from our model. These graphs can also be generated through the GUI. The green lines indicate the observed data and the red line indicates the future predictions made by the model.

From the graph generated, we get to know that the pollutant NO_2 is likely to decrease in future, whereas the SO_2 and CO levels are likely to increase in future. If the concentration of the pollutants goes above the specified threshold, an alert message will be sent to the registered users. With this information, the amount of pollution caused due to various sources can be reduced by taking some preventive measures, leading a healthier and safer

environment. Figure 8 shows how live data regarding the concentration of pollutant is displayed using the LCD.

Figure 6: Graph showing Predicted SO_2

Figure 7: Graph showing Predicted NO_2

VI. CONCLUSION

The main agenda of our work is to get the approximate quantity of pollutants present in air thereby giving awareness to the people of that specific region. A system is developed which will provide the information regarding the air quality and concentration of pollutants using LCD display. Alert message will be sent to people of specific region when the concentration of pollutant exceeds the certain limit. The sensor data is stored in the .csv file which can be used for predicting the concentration of pollutants in upcoming years.

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