JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AIR POLLUTION MONITORING SYSTEM USING IOT AND DATA ANALYTICS

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Abstract: Internet of Things (IoT) may be a worldwide system of "smart devices" which will sense and connect with their surroundings and interact with users and other systems. Global air pollution is one of the major concerns of our era. The level of pollution has increased with times by lot of things like the increase in population, increased vehicle use, industrialization and urbanization which ends up in harmful effects on human wellbeing by directly affecting health of population exposed to it. Air quality goes down when enough number of harmful gases present in the air like carbon dioxide, smoke, alcohol, benzene, NH3, and NO2. An IoT based Air pollution monitoring system includes a MQ Series sensor interfaced to a Node MCU equipped with a ESP8266 WLAN adaptor to send the sensor reading to a Thing Speak cloud. Further scope of this work includes a suitable machine learning model to predict the air pollution level and a forecasting model, which is basically a subset of predictive modelling. We will be using out IoT device as a prototype to collect the data, and for expanding our model we used an authorized open-source dataset provided by US Govt. The paper is mainly to monitor, visualize the pollution data and its forecasting.

Key words: IoT, Smart Device, Pollution, Monitoring.

I. INTRODUCTION

This document is template. We ask that authors follow some simple guidelines. In essence, we ask you to make your paper The Internet has become ubiquitous and popular in almost every corner of the globe and is affecting human life in an unimaginable way. So we are now entering an era of "Internet of Things (IoT)". It includes traditional computing devices like laptops, tablets and smartphones, but also includes a growing list of other devices that have recently become internet enabled. Examples include home appliances, automobiles, wearable electronics, security cameras and lots of other things.

In order for a device to be part of the Internet of Things, it must be able to communicate with other devices. Therefore, it requires some sort of built-in wired or wireless communication. Most IoT devices are Wi-Fi enabled, but Bluetooth also can be wont to transfer data to nearby devices. IoT devices are commonly called "smart devices", since they're ready to communicate with other things. Along with the capacity to speak, many IoT devices also include an array of sensors that provide useful information. While the Internet of Things is still in its infancy, it provides promising opportunities for the future. In time, the web of Things will subsided of an abstract idea and more of how of life.

With fast development of industrialization and urbanization pollution has become more common. Air pollution is presence of contaminants or pollutant substances that effect human health. If we know the quantity of pollutant, then proper precautions can be taken to minimize the pollution levels in air. Recent researches prove the high correlation between atmospheric pollutants and disease like asthma. The recent advancements in embedded electronics have led to the usage of wireless network technologies in monitoring sensor data and air pollution . The aim in this paper is to come out with prediction and forecasting model for certain air pollutants like CO,CO2,SO2 and temperature which are considered to be quite harmful. Two machine learning algorithm have been

implemented which include Arima.These models have very good predictive capacity, generalization power and have a wide range of applications.

Further scope of this work includes a suitable machine learning model to predict the air pollution level and a forecasting model, which is basically a subset of predictive modeling. We will be using out IoT device as a prototype to collect the data, and for expanding our model we used an authorized open source dataset provided by US Govt. The paper is mainly to monitor, visualize the pollution data and its forecasting. Specifically three machine learning (ML) algorithms were implemented to find out the best predictive model and a forecasting model for calculating AQI of four different gases: Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2) and Ozone (O3). The ML algorithms used over here are Linear Regression, Random Forest and XGBoost for predictive modeling and ARIMA model for time-series forecasting. The performance metrics was based on Root Mean Square Error (RMSE) and Mean Absolute Error (MAE).

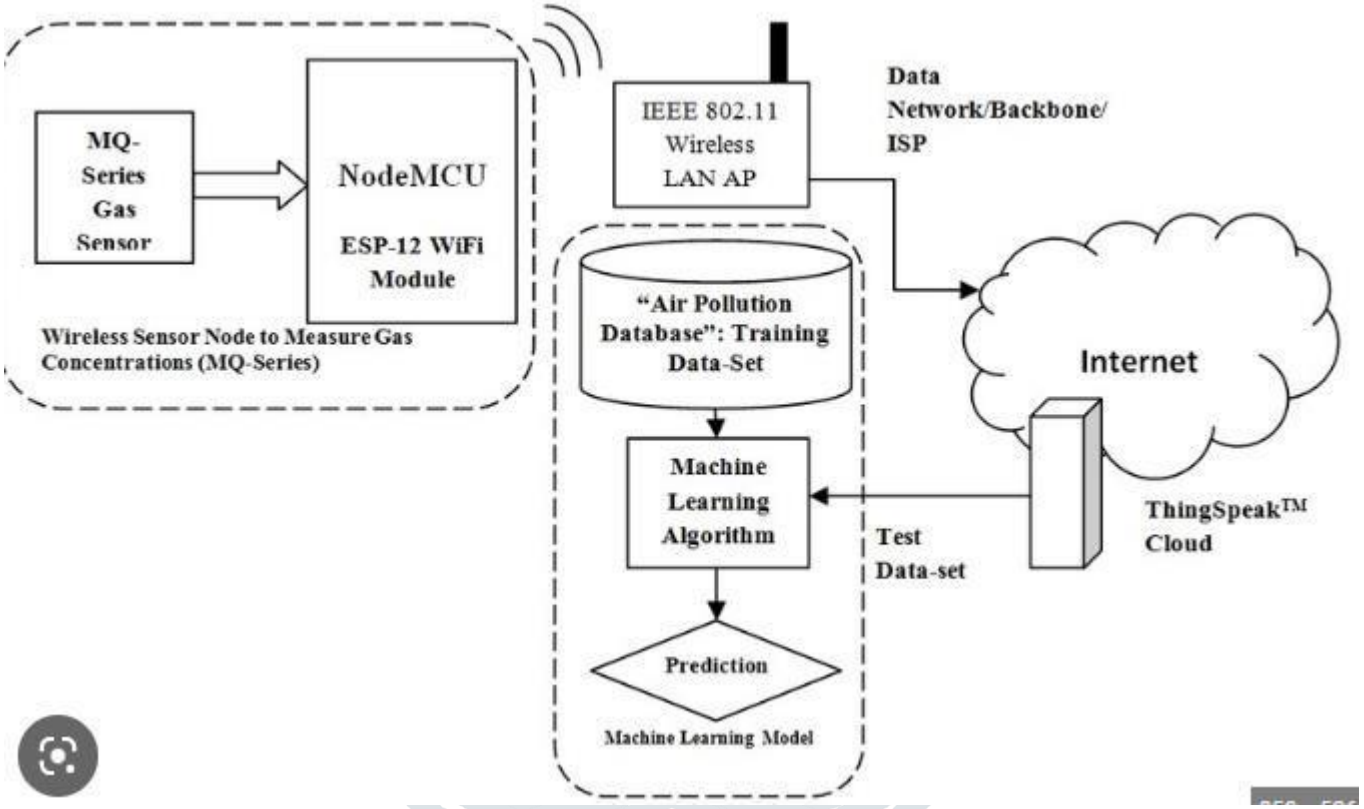

Figure 1:Block Diagram of Proposed IoT based Air Pollution Monitoring System

It was observed that Random Forest had the best performance. From this paper, the model can thus be deployed in real-world in areas with high-pollution An IoT based Air pollution monitoring system includes a MQ Series sensor interfaced to a NodeMCU equipped with a ESP8266 WLAN adaptor to send the sensor reading to a ThingSpeak cloud. Further scope of this work includes a suitable machine learning model to predict the air pollution level and a forecasting model, which is basically a subset of predictive modeling. We will be using out IoT device as a prototype to collect the data, and for expanding our model we used an authorized open source dataset provided by US Govt. The paper is mainly to monitor, visualize the pollution data and its forecasting. Specifically three machine learning (ML) algorithms were implemented to find out the best predictive model and a forecasting model for calculating AQI of four different gases: Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2) and Ozone (O3). The ML algorithms used over here are Linear Regression, Random Forest and XGBoost for predictive modeling and ARIMA model for time-series forecasting. The performance metrics was based on Root Mean Square Error (RMSE) and Mean Absolute Error (MAE). It was observed that Random Forest had the best performance.

II. LITERATURE SURVEY

[1] Monika Singh Et al. in August 2019 proposed an Air Pollution Monitoring System. This system uses an Arduino microcontroller connected with MQ135 and MQ6 gas sensor which senses the different types of gases present in the environment. It was then connected to the Wi-Fi module which connects to the internet and LCD is used to display the output to the user and buzzer alerts when the ppm crosses certain limit. Their applications were industrial perimeter monitoring, indoor air quality monitoring, site selection for reference monitoring stations, making data available to users.

[2] Yamunathangam Et al. in November 2018 used IoT by measuring the concentration of gas using various sensors which were observed through serial monitor of arduino. This data is collected in Thing speak channels by means of Ethernet shield which is available in live for further processing. These analyzed results were viewed through thing speak in a graphical format. Then the average pollution level was calculated using matlab analysis and the time controlled results were viewed through an android app. Further based on the location, the air quality index value was obtained through the android app. Along with this, the health effects were also displayed in this app, so that the users can stay aware of the pollution levels.

[3] K. S. E. Phala Et al. in November 2014 presented an air quality monitoring system that consists of air quality monitoring station, communication links, a sink node module and a data server. They developed the GSM module based sink node with data server PC. The real-time data were saved in a micro SD card in text format and also saved in the data server (PC). For the data base they chose MySQL as the DBMS. Electrochemical and infrared sensors were used to measure the concentrations of CO, CO2, SO2 and NO2. GSM modules have been used for the wireless communication between the base station and remote sensor node. The GSM modules communicate over cellular networks and a MCU was used to control all the processes on the sensor node. The MCU samples the sensor outputs using an internal ADC, it then calculates the gas concentrations and transmits the computed data as packets using the GSM. A test incubator was designed and constructed to evaluate the performance of the sensor node. The sensor node was tested by placing it inside the incubator; pumping gas into the incubator and observing the measurements taken by the sensor node. The base station comprises a sink node serially connected to a computer which runs the GUI software. The sink or receiving node captures the data transmitted by the remote sensor node and serially forwards it to the computer. The data was then plotted on the GUI and stored in text files.

[4] Nitin Sadashiv Desai Et al. in 2017 proposed a system that consists of Beagle bone Interfaced with air pollution measure sensors such as carbon dioxide [CO2], carbon monoxide [CO] and noise sensor. Analog output from sensor was read from Analog pin of Beagle bone black which reads the input signal in the range 0 v to 1.8v. Data from sensor was uploaded on Azure Cloud with the help of python SQL. Reserved data base was created in the beagle bone itself in the form of .CSV file. At the end of each day, same data present in the .CSV file is uploaded in the cloud data base. Old data in the beagle bone have been deleted with the help of automated shell script. Data from different sensor was stored in the Azure data base. This data from database has been fetched as input for machine learning service. Machine learning service was used to train the module with the help of previous data. Power BI have been used to represent sensor data fetched by beagle bone black.

[5] Harsh Gupta Et al.in 2019 presented an IOT based Air Pollution Monitoring System which consists of sensors that were to constantly monitor the Temperature, Humidity, Carbon Monoxide, Smoke, LPG, PM2.5 and PM10 levels in the atmosphere. In their work, a one-way communication between Thing Speak, an open source cloud platform, and an Android Application has been developed. Raspberry Pi has been used as a gateway to interface the hardware system. Once the firebase API was included in Android or iOS App, firebase features like Analytics, Authentication, Storage, Messaging, Hosting, Crash reporting, Real-time Database etc. were used. The Graphs were plotted in Thing Speak according to the sensors data received and the same were visualized in an Android App in a tabular format.

III. PROPOSED METHODOLOGY

It indicates the early phase of the project. An IoT based air pollution detection kit is developed. It deals with the collection of data from gas sensors connected to Raspberry Pi and the information is sent to the cloud platform that stores it.

This stage involves the clarification of the various components for optional performance. MCP3008 is a 10 bit converter which is calibrated to convert analog data to digital with on-board sample and hold circuitry. The data collected is stored, processed and can be monitored using the Mobile Application. Users can review the stored data through the application.

The various components are interfaced together and the project deliverables are built with the help of different circuit designs. The testing, debugging and troubleshooting of the design is performed to test the performance of the design under various conditions. If a circuit design fails to pass the tests, then a newer circuit design should be completed, implemented and tested.

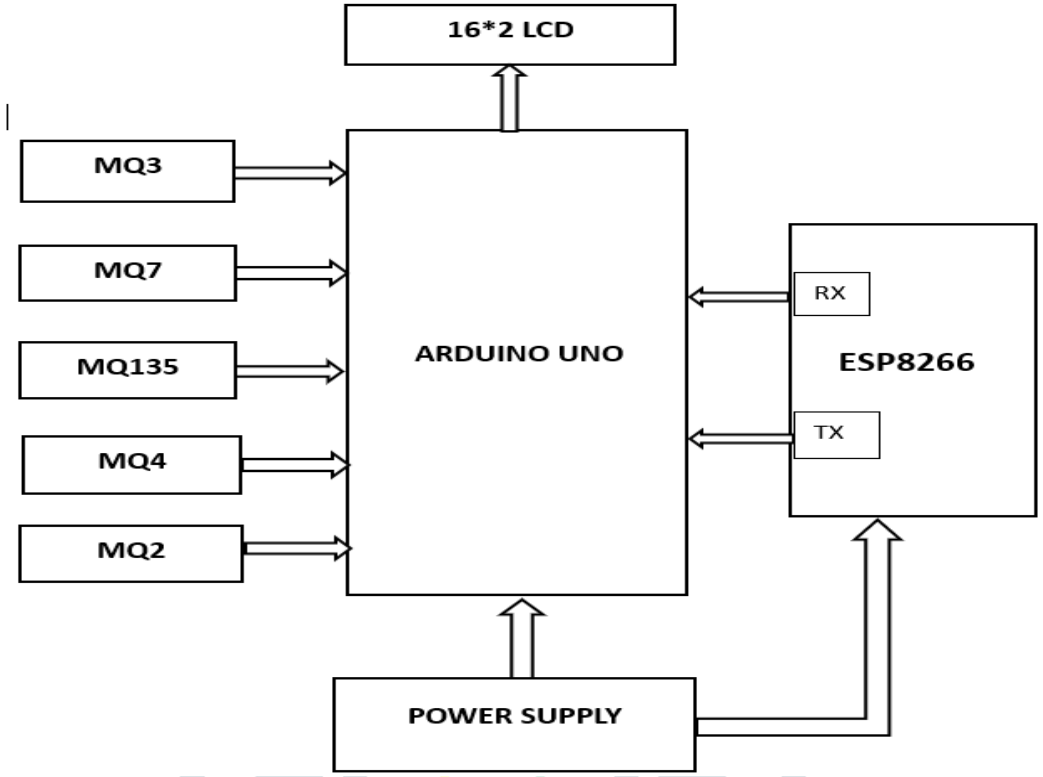

Figure 2. Block diagram of the Proposed System

IoT mainly deals with connecting smart devices (embedded electronics devices) to internet by harnessing the advantage of OSI layered Architecture. In the context of this work we propose a cluster of Air Quality Monitoring Sensor motes, which are used to measure the concentration of Air pollutants in the air. All the Air Sensors are interfaces with a tiny embedded platform equipped with network connectivity and are interconnected to internet making it a global network of connected things. We have used PIC 16F877A microcontroller which features 256 bytes of EEPROM data memory, self programming features which make it ideal for more advance level A/D applications in automotive, industrial, appliances and consumer applications.Mq-7(CO) , Mq-135(CO2),Mq-136(SO2) and temperature sensors are used to collect the gas concentration measurements. This sensor data would be captured and sent to php server for IoT based data acquisition.

We aim to accurately predict concentrations of CO2, SO2, CO and temperature. Using the historical data of the gas sensors and their AQI value we try to obtain a predictive model that indicates the graphical representation of the AQI value by one-step ahead forecast and dynamic forecast implemented by ARIMA algorithm. The process of building the prediction models mainly deal with 3 steps:

- Data Pre-processing: The first step of building a prediction model is data pre-processing where data is cleaned, missing values are filled, outliers are removed and also data is arranged in a way to fit for the Machine Learning algorithms.

- Feature Engineering: Features are one of the major factors which increase the prediction accuracy such, day, month, time of the day, etc.

- Building Forecasting Model: Model is built to predict the future, i.e. on the unseen data based on the historical data.

IV. RESULTS

From the context of the work here are the insights and analytics we got from the data that we generated. The graphical representation is the AQI values predicted for one particular area.

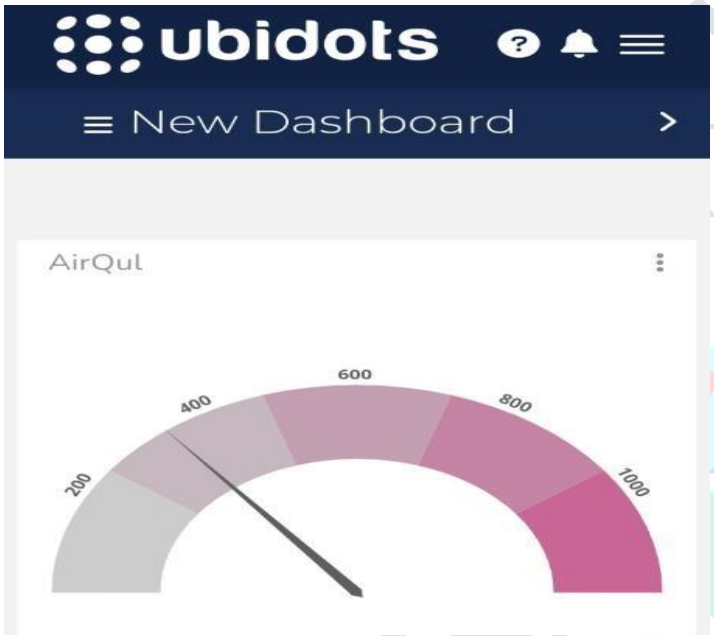

Figure 3 : Results of Dashboard

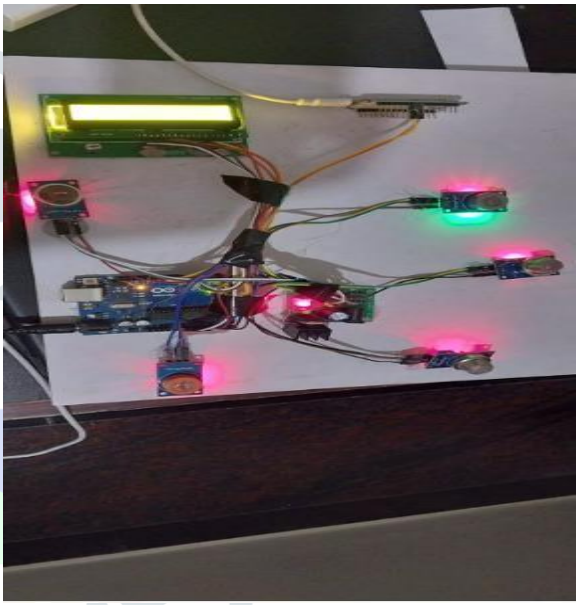

Figure 4: Results of air pollution

Figure 5: Results of air pollution

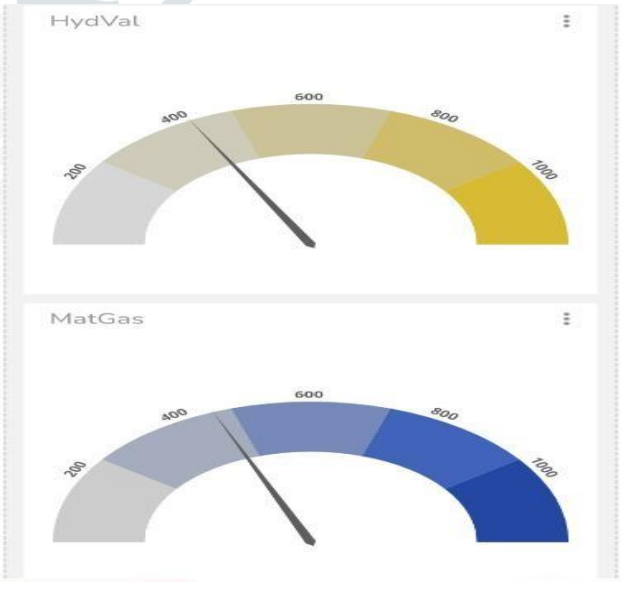

Figure 6: Results of air pollution

V. CONCLUSION

Air Pollution is the major affecting factor to our environment. Not only affecting the environment and alsoaffects the human health. The mobile application is developed to monitoring system it tracking the how much the human has exposed in a day. The gas sensors was used for identifying the Leakage Gas, Carbon Monoxide, Smoke, and Propene. The sensor senses the gases and convert from analog to digital and displays in the application. Air quality is a critical issue that straightforwardly influences human wellbeing. Air quality information are gathered remotely from checking bits that are outfitted with a variety of vaporous also, meteorological sensors. This information are investigated and utilized as a part of anticipating fixation estimations of contaminations utilizing savvy machine to machine stage. The stage comprises of a ML-based calculations to construct the estimating models by training from the gathered information . ARIMA performs pretty well as a forecasting model, what can be used as to make a daily forecast just like regular weather forecasting.

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