"Prediction and Monitoring of Pollutants using IoT"

A project report submitted for the partial fulfillment of academic requirements for the award of Degree

in

BACHELOR OF ENGINEERING

in the Department of

INFORMATION SCIENCE & ENGINEERING

Major Project Phase-2 (IS8C02)

Submitted by

Rituraj	4NI18IS071
Abhinav Kumar	4NI18IS005
Vaibhav Katiyar	4NI18IS107
Siddhant Kumar Jaiswal	4NI18IS087

Under the supervision of
Ms. Shwetha G.N , Asst. Professor,
Department of I.S.&E.,
NIE, Mysuru

Department of Information Science & Engineering

The National Institute of Engineering

(An Autonomous Institute under Visvesvaraya Technological University, Belagavi)

Manandavadi Road, Mysuru 570 008, Karnataka, INDIA

July 2022

The National Institute of Engineering

(An Autonomous Institute under Visvesvaraya Technological University, Belagavi)

Manandavadi Road, Mysuru – 570 008, Karnataka, INDIA

Recognized by AICTE, New Delhi

Accredited by National Board of Accreditation, New Delhi

Grant-in-Aid by Government of Karnataka

Department of Information Science & Engineering

CERTIFICATE

Rituraj	4NI18IS071
Siddhant Kumar Jaiswal	4NI18IS087
Vaibhav Katiyar	4NI18IS107
Abhinav Kumar	4NI18IS005

Certified that the project work entitled "**Prediction and Monitoring of Pollutants using IoT**" carried out by bonafide students of 8th Semester is submitted in partial fulfillment for the award of Bachelor of Engineering Degree in Information Science and Engineering of **The National Institute of Engineering, Mysuru,** an autonomous institute under Visvesvaraya Technological University, Belagavi during the academic year 2021-2022. It is certified that all suggestions/ corrections suggested during Internal Assessment have been incorporated in the Report deposited in the departmental library.

The project report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the award of the said Degree.

Signature of the Guide	Signature of the HoD	Signature of the Principal
Ms. Shwetha G.N.	**Dr. S Kuzhalvaimozhi**	**Dr. Rohini Nagapadma**
Assistant Professor,	Prof. & H.O.D.	Principal,
Dept of ISE, NIE, Mysore	Dept of ISE, NIE, Mysore	NIE, Mysore

Viva-Voce:

Name of the Examiners	Signature with Date
1.	
2.	

DECLARATION

We, Abhinav Kumar bearing USN : 4NI18IS005, Vaibhav Katiyar bearing USN : 4NI18IS107, Siddhant Kumar Jaiswal bearing USN : 4NI18IS087, Rituraj bearing USN : 4NI18IS071 students of 8th semester of UG programme, Department of Information Science and Engineering, The National Institute of Engineering , Mysore hereby declare that the project work entitled "Prediction and Monitoring of Pollutants Using IoT" has been carried out under the guidance of Ms. Shwetha G.N, Assistant Professor, Department of Information Science and Engineering.

This project work is submitted to **The National Institute of Engineering**, Mysuru, (An Autonomous institute under VTU, Belagavi) in partial fulfillment of the course requirements for the award of degree in Information Science and Engineering during the academic year 2021-2022. This written submission represents a record of original work and we have adequately cited and referenced the original sources.

Further, the matter embodied in this thesis has not been submitted to any other University or Institution for the award of any degree.

Place: Mysuru

Date:

1. Abhinav Kumar 4NI18IS005
2. Siddhant Kumar Jaiswal 4NI18IS087
3. Rituraj 4NI18IS071
4. Vaibhav Katiyar 4NI18IS107

ACKNOWLEDGEMENT

We are extremely thankful to **Dr. Rohini Nagapadma,** Principal, NIE, Mysuru, for providing us the academic ambiance and laboratory facilities to work, and everlasting motivation to carry out this work and shape our careers.

We express our sincere gratitude to **Dr. S Kuzhalvaimozhi**, Professor and Head of Dept. of Information Science and Engineering, NIE, Mysuru, for her stimulating guidance, continuous encouragement, and motivation throughout the course of the present work.

We extend our gratitude to Guide **Ms. Shwetha G.N**, Assistant professor, Co-Guide **Mr. Rajesh N,** Assistant Professor and our Project Coordinator **Ms. Prajakta Madankar,** Assistant Professor, Dept. of Information Science and Engineering, NIE, Mysuru, for their support and guidance over the entire course of work.

We take this opportunity to thank all our friends, classmates who always stood by us in difficult situations also helped us in some technical aspects, and last but not least, we wish to express our deepest sense of gratitude to our parents who were a constant source of encouragement and stood by us as a pillar of strength for completing this work and course successfully.

Rituraj (4NI18IS071)
Abhinav Kumar (4NI18IS005)
Siddhant Kumar Jaiswal (4NI18IS087)
Vaibhav Katiyar (4NI18IS107)

ABSTRACT

Urbanization, industrialization, and regional economic integration have developed rapidly in the World in recent years. Air pollution has attracted more and more attention. Air pollution is composed of harmful gases and particulate matter. However, PM2.5 is the main particulate matter in air pollution. The other parameters like humidity , heat and pressure also affect the AQI level.

We will be collecting data using sensors like Temperature Sensors, Humidity Sensors, Pressure Sensors, Gas Sensors. Gas sensors will give different concentrations of gases in the atmosphere which will ultimately predict AQI(Air quality Index) level. From that AQI level, we can predict the different respiratory diseases as when the concentration increases more than 200 ppm, it starts affecting the lungs, leading to diseases like asthma and lung cancer.

CONTENTS

List of Figures

CHAPTER 1

INTRODUCTION

Project uses gas sensors to detect the existence of poisonous gases and compounds in the atmosphere and continuously delivers this data. The sensors communicate with Arduino which precedes this data and delivers over the requisition.

IoT technology support in developing a progress report of a device in a real-time environment. Internet of Things is an innovation that connects the sensors with the installed framework and enables the information from these sensors to go over the internet.

With The help of emerging technology of machine learning, collected data will be trained into a model which predicts the air quality for various chronic diseases like lung cancer, stroke, asthma, bronchitis, etc.

1.1 Existing System

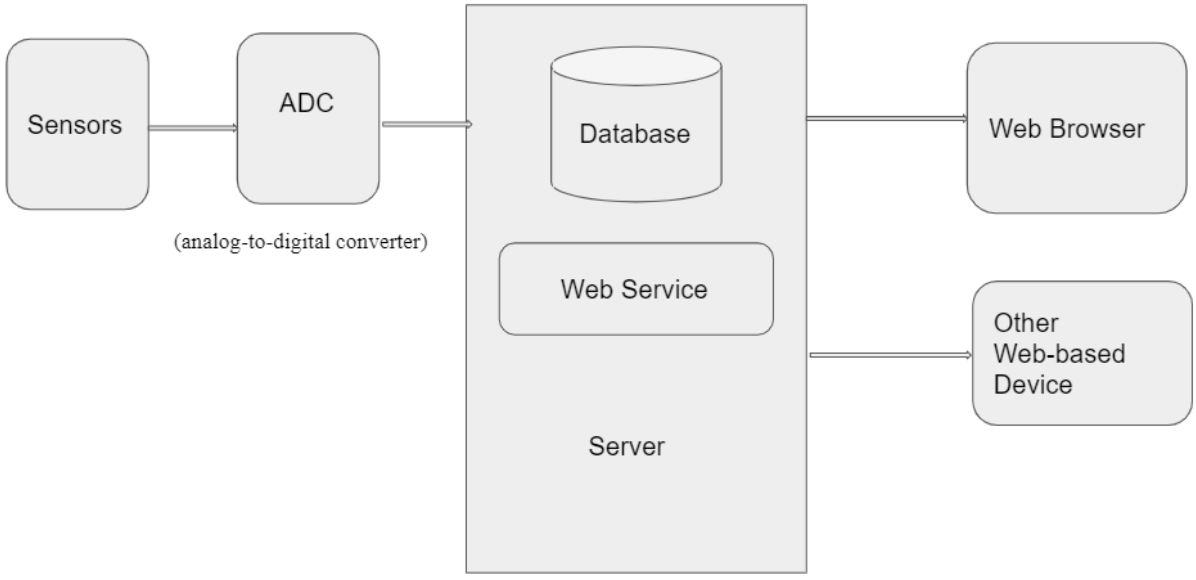


Fig 1.1.1 Existing System

Sensors take input from the environment. The input is in the form of analog so ADC (Analog-to-Digital Converter) is used to convert it into digital form. The digital data is then stored into the Data Warehouse. This data can be accessed by different web services and servers. When some client requests the data then the server fetches it from the warehouse and delivers it to the client.

1.2 Disadvantages of Existing System:

In the existing system, the sensor senses from the environment and displays only the sensed values to the interested client in real time. This system doesn't predict the PM2.5 level.

1.3 Proposed System

The proposed model is for controlling the air(AQI level) and noise foulness in the environment to make surrounding more rational and more interactive with the objects through wireless Communication.

Our System consist of Different Phases/Levels -

- At Level 1, Sensors for Temperature, Gas ,Sound ,Rain, Humidity and Pressure will give appropriate data.

- At Level 2, All the gathered data through these sensors will be converted to digital using Arduino.

- At Level 3, Data Warehouse will be stored in the available server and will be provided for future usage.
- At Level 4, All the gathered data will be used to train the model using various regression techniques like Linear Regression , Random Forest Regression , XGBoost Regressor , CatBoost Regressor , Stochastic Gradient Descent Regression , Kernel Ridge Regression , Elastic Net Regression , Bayesian Ridge Regression , Gradient Boosting Regression , Support Vector Machine.
- At Level 5, the model with best accuracy will be chosen out of all to ultimately predict AQI Level and give results for different weather conditions.

1.4 Objectives

1. Sensing the concentration of different pollutants in the weather with the help of various sensors.
2. Storing the data gathered, in the data warehouse.
3. Using the stored data values to predict PM2.5(Particulate Matter) concentration and get the AQI level.

CHAPTER 2

LITERATURE SURVEY

2.1 IEEE Papers

- In this paper [1] the authors are concentrating on the framework on which the air and sound pollution can be tracked and monitored and the proposed model gives a warning when a dangerous level is reached. The paper is focused more on the overall model of the monitoring system and less on the actual sensing technology.
- This paper is focused on air quality sensing using MQ-135 and MQ-7 sensors and then performing machine learning analysis to provide visual graphical data which can be viewed by the public on the ThingSpeak platform. ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. These sensors are not enough to measure all the pollutants present in air. [2]
- The paper talks about the various health hazards caused by pollutants in the air in detail as well as giving a comprehensive list of all the sensors that can be used to detect and measure the concentration of various gases. The paper also talks about various IoT architectures and the differences between a single computer board (Raspberry Pi) and microcontroller platform (Arduino). [3]
- The paper shows a practical approach to air quality monitoring by making a prototype using various IoT technologies and providing an inexpensive and mobile solution to the problem. Sensors like MQ-9 (for detecting carbon monoxide), MQ-2 (for detecting smoke) and PMS3003 (for PM2.5 particles) are used. NodeMCU is used as a processing unit for sending the detected data to the Internet.[4]

CHAPTER 3

SYSTEM REQUIREMENTS

3.1 Hardware Requirements

The following are the Hardware Requirements for the running the system

Hard Disk	: 8 GB or more
Ram	: 4 GB RAM and above
Processor	: Intel i5 and above
Microcontroller	: Arduino Uno
Processor Speed	: 1.5 GHz or higher
Sensors	: PMS5003, MQ 135, MQ 7, MQ 137, DHT 11, ESP8266, Jumper Wires, Resistors

3.2 Software Requirements

Operating System	: Windows 7 or above / Linux / Mac
Software	: Proteus 8
Programming Languages	: Python, Sketch

CHAPTER 4

SYSTEM DESIGN

4.1 Introduction

The purpose of the design phase is to plan a solution to the problem specified in the requirements. This phase is the first step in moving from the problem domain to the solution domain. In other words, starting with what is needed and then moving toward design so as to satisfy the needs. The design of a system is perhaps the most critical factor affecting the quality of the software.

It has a major impact on the later phases particularly testing and maintenance.

The design activity often results in three separate outputs:

- Architecture Design
- High Level Design
- Detailed Design

4.1.1 Architecture Design

The architecture design focuses on looking at a system as a combination of many different components, and how they interact with each other to produce the desired result. The focus is on identifying components or subsystems and how they connect. In other words, the focus is on what major components are needed.

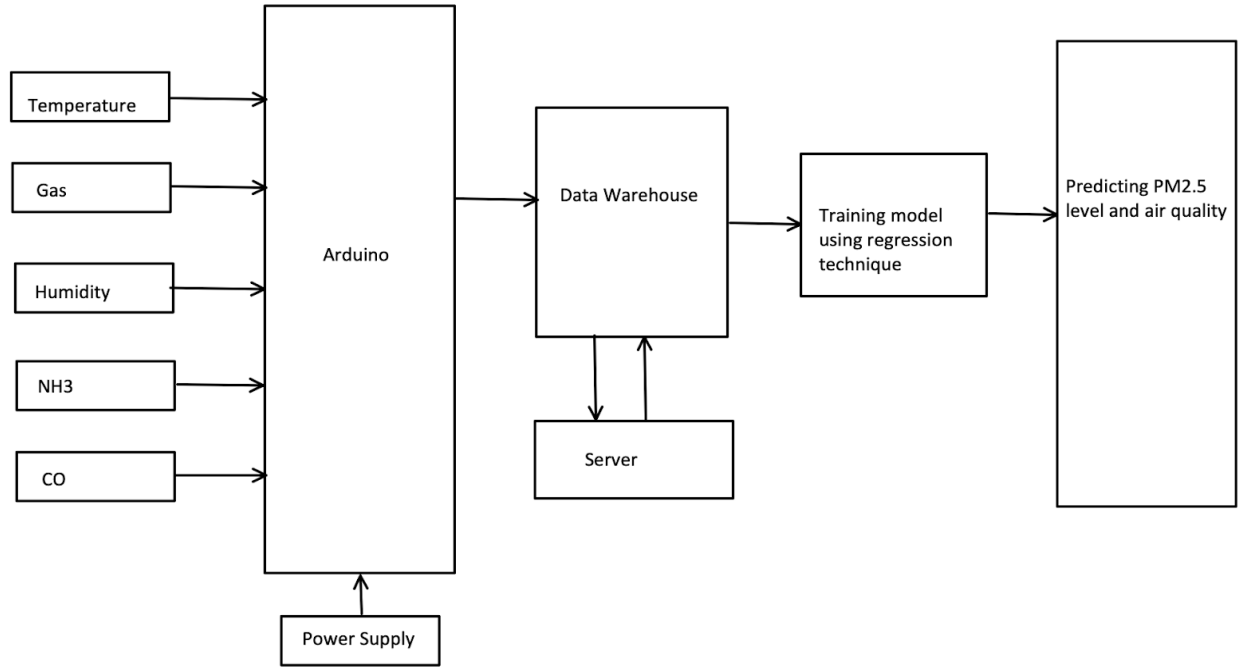


Fig 4.1.1 Architectural Design

4.1.2 High Level Design

The high-level design identifies the modules that should be built for developing the system and the specifications of these modules. At the end of system design all major data structures, file format, output formats, etc., are also fixed. The focus is on identifying the modules. In other words, the attention is on what modules are needed.

4.1.3 Detailed Design

In the detailed design, the internal logic of each of the modules is specified. The focus is on designing the logic for each of the modules. In other words, how modules can be implemented in software is an issue. A design methodology is a systematic approach to creating a design by application of a set of techniques and guidelines. Most methodologies focus on high level design.

Our Proposed Solution is divided into 3 modules

1. Data Collection
2. Model Formation
3. Prediction and display of AQI Level.

4.2 Data Flow Diagram

A Data Flow Diagram (DFD) graphically represents the functions, or processes, which capture, manipulate, store, and distribute data between a system and its environment and between components of a system.

The first phase of the System Design is Collection of Data from Different Sensors and Store it in database file.

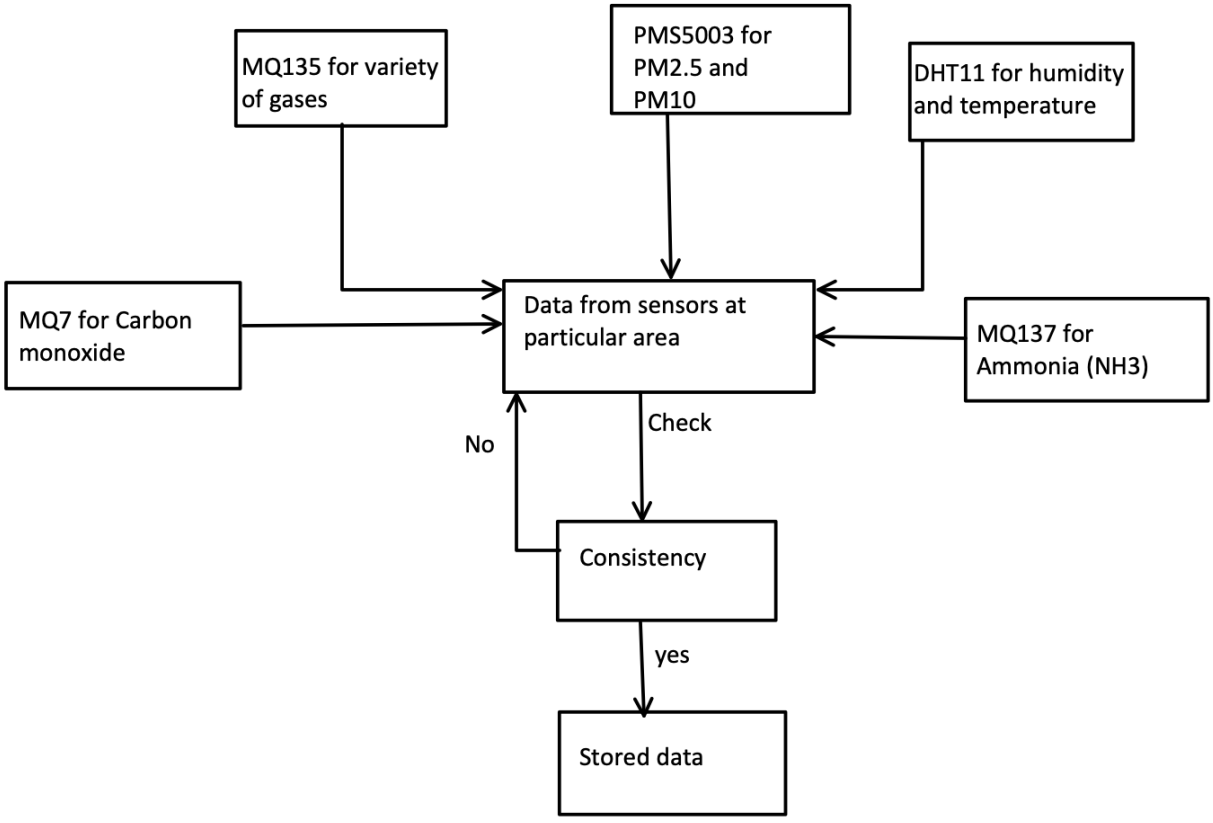


Fig 4.2.1 Data Flow Diagram

In the second phase of the system design the collected data will be trained by taking 30% dataset as test cases and 70% of dataset for training the model.

Regression analysis is a statistical method to model the relationship between a dependent (target) and independent (predictor) variables with one or more independent variables. More specifically, Regression analysis helps us to understand how the value of the dependent variable is changing corresponding to an independent variable when other independent variables are held fixed.

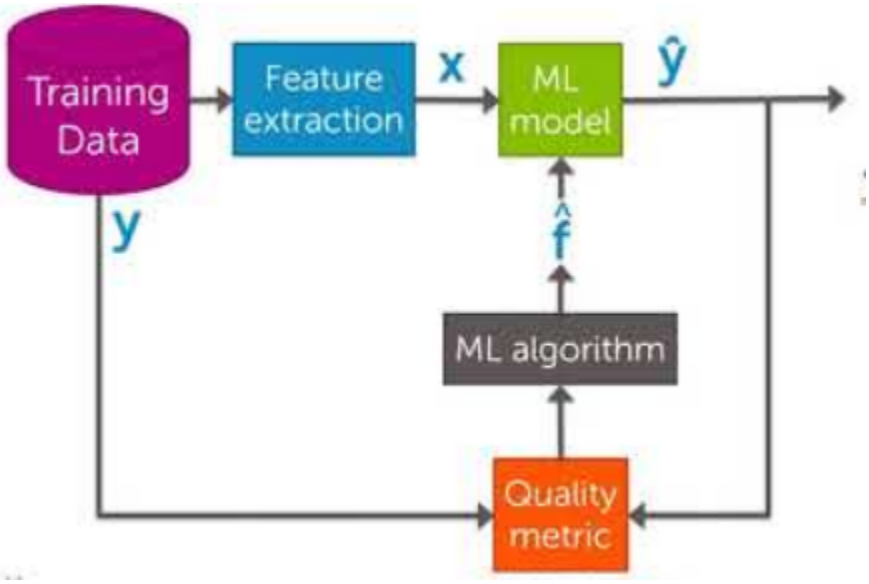


Fig 4.2.2 ML Regressing Model Design

For the process different Machine Learning Regression models can be taken into consideration. In our design part we are taking random forest regression models for training the model.

Random Forest Algorithm Design

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

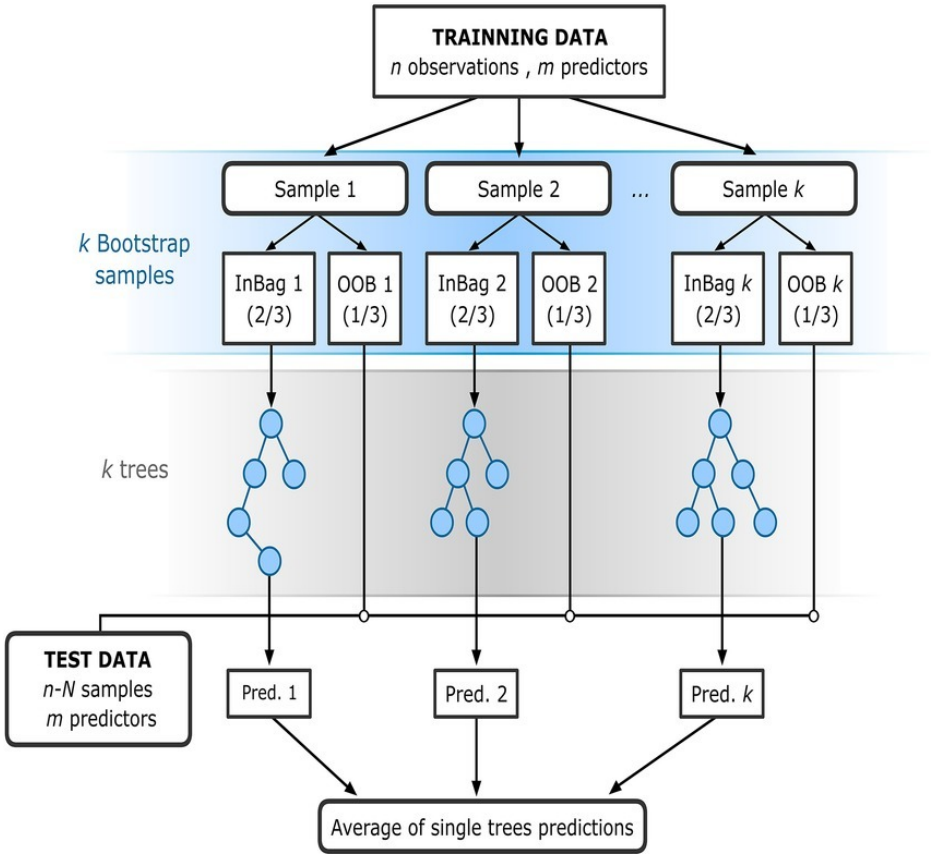


Fig 4.2.3 Random Forest Regression Design

The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfitting.

Random Forest works in two-phase first is to create the random forest by combining N decision trees, and second is to make predictions for each tree created in the first phase.

The Working process can be explained in the below steps and diagram:

Step-1: Select random K data points from the training set.

Step-2: Build the decision trees associated with the selected data points (Subsets).

Step-3: Choose the number N for decision trees that you want to build.

Step-4: Repeat Step 1 & 2.

Step-5: For new data points, find the predictions of each decision tree, and assign the new data points to the category that wins the majority votes.

In the third phase of system design the users are presented with choices : if they want to check the AQI variations with pollutant concentration they can manually enter the data and the trained model will predict the PM 2.5 and AQI. If the user wants to get the real time value of PM2.5 and AQI then the real time data will be extracted from the database and predict the PM2.5 and AQI.

Output of these predictions will be displayed on the Web Application and based on these prediction information of different diseases caused by these pollutants will also be displayed.

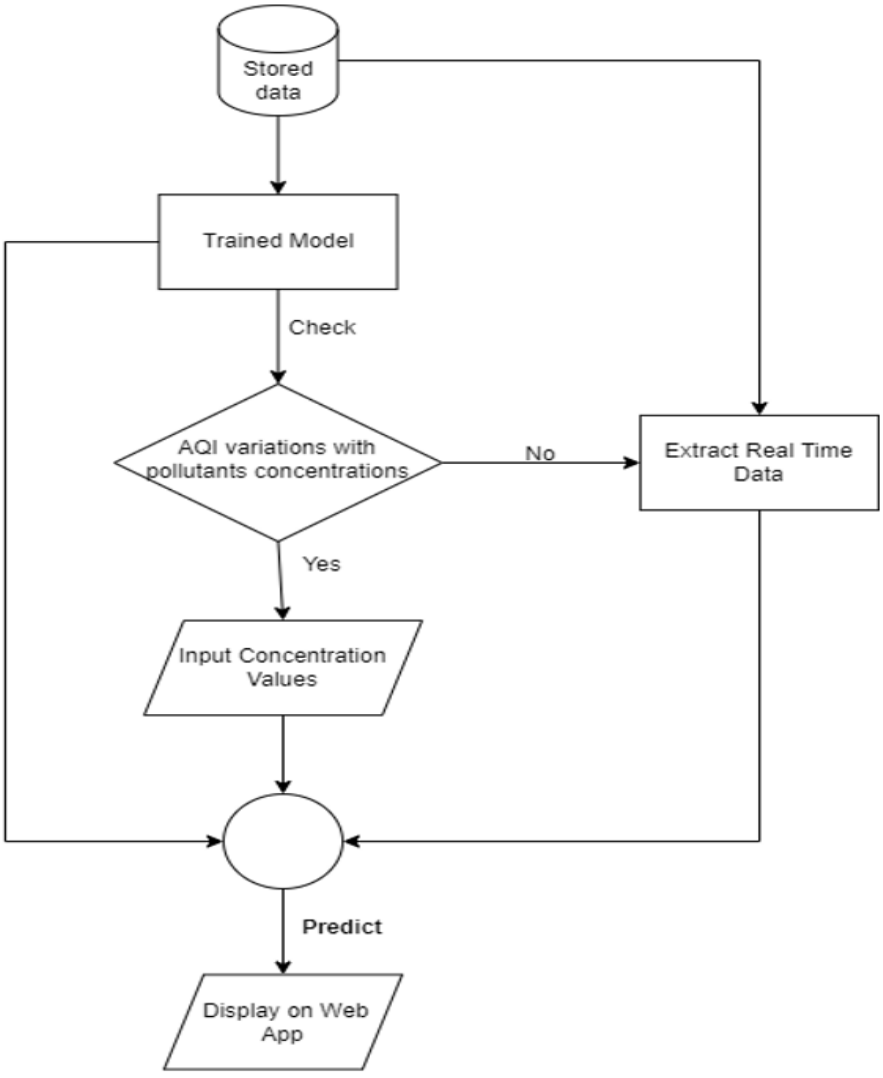


Fig 4.2.4 Display Design

CHAPTER 5

SYSTEM IMPLEMENTATION

5.1 Introduction

The IoT module will be have to assembled which includes the following sensors and other devices as follows -

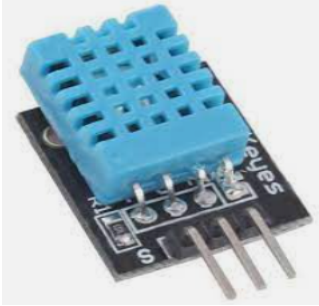
1. MQ-7 (for measuring carbon monoxide)

2. MQ-137 (for measuring ammonia gas level)

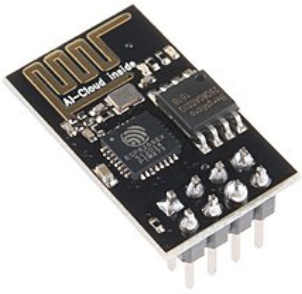
The ability of a Gas sensor to detect gases depends on the chemiresistor to conduct current. The most commonly used chemiresistor is Tin Dioxide (SnO2) which is an n-type semiconductor that has free electrons (also called as donor)

3. PMS5003 (for measuring PM2.5 and PM10 level)

4. DHT11 (for measuring temperature and humidity)

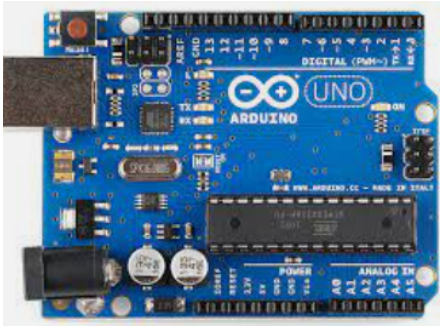


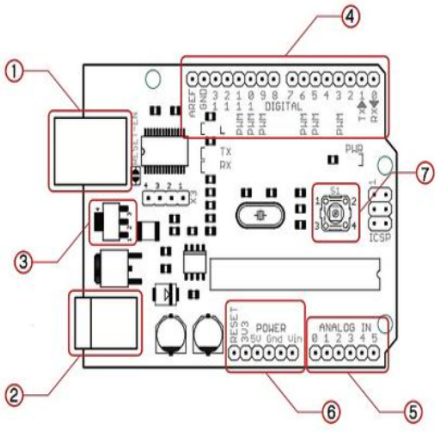
5. Wifi Module (ESP8266)



6. Arduino Uno

   Arduino's processor basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory and the data memory.The code is stored in the flash program memory, whereas the data is stored in the data memory.



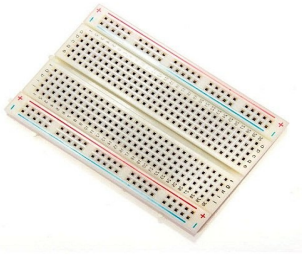


The most important parts on the Arduino board high lighted in red:

1: USB connector
2: Power connector
3: Automatic power switch
4: Digital pins
5: Analog pins
6: Power pins
7: Reset switch

7. Jumper wires

8. Resistors,Breadboard



Resistor Breadboard

5.2 Phase 1 - Simulation and Gathering of Sensors

Before assembling the whole system everything has to be simulated so that we can get a fair idea how the sensor modules will be connected to the Arduino microcontroller. This will make the whole process of assembling the system easier when we do buy the sensors. The simulation can be made on a software called Proteus which is a proprietary software tool suite used primarily for electronic design automation. The software has all the sensor libraries required to conjure a simulation. If the sensors are not present, the libraries can be downloaded from the internet. The sensors have to be pulled in the simulation window and

its various terminals have to be connected to the arduino board through wires. A visual terminal can be added too to obtain the data on the screen.

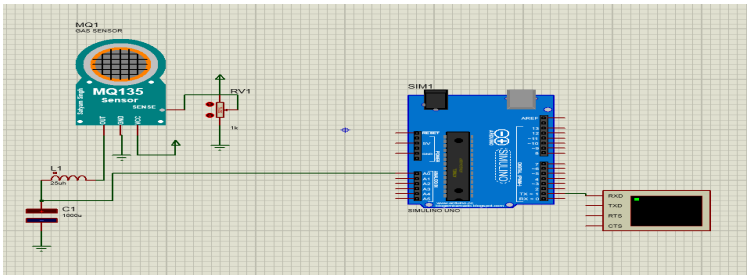


Fig 5.2.1 Connection of MQ-135 Sensor in Proteus 8

Once all the connections are done then the code written in Arduino IDE using Sketch programming language for the simulation to work has to be converted into a .HEX file by clicking on Export Compiled Binary which is then stored in Documents/Arduino/Filename/Filename.HEX

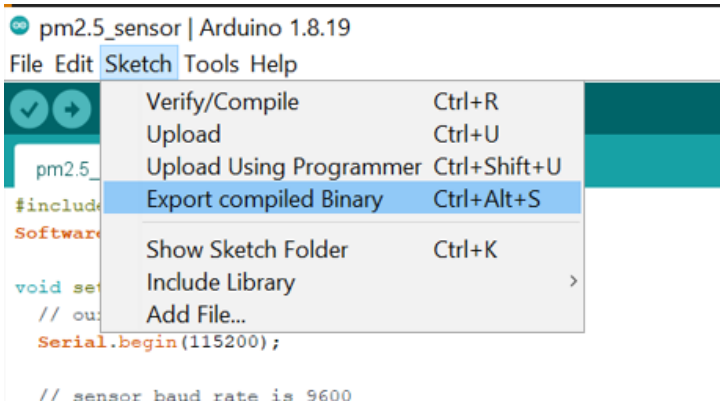


Fig 5.2.2 Export compiled binary has to be clicked

The Arduino module has to be clicked and the .HEX file has to be uploaded there.

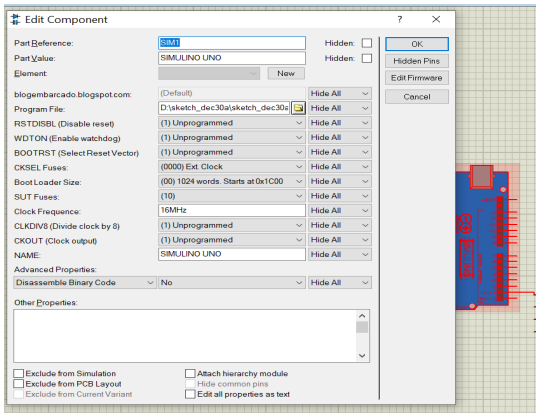


Fig 5.2.3 Upload the corresponding .HEX file

The run simulation button has to be pressed after this which starts the simulation as shown below. The visual terminal will appear showing gas raw value in ppm as specified in the

program instructions.

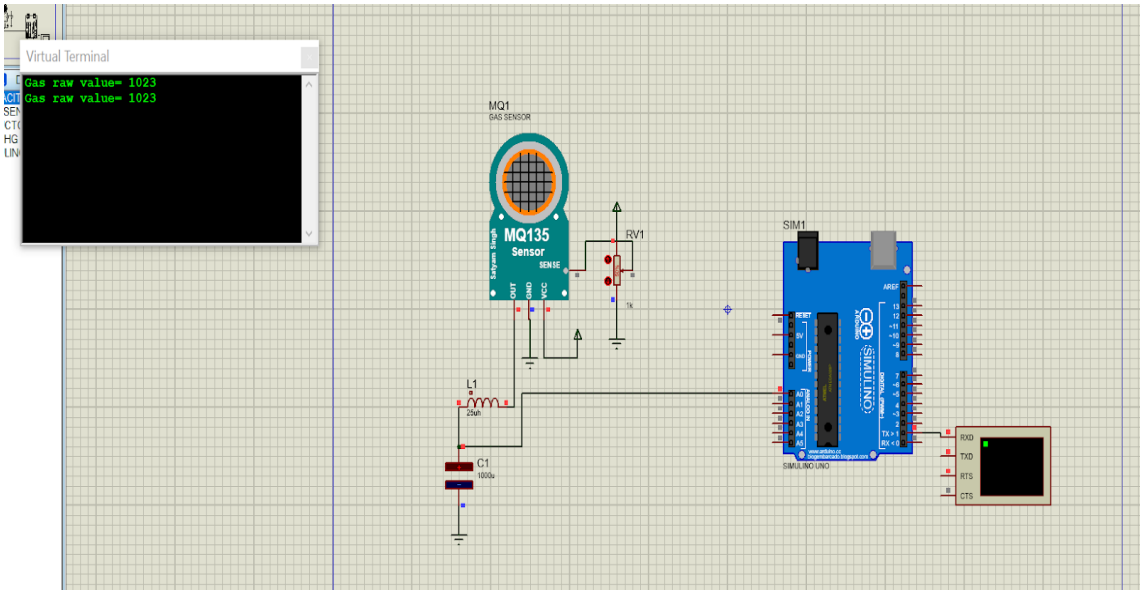


Fig 5.2.4 Running the simulation

After the simulation is successful and the results are exactly what we wanted we can start buying and gathering the different sensors required in the project.

5.3 Phase 2- Assembling the IoT module and Gathering Data for Machine Learning Analysis

The Phase-2 of the project started from the purchasing of IOT sensors required for this project. The next step was to make all the necessary connections in order for all the sensors to work simultaneously. All the sensors were connected with the Arduino which supplied power to the sensors as well as received analog output from them. The next step was to write the necessary code in Arduino IDE. The raw sensor data has to be calibrated and turned into useful data through the code. After the code is successfully uploaded in the Arduino the sensor data can be seen on the Serial Monitor. The below images show the collection of sensor data which is being directly uploaded into ThingSpeak through a Wifi Module (ESP8266) which enables Arduino to access any network.

ThingSpeak is an open-source software written in Ruby which allows users to communicate with internet enabled devices. It facilitates data access, retrieval and logging of data by providing an API to both the devices and social network websites.

ThingSpeak can be used to write and read sensor data using APIs which is useful because the data is then needed for training the ML model.

The measuring range for all sensors are as follows - MQ-135 = 10-1000 ppm , MQ-7 = 10-500 ppm (Standard = 4 mg/m3) , MQ-137 = 5-500 ppm (Standard = 400 ug/m3) , PMS5003 = 0-500 ug/m3, DHT11 = Temperature (0-50 °C) , Humidity (20-90 %)

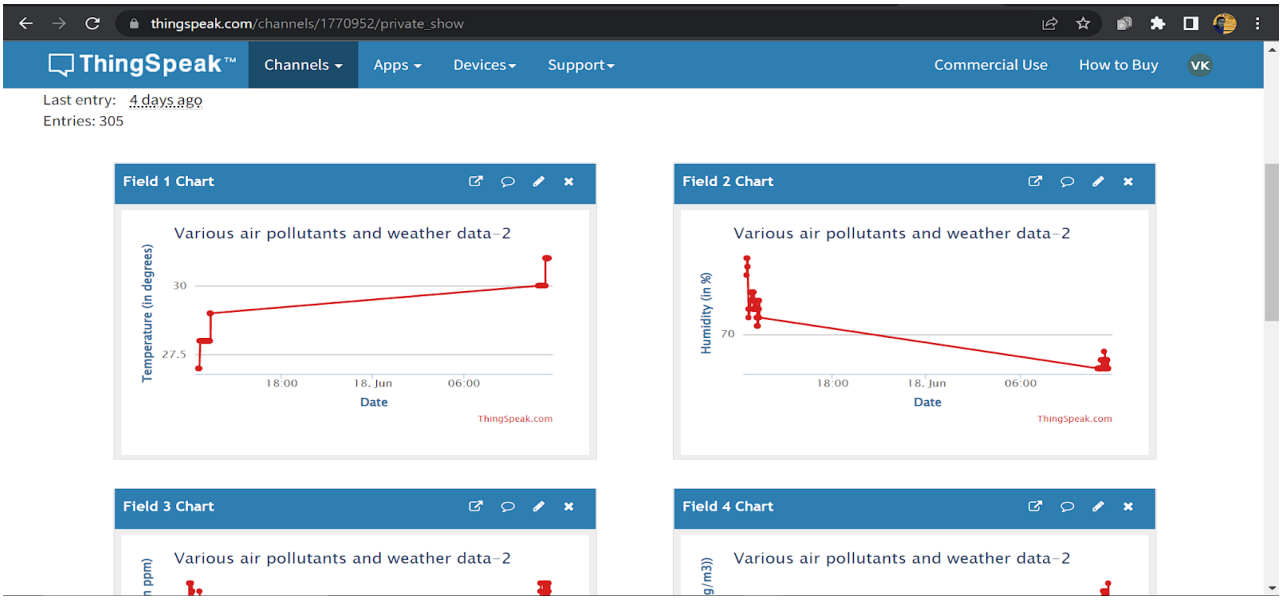


Fig 5.3.1 ThinkSpeak channel showing sensor data in the form of graphs

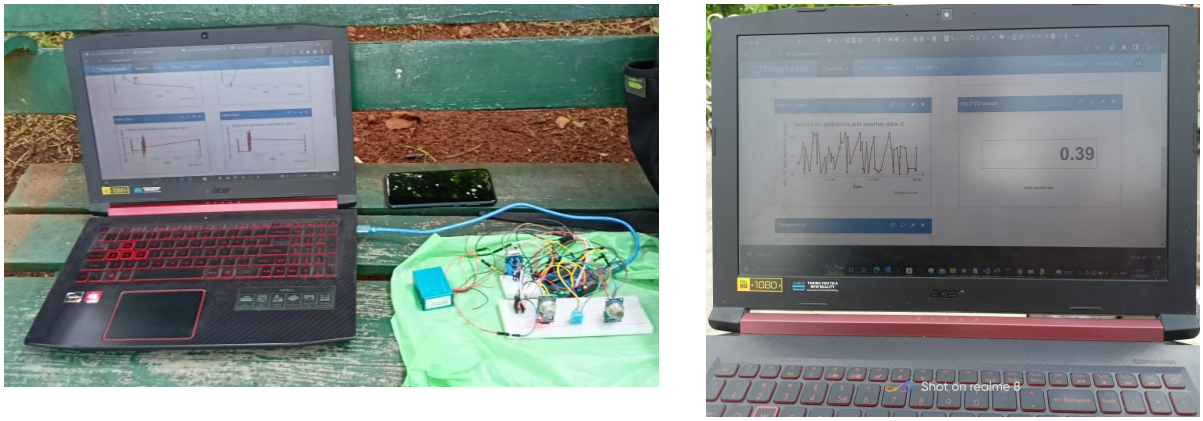


Fig 5.3.2 Collecting the data

CHAPTER 6

TESTING

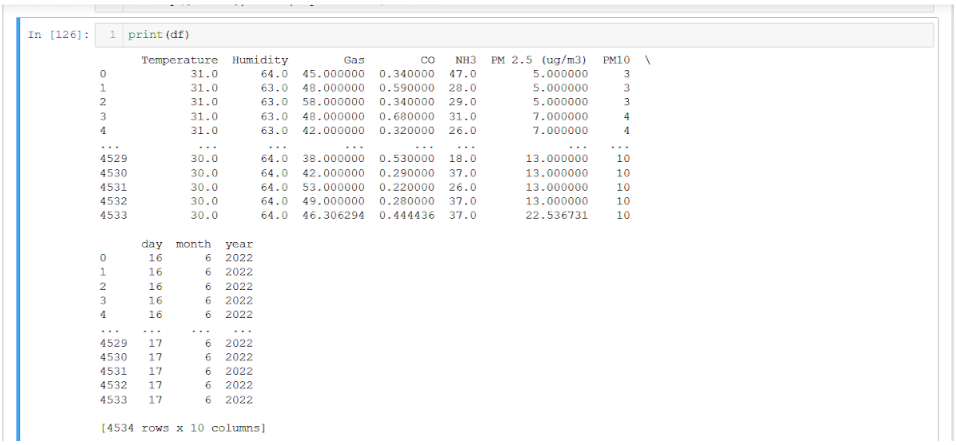
Testing is an essential footstep in the development of a system. Testing is the course of action of verifying the correctness of the system that is already developed. After the system is developed, it needs to be verified with the functionalities that each functional specification is working in a correct manner. It also ensures the newly developed system meets the quality requirement and genuineness. Testing is performed at various levels of the system with the sole aim of making a secure and qualified system. In other words, the testing is performed to check whether the system is working as in the same way the system was designed and expected to work. The testing is mainly performed to achieve and affirm the quality of the project. The testing performs the quality assurance for the software. Testing involves writing test cases for each operation to check and verify the functionality of the module.

6.1 ML model Testing

In the process of modeling of data we take a sample dataset to check on the accuracy of the model that can be achieved by applying a random Forest regression model.

The code is first uploaded into the Arduino which enables it to send data into ThingSpeak which collects the data which later forms the dataset for the model.

Fig 6.1.1 Arduino Code



```
In [126]: print(df)

      Temperature  Humidity        Gas        CO   NH3  PM 2.5 (ug/m3)  PM10  \
0            31.0      64.0  45.000000  0.340000  47.0        5.000000     3
1            31.0      63.0  48.000000  0.590000  28.0        5.000000     3
2            31.0      63.0  58.000000  0.340000  29.0        5.000000     3
3            31.0      63.0  48.000000  0.680000  31.0        7.000000     4
4            31.0      63.0  42.000000  0.320000  26.0        7.000000     4
...           ...       ...        ...       ...   ...             ...   ...
4529         30.0      64.0  38.000000  0.530000  18.0       13.000000    10
4530         30.0      64.0  42.000000  0.290000  37.0       13.000000    10
4531         30.0      64.0  53.000000  0.220000  26.0       13.000000    10
4532         30.0      64.0  49.000000  0.280000  37.0       13.000000    10
4533         30.0      64.0  46.306294  0.444436  37.0       22.536731    10

      day  month  year
0      16      6  2022
1      16      6  2022
2      16      6  2022
3      16      6  2022
4      16      6  2022
...   ...    ...   ...
4529   17      6  2022
4530   17      6  2022
4531   17      6  2022
4532   17      6  2022
4533   17      6  2022

[4534 rows x 10 columns]
```

Fig 6.1.2 Dataset Tested

By Doing all the processing on missing data and making the data consistent we came up with a model of accuracy of 96% approx.

5. Using Random Forest

```
In [135]: %%time

from sklearn.ensemble import RandomForestRegressor

rfc = RandomForestRegressor(n_estimators = 150,random_state = 0)
rfc.fit(X_train, y_train)
y_pred = rfc.predict(X_test)
y_pred=y_pred.round(decimals=3)

scores['RandomForestReg.'] = round((r2_score(y_test,y_pred)*100),2)

print("Random Forest Regression_____________________")
print()
print('R2 score             : ',r2_score(y_test,y_pred))
print('mean Absolute Error  : ',math.sqrt(mean_squared_error(np.array(y_test),y_pred)))
print("Accuracy             :  {:.2f}".format(r2_score(y_test,y_pred)*100),"%")
print('-----------------------------------------')

Random Forest Regression_____________________

R2 score             :  0.9681089121069325
mean Absolute Error  :  1.7079979736548776
Accuracy             :  96.81 %
-----------------------------------------
Wall time: 983 ms
```

Fig 6.1.3 Training the model

After training we will be predicting the PM2.5 concentration and The corresponding AQI level.

```python
def air_condition(pm_conc):
    if pm_conc<=12.0:
        print("AQI level is Between 0 to 50")
        print("Good Weather Conditions")
    elif pm_conc>12.1 and pm_conc<=35.4:
        print("AQI level is Between 51 to 100")
        print("Moderate Weather Conditions")
    elif pm_conc>35.5 and pm_conc<=55.4:
        print("AQI level is Between 101 to 150")
        print("Unhealthy Weather Conditions for Older Age Groups")
    elif pm_conc>55.5 and pm_conc<=150.4:
        print("AQI level is Between 151 to 200")
        print("Unhealthy Weather Conditions")
    elif pm_conc>150.5 and pm_conc<=250.4:
        print("AQI level is Between 201 to 300")
        print("Very Unhealthy Weather Conditions")
    else:
        print("AQI level is Above 300")
        print("Hazardous Weather Conditions")
```

```python
#testing
wth = [['100','4','20','0.2','10.6','0.5','15.3','12.4','0.002','0.0005','1.005','9','10','2020']]
```

```python
pm_pred = rfc.predict(wth)
print(pm_pred)
air_condition(pm_pred)
```

```
[50.46768667]
AQI level is Between 101 to 150
Unhealthy Weather Conditions for Older Age Groups
```

Fig 6.1.4 Prediction from model

CHAPTER 7

DEPLOYMENT

For the deployment of our application we chose Heroku. Heroku is a cloud platform as a service (PaaS) supporting several programming languages.Applications that are run on Heroku typically have a unique domain used to route HTTP requests to the correct application container or dyno. Each of the dynos are spread across a "dyno grid" which consists of several servers. Heroku's Git server handles application repository pushes from permitted users.

All Heroku services are hosted on Amazon's EC2 cloud-computing platform.The Heroku network runs the customer's apps in virtual containers which execute on a reliable runtime environment. Heroku also provides custom buildpacks with which the developer can deploy apps in any other language. Heroku lets the developer scale the app instantly just by either increasing the number of dynos or by changing the type of dyno the app runs in.

We have created one configuration file in Heroku which will manage the source code from the github and makes the deployment easy. We can check the correctness of data from the Heroku logs.

WebApp:- https://air-pollution-majorp.herokuapp.com/

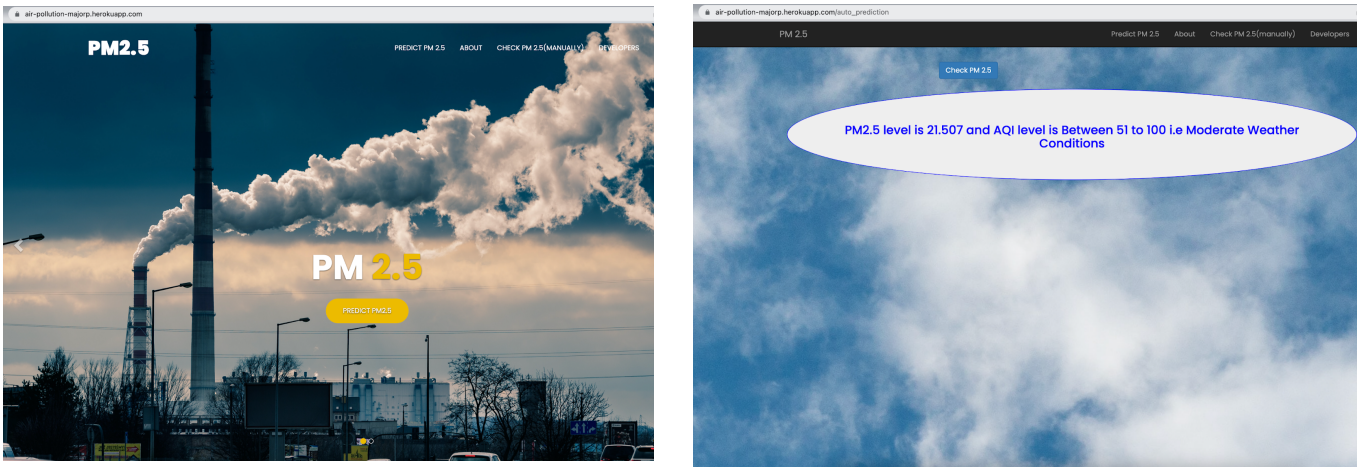


Fig 7.1 Images of website deployed on heroku

CHAPTER 8

ADVANTAGES AND DISADVANTAGES

Advantages of ARDUINO

- inexpensive
- open source in hardware
- don’t need to external programmer (Burner)
- programming ease
- open source in software
- IDE Software operate on any operating system

Disadvantages of ARDUINO

- Cannot run more than one program at the same time
- No memory safety checks
- Expensive for the CPU power and memory
- Lack of built-in communications
- Lack of built-in peripherals
- Limited number of programming languages
- Limited number of IDEs

Advantages of Random Forest Regression Model

- Random Forest is based on the bagging algorithm and uses Ensemble Learning technique. It creates as many trees on the subset of the data and combines the output of all the trees. In this way it reduces overfitting problems in decision trees and also reduces the variance and therefore improves the accuracy.
- Random Forest can be used to solve both classification as well as regression problems.
- Random Forest works well with both categorical and continuous variables.
- Random Forest can automatically handle missing values.
- No feature scaling required: No feature scaling (standardization and normalization) required in case of Random Forest as it uses rule based approach instead of distance calculation.
- Handles non-linear parameters efficiently: Non linear parameters don't affect the performance of a Random Forest unlike curve based algorithms. So, if there is high non-linearity between the independent variables, Random Forest may outperform as compared to other curve based algorithms.
- Random Forest can automatically handle missing values.
- Random Forest is usually robust to outliers and can handle them automatically.
- Random Forest algorithm is very stable. Even if a new data point is introduced in the dataset, the overall algorithm is not affected much since the new data may impact one tree, but it is very hard for it to impact all the trees.

- Random Forest is comparatively less impacted by noise**.**

Disadvantages of Random Forest

- Complexity: Random Forest creates a lot of trees (unlike only one tree in case of decision tree) and combines their outputs. By default, it creates 100 trees in the Python sklearn library. To do so, this algorithm requires much more computational power and resources. On the other hand, the decision tree is simple and does not require so much computational resources.

- Longer Training Period: Random Forest requires much more time to train as compared to decision trees as it generates a lot of trees (instead of one tree in case of decision tree) and makes decisions on the majority of votes.

CHAPTER 9

COST EFFECTIVENESS

In a project, there is always something that needs executing, and every task has a cost and expected benefits. Because of the high stakes, we cannot just make decisions based on gut instinct. We prefer to minimize risk to the best of their ability and act only when there is more certainty than uncertainty.

For analytical purposes, this needs to be more closely defined as the optimum trade-off between specific parameters. These parameters include affordable scope requirements, quality including aesthetic value, time to put in place, enhanced production or reduced operating costs, and so on, all according to the type of project and original basic project objectives. The cost analysis in project management was designed to assess the cost compared to the benefits in the project proposal.

This process begins with a list, which includes all the expenses of the project together with the benefits that will derive from it once the project will be successfully completed.

The purpose of the cost-benefit analysis is to have a systemic approach in order to understand the advantages and disadvantages of various solutions through a project, including transactions, activities, business requirements, and investments. Cost-benefit analysis offers options and is the best approach to achieve a goal while saving on investment.

There are two main purposes for using a cost-benefit analysis for a project :-

- To determine if the project is valid, justifiable and feasible, verifying if its benefits exceed the costs.
- It offers a reference base for comparing projects by determining which project benefits are greater than its costs.

CONCLUSION

It is necessary to have the air and noise contamination model for identifying the broad line of gases and compounds. The actuators using here have a broad lifespan, can be available easily, can be handled easily, cost-effective and of course, are pithy in the environment. The virtue of air and noise can be controlled inside as well as outside. This model has easy circuit connections. It performs in actual time and will have an ocular turnout. The principal aim of this project is to give the assurance that the level of air and noise contamination can be checked and controlled by fetching up certain measures that can sequentially be taken for the air and sound contamination model is a key to move ahead and put an answer to the largest hazard.

This concept of IoT is practically proved for controlling certain criteria. It also delivered the actuators criterion and data to the clouds. This technology intensifies the way of controlling different facets of nature like air trait and sound trait problem is emphasized and presented in this article. This IoT based system is a good way for wholesome substances. So if we use this contrivance, then not only the regime but also the ordinary people can include in this process for controlling the air and sound contamination and assure a secure and healthy nature. This instinctive device, once rooted, can be capable of endlessly stalking the contamination level and analyzing the identified data. The best extending significance of this contrivance is that the output is displayed both in digital as well as an analog form through a common web application.This controlling system can be fixed at various places in the downtown or any other field like hospitals, highways, school campuses, houses, plazas, shopping centers, etc. The actuator keeps on analyzing the mark of air and noise contamination and gives the outputs. Now, with the help of this application we can able to get the information of contamination of a specific field and after that the ordinary people can take the required assess corresponding and the regime can alarm different enterprise in relation to the degree of pollution they conduce in and procure the needed measures so now it has come more flexible and effective for the regime along with the people to indulge in this operation and put an added point to it. Peoples are today equitably alert and queer for their surroundings. This idea of IoT is advantageous for the good fortune of the community and it is carried by employing such trends of technology.

FUTURE ENHANCEMENT

We can collect data from various areas and different cities.More sensors can be used to further increase the precision and accuracy of PM 2.5. We can scale it by providing PM2.5 and other measurements of concentration of gases for different locations.

REFERENCES

[1] K. Cornelius, N. K. Kumar, S. Pradhan, P. Patel and N. Vinay, "An Efficient Tracking System for Air and Sound Pollution using IoT," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), 2020, pp. 22-25, doi: 10.1109/ICACCS48705.2020.9074301.

[2] Kinnera, Bharath Kumar Sai & Subbareddy, Somula & Luhach, Ashish. (2019). IOT based Air Quality Monitoring System Using MQ135 and MQ7 with Machine Learning Analysis. Scalable Computing: Practice and Experience. 20. 599-606. 10.12694/scpe.v20i4.1561.

[3] H. Mokrani, R. Lounas, M. T. Bennai, D. E. Salhi and R. Djerbi, "Air Quality Monitoring Using IoT: A Survey," *2019 IEEE International Conference on Smart Internet of Things (SmartIoT)*, 2019, pp. 127-134, doi: 10.1109/SmartIoT.2019.00028.

[4] A. Kumar, M. Kumari and H. Gupta, "Design and Analysis of IoT based Air Quality Monitoring System," *2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC)*, 2020, pp. 242-245, doi: 10.1109/PARC49193.2020.236600.

[5] Navreetinder Kaur, Rita Mahajan, Deepak Bagai, "Air Quality Monitoring System based on Arduino Microcontroller," International Journal Innovative Research in Science, Engineering and Technology (IJIRSET), Vol 5, Issue 6- June 2016.

[6] Palghat Yaswanth Sai.“An IoT Based Automated Noise and Air Pollution Monitoring System” International Journal Of Advanced Research In Computer And Communication Engineering Vol. 6, Issue 3, March 2017.

[7] Arushi Singh, Divya Pathak, Prachi Pandit, Shrutipatil, Prof. Priti. C. Golar." IoT Based Air and Sound Pollution Monitoring System" International Journal Of Advanced Research In Electrical, Electronics And Instrumentation Engineering Volume 6, Issue 3, March 2017.

[8] Uppugunduru Anil Kumar, G.Keerthi, G.Sumalatha, M.Sushma Reddy “ Iot Based Noise and Air Pollution Monitoring System” International Journal of Advance Technology

in Engineering And Science Volume 5, Issue 3, March 2017.

[9] Ms. Sarika Deshmukh, Mr..Saurabh Surendran, Prof. M.P. Sardey. ”Air And Sound Pollution Monitoring System Using Iot " International Journal On Recent And Innovation Trends In Computing And Communication Volume 5, Issue 6, June 2017.

[10] Palaghat Yaswanth Sai: An IoT Based Automated Noise and Air Pollution Monitoring System Vol. 6, Issue 3, March 2017.