Air Quality Monitoring and Predicting the People to be Affected using LSTM for Hospitals

S.Veena[a], L.Sudha[b], K.B.Aruna[c],V.Sureka[d]

[a] Professor, [b,c,d]Assistant Professor
[a,b,c,d] S.A.Engineering College
[a] veenas@saec.ac.in, [b] sudhal@saec.ac.in, [c] arunakb@saec.ac.in, [d] sureka@saec.ac.in

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Abstract: Air pollution is one of the major concerns in the modern era , around 4.6 million people die in a year due to air pollution , with over 91% of the world population living in unhealthy surroundings which does not meet the standards of the World health organization(WHO). In India around 1.2 million people die early due to air pollution and 9 out of 10 people in India live in unhealthy environments. Though the world is developing at a rapid pace, solutions for such a problem are still unknown, many systems are available to monitor the air pollution around the world but nothing has been done to the healthcare field. This system not only monitors the air pollution but also can predict the number of people going to get affected in a particular area and inform nearby hospitals through which the hospitals can approximately buy medicine for the patients. The Novel Air Quality Monitoring System-Artificial Intelligence(NAQMS-AI) is proposed, which implements artificial intelligence to predict the number of people going to get affected using Long Short Term Memory also known as LSTM algorithm. The air quality of a particular area is calculated based on the location of the device which is computed with the help of Google API , it also helps in finding the nearby hospitals and filter the sensors based on their location. The data which is got from the sensors are stored in cloud which is Google Drive in the form of excel sheet. Thus the proposed system helps the hospitals to keep track of how many people are going to get affected on monthly basis and can approximately estimate the cost for treating all the patients.

Keywords: Air Quality, Location Tracking, Machine Learning, Data Analysis, Prediction, Healthcare

1. Introduction

Air pollution is one of the major concerns in the modern era , as many people die early. This system basically monitors the air pollution in a particular area and predicts the number of people going to get affected by air pollution using Artificial Intelligence algorithm. Location based air pollution is computed with the help of Google API which helps in maintaining the location of the devices as well as the location of the nearby hospitals. Notification is sent to nearby hospitals about the number of patients going to get affected in upcoming months so that the hospitals can approximately handle the patients and cost for treating them.

The Internet of Things (IOT) is an integrated system of various computing devices, mechanical and Digital machines provided with Identifiers, which are unique and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

AI deals with the area of developing computing systems which are capable of performing tasks that humans are very good at, for example recognising objects, recognising and making sense of speech, and decision making in a constrained environment.

Narrow Artificial Intelligence is a type of Artificial Intelligence, where the system is very good in performing a single task. Google Translate is an example of Narrow Artificial Intelligence.

Artificial General Intelligence is another type of Artificial Intelligence, which can perform any task that a human can do. It is also very good at taking decisions like humans. The challenges of Artificial general Intelligence are energy consumption, hardware and catastrophic memory loss.

Super Intelligence is a type of intelligence that outperforms humans. The main features of this Super Intelligence are general wisdom, problem solving and creativity.

Classical Artificial Intelligence includes algorithms and approaches like rules-based systems, search algorithms and informed search algorithms like A and A*. Classical Artificial Intelligence also includes logic, involving propositional and predicate calculus. With the arrival of the internet, smart mobile and social media, Artificial Intelligence algorithms became very popular. Machine Learning and Deep Learning, are used to support Big Data to perform their tasks in an optimized manner.

Machine Learning

Machine Learning is a form of Artificial Intelligence, where statistical methods are applied to train the data to achieve the goal.

2. Related Work

Swati Dhingra et al.[1] had proposed an IoT system which helps in finding the most optimal route for traveling to avoid air pollution. It uses historical data to predict the air pollution in a particular route in which the user wants to travel. The drawback of this system is that it costs a lot and it is nearly impossible to accurately predict the route and to deploy sensors all over the street. It also cannot handle large number of data and does not use cloud.

Vincenzo Di Leece et al[2] proposed an intelligent distributed system which is designed to monitor the air quality in an indoor environment. Low cost sensors are used and they are equipped with communication modules. A multi agent system handles the aspects of the system which monitors. These aspects are: Data analysis, data integration and user centered interfaces. High cost sensors for air quality sensing

Quan Dong, Baichen Li et al[3] had discussed a system which acts as a wearable and stationary point of care for pediatric asthma research. It is a cloud based wearable which helps in measuring the asthma patients exposure to various gases such as O3(Ozone),NO2(Nitrogen Di Oxide) and other aldehydes in real life setting. The levels of these gases that can be measured are between 30ppb and 10ppm. It helps in studies of asthma and environmental monitoring. This system is meant only for asthma patients not for any other respiratory problem.

Kin-Fai Ho et al.[4] had illustrated a system which is used to monitor indoor air and generate health reports based on the air quality. The data will be captured and stored in the cloud to enhance storage of data and improve computational efficiency. A self reporting system is implemented so that the user can self upload the report onto the cloud for analysis. This data can be used to take precautions which can help the user to avoid inhaling any harmful gases. It is used only in indoor air quality monitoring. It can be extended outdoors to be more effective.

Mostafizur Rahaman Laskar et al. [5] had proposed a system which integrates both IoT and wireless sensor networks. It is an embedded application which is designed specially for people who are more concerned about air pollution. This system uses Google maps API for navigation and localization. It generates the optimal route through which a user can travel to avoid air pollution. The route is computed using wireless LAN based on cloud servers. Lacks in disease specific recommendations for users, the route is given in general.

P T Nithia et al. [6] had discussed a health advisory system for homemakers with various sensors. In this system, the concentration of various harmful gases present in the kitchen like , methane , ethane, carbon dioxide etc are monitored. If these harmful gases reach or cross a certain level then a warning message will be sent to the homemaker via an android app and the user can turn on exhaust fan or open windows or even inform others in case of emergency.

3. Technologies Used

IOT:

IoT(Internet of Things) is a system which connects many objects, devices, people over a internet, it does not require any human interaction used to transfer the data from one location to another location.It is generally embedded with sensors, communication hardware, microphone and processor which collect the data in a form of image, audio, video, process it and transfer it to the destination automatically.IoT have becoming an emerging technology in day- to- day life, facilitate human in many ways, it ease to do things in comfortable manner, where we doesn't need to present physically, which saves the times. Security systems, vending machines, automatic heaters, fans, light switch off/on, in cars, etc are the examples of IoT. Since IoT plays a very important part in human life.

Machine learning:

Machine Learning is subset of AI(Artificial Intelligence) which is a study of algorithm and statistical model to train machines in order to perform a specific task. The system is trained to learn and adapt to new data without any explicit coding. Machine learning algorithms builds a mathematical model generally referred as training data, a set of data, focus on predictions or decisions in order to figure out the appropriate result. For Example, if a images of dogs and cats are shuffled and given to humans and machine, humans can easily identified which is dog and which is cat; but in the case of machine it is not possible, so for the machine, large collection of data that is images of dogs and cats are given to the machine and train the machine to classify animals based on features of animals such as size, shape, color. Hence by this way, the machine starts to train itself in supervised, unsupervised,

reinforcement learning. And in turn the predictions with higher accuracy provided as result. Machine learning applied in medical diagnosis, image processing, prediction, classification, learning association, regression etc.

Machine learning is categories in supervised, unsupervised and reinforcement learning. Supervised learning is training the machines with labeled dataset that is providing the machine about some information of that data. Unsupervised learning is training the machine without pre-existing label; it is like a self -organizing learning. Reinforcement learning is interaction of model with an environment, that is algorithm used, try to learn to adapt with the environment on its own.

Deep learning:

Deep Learning is a subset of machine learning in Artificial Intelligence(AI), it is capable in learning of unstructured or un labeled data, generally known as unsupervised learning. In contrast, we can say deep learning is a machine learning technique that learns task and features directly from data. A data can be of image, text, audio etc. Deep learning consists of many architecture such as Deep Neural Network(DNN), Convolutional neural network(CNN),recurrent neural network and deep belief network which helps to provide precise output. Nowadays, Convolutional neural network is more suitable for deep learning technique. Deep learning is used in many areas such as natural language processing, image analysis, speech recognition, board game programs, machine translation etc. Deep learning works by filtering its data(input) allows passing it into several layers(hidden layers). A traditional deep learning technique contains two or three hidden layers, but currently, approximately 10 -100 hidden layers were used. The idea behind deep learning is to build a learning algorithm that mimics the human brain.

4. Air Quality Monitoring System

The entire process of this system is explained by the architecture diagram , the ESP8266 WIFI Module will collect the data via the MQ135 sensor and process it and save it in the cloud in real time. The data is stored in Google drive in excel format with the time at which the data is collected. The excel sheet is downloaded and given as input to the Artificial intelligence algorithm. Here the algorithm used is the Long Short Term method(LSTM) which in turn will predict the number of patients who are going to get affected by air pollution in the upcoming months. This data is shared with the hospitals nearby the devices via a third party API IFTTT in the form of mail and SMS.

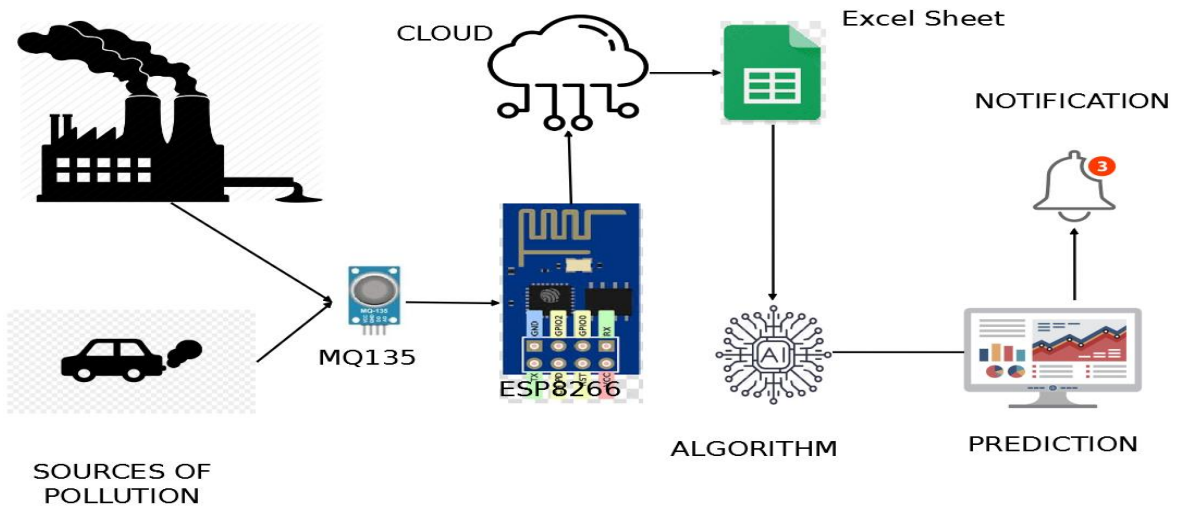

Figure 1 : Architecture of a Novel Air Quality Monitoring System using Artificial Intelligence(NAQMS-AI)

Algorithm

1.Tracking the Location of the device

2.Measuring the Air quality

3.Data storage in Cloud

4. Prediction using Long Short Term Algorithm(LSTM)

5. Notification to the nearby hospitals

The steps of NAQMS-AI are illustrated as below:

Location Tracking

The first step of the current location of the device is computed , for this the requirements are IP address and MAC address of the Esp8266 which are taken from the WIFI to which the device is connected. Then the address is given as input to the Google API which finds out the location of the device by analyzing the google database which consists of the WIFI devices and its location

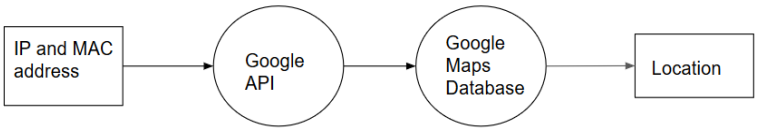

Figure 2 : Location Tracking in NAQMS-AI

Measuring the Air Quality

In the second step of **NAQMS-AI,** the air quality is calculated with the help of the sensor which is MQ135 , it is a sensor which calculates the air quality based on the presence of the harmful gases such as Alcohol, Benzene, NitrousOxide, smoke, Ammonia and carbon dioxide. The traces of the above mentioned gases will increase the air pollution. The sensor is connected to the ESP8266 WIFI module which helps in the computation and acts as a power source for the MQ135.

Figure 3 : Measuring the Air Quality in NAQMS-AI

Data storage in Cloud

In the third step, the measurement of the air quality is obtained from the ESP8266 and saves it in Google Drive which acts as the cloud storage. The device which is provided with the internet , gets each value from the sensor and through a third party API the data is sent to the Google Drive along with the time and date at which the data is stored. The data is later exported as an excel sheet for further process.

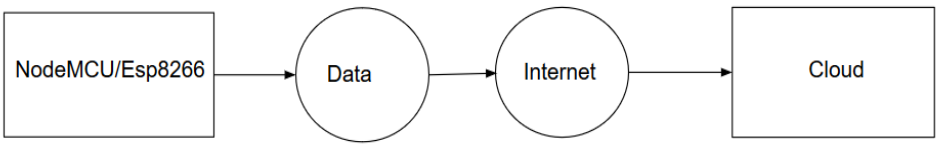

Figure 4 : Data storage in Cloud

Prediction using Long Short Term Algorithm(LSTM)

In the fourth step, the excel which was exported in the previous step will act as an input to the Prediction algorithm. The Long Short Term Algorithm (LSTM) is used to predict the values that is , it will predict the number of people going to get affected by air pollution in the future so that the hospitals can approximately

estimate the cost for treating the people with respiratory problems.

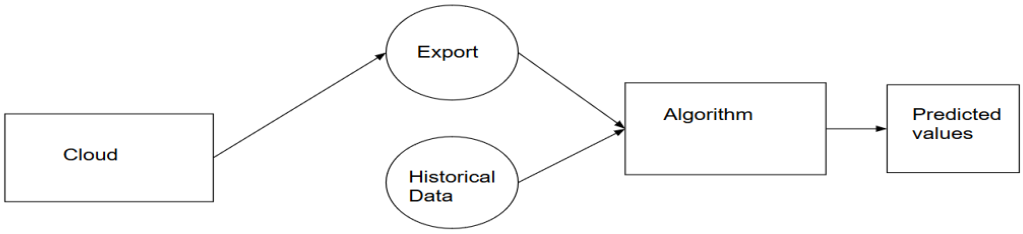

Figure 5 : Prediction using Long Short Term Algorithm(LSTM) in NAQMS-AI

Notification to the nearby hospitals

The fifth step is sending the notification, which acts as the main communication between the device and the nearby hospital. When the algorithm completes its prediction, the predicted values along with the AQI are sent to the nearby hospital in the form of mail or SMS.

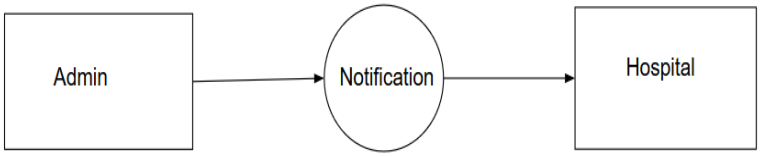

Figure 6 : Notification to the nearby hospitals in NAQMS-AI

5. Results

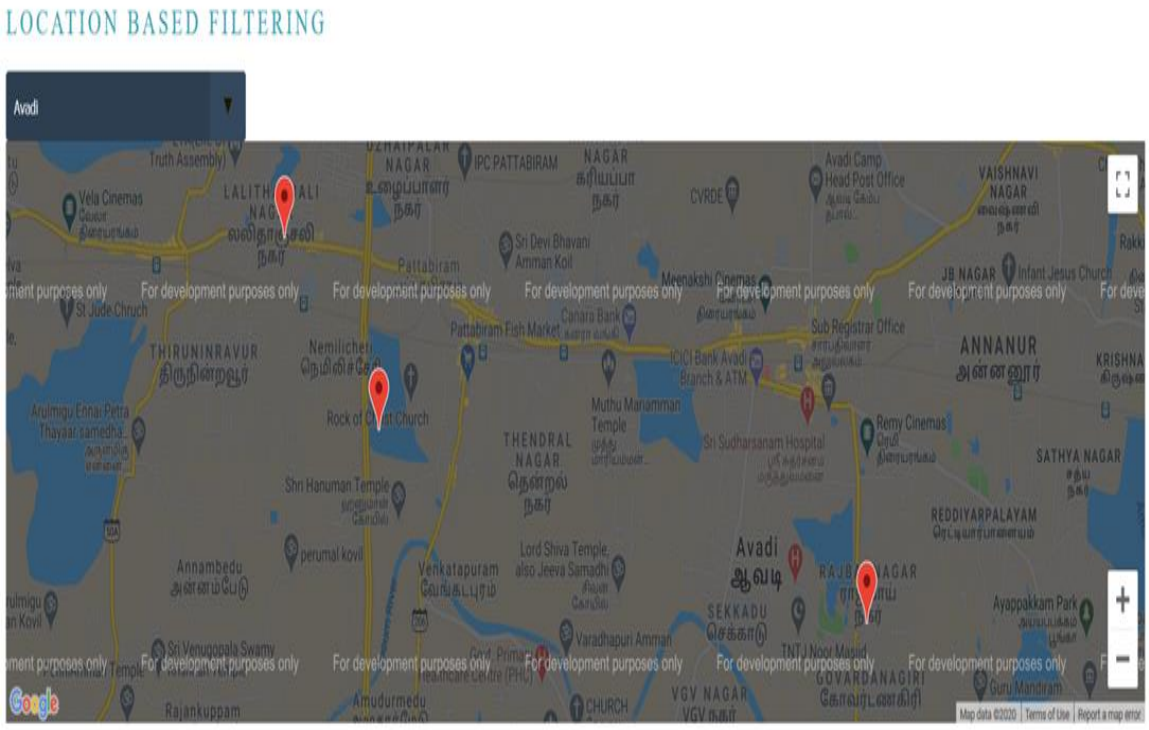

Figure 7 : Location with Filter –Sample

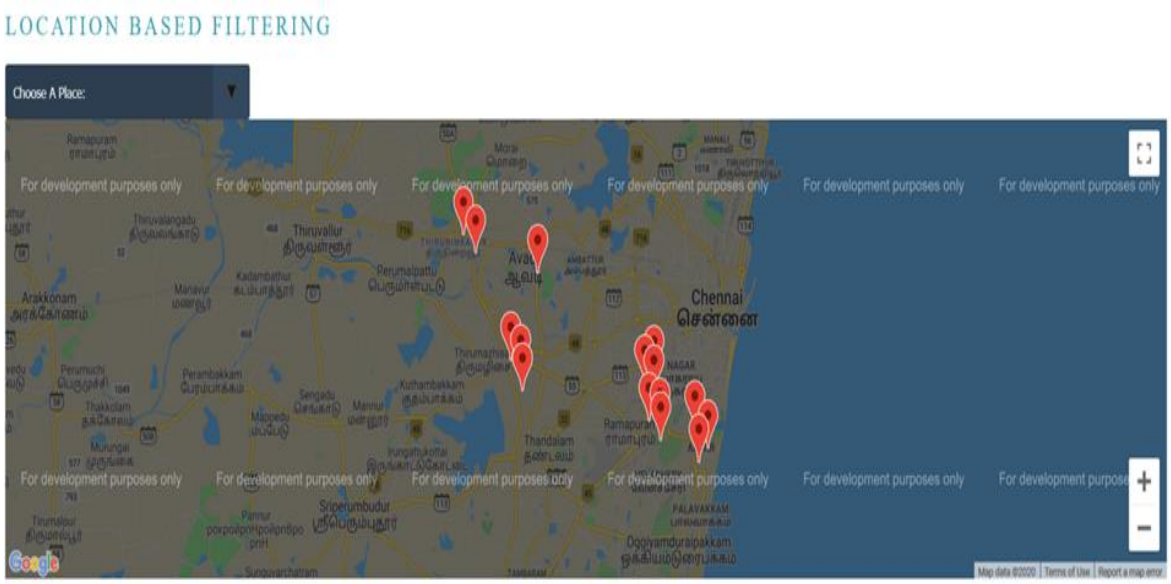

Figure 8 : Location with Filter – Sample2

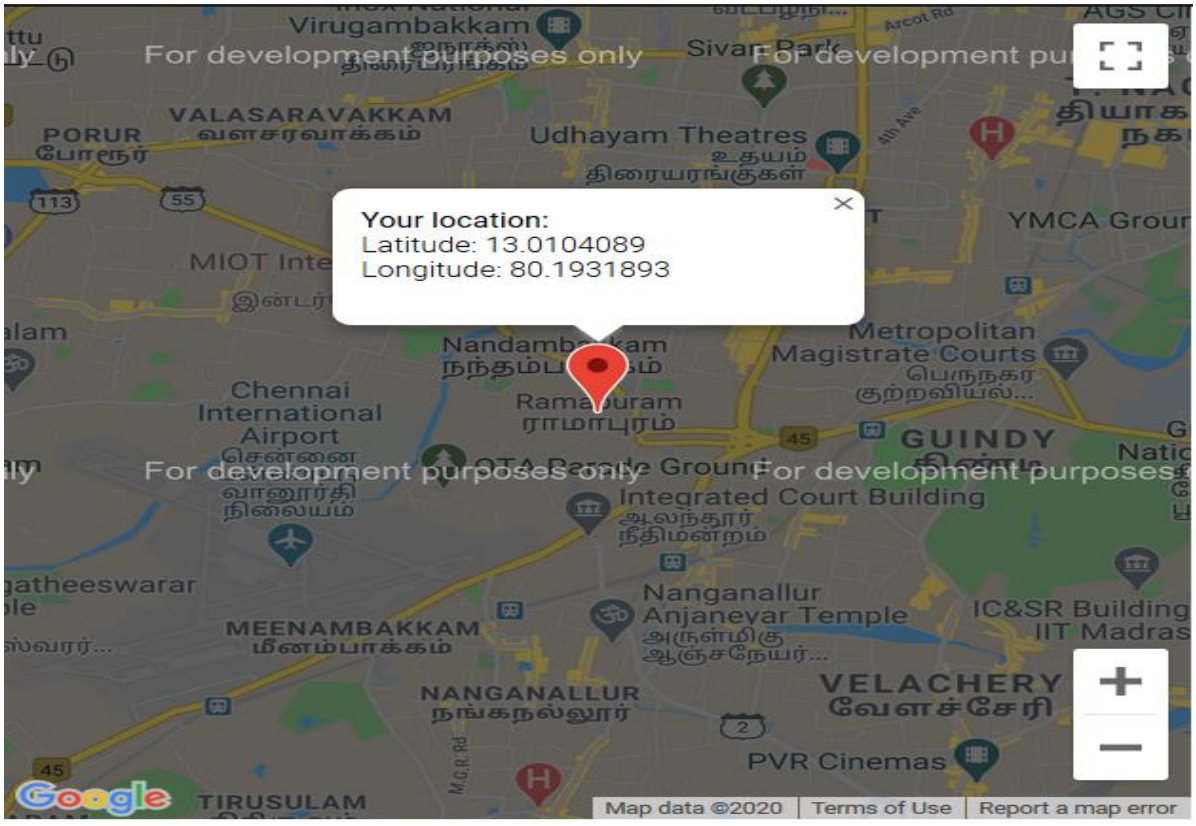

Figure 9 : Current Location of the Sensor

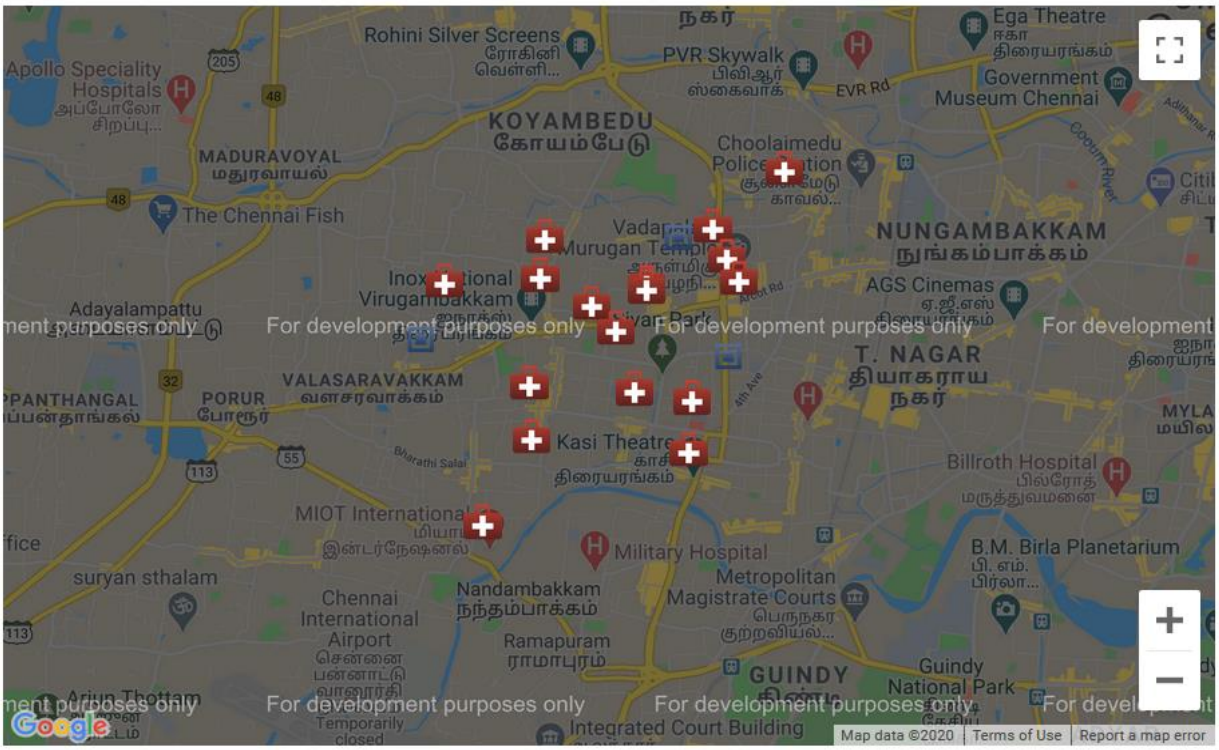

Figure 10 : Locating the Nearby Hospitals

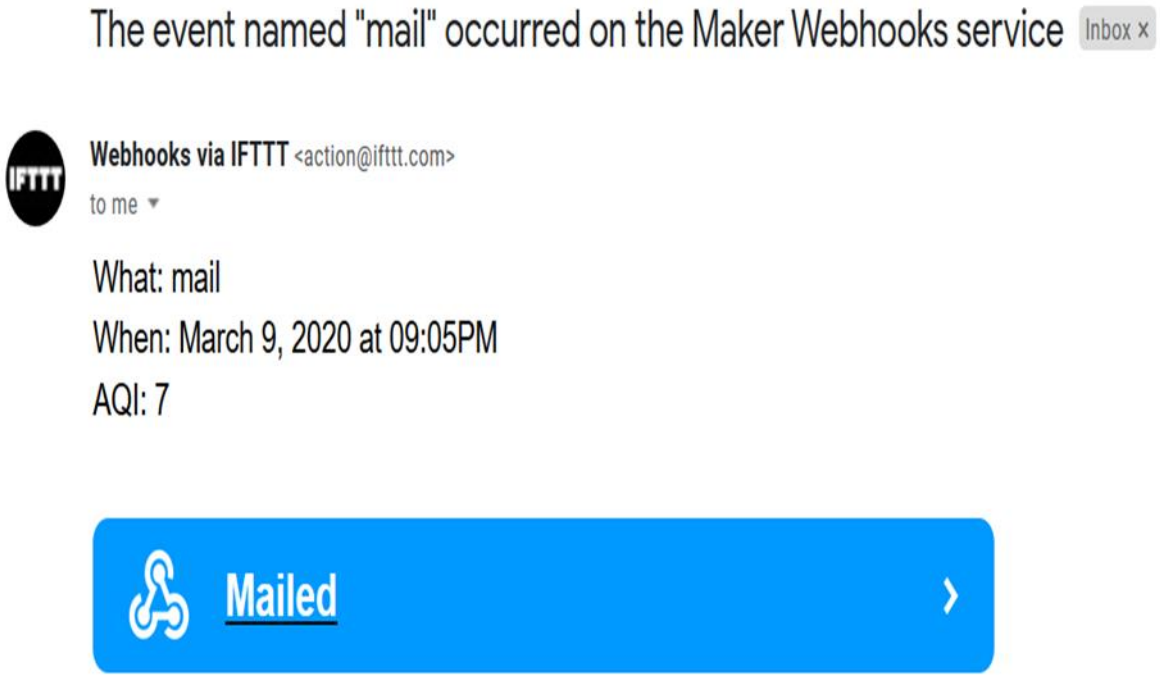

Figure 11 : AQI Mailed to the Hospital

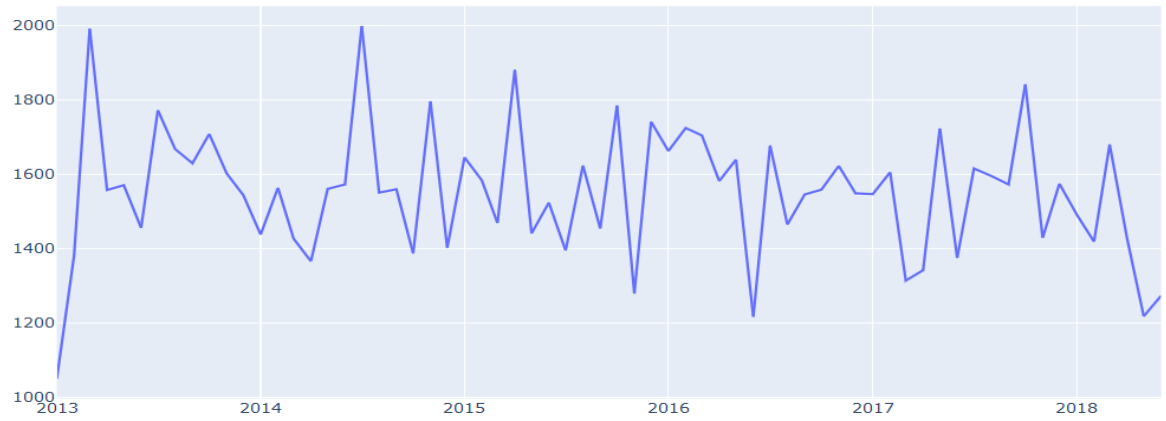

Figure 12 : People affected with Air Pollution

Airquality

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fx March 7, 2020 at 01:47PM

	A	B	C	D
1	March 7, 2020 at 01:47PM	AQI	5	
2	March 7, 2020 at 01:48PM	AQI	3	
3	March 7, 2020 at 01:49PM	AQI	1	
4	March 7, 2020 at 01:50PM	AQI	2	
5	March 7, 2020 at 01:51PM	AQI	7	
6	March 7, 2020 at 01:52PM	AQI	3	
7	March 7, 2020 at 01:52PM	AQI	2	
8	March 7, 2020 at 01:54PM	AQI	1	

Figure 13 : Data stored in Cloud

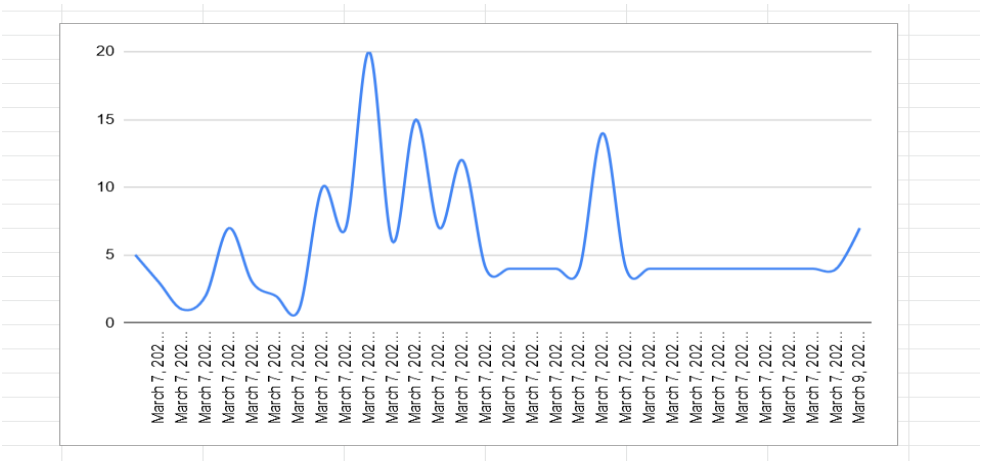

Figure 14 : Live Data Graph

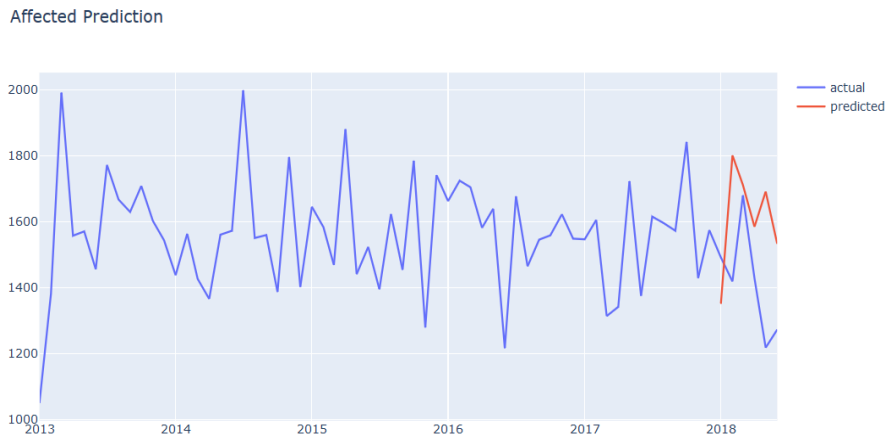

Figure 15 : Comparison of Actual vs Predicted Values

6. Conclusion

Pollution in earlier days was negligible. Currently, however, pollution is increasing day-by-day because of various reasons such as industrial growth, development of automobile industries, and chemical industries. Therefore, to reduce the level of pollution from such sources and to protect humans and the environment from harmful gases, this system helps a person to detect, monitor, and test air pollution in a given area and find the origin of the pollution and raise awareness about the quality of air that we live in. In the Future, Fog computing can be used to make it better and more reliable as it helps in faster data processing and it works better than cloud computing.

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