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Air Pollution Monitoring and Prediction System using the Internet of Things

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Abstract: - *With the increase in population, pollution is increasing day by day due to industrialization, urbanization, and vehicles use. All these factors can affect human health directly or indirectly by respiration, intake of water, eating food and in many other ways. Air pollution monitoring system using the Internet of Things is used to control the quality of air over web server with the help of internet. When the quality of air reaches lower to a certain level, it will activate an alarm.*

It means when there is an increase in the level of harmful gases like NH3, CO2, NOx, alcohol, smoke, benzene, etc. It shows the quality of air in PPM (part per million) on the LCD as well as on the server so that the pollution in the air can be monitored.

These research paper mainly focused on the proof of pollution monitoring and detect on particular location or geographical area for an IOT physical gadgets that collects information with respect to physical parameters, utilizing an advanced microcontroller stage, from different sorts of sensors, through diverse methods of correspondence and after that transfers the information to the an internet. The displayed gadget has been intended for remote checking of climate various environments.

These article centers around the method of transferring obtained information on the web with the goal that the gadget can be utilized to remotely screen climate parameters and in the long run examine environmental change designs like temperature, humidity, Atmospheric Pressure. The paper also discusses the basic concept of Internet of Things and its potential applications, especially for weather monitoring.

Key words: *Artificial Intelligence, Machine Learning, Internet of Things, Air Pollution, Sensors, Monitoring System, Arduino, MQ135*

1. INTRODUCTION

Air pollution can be defined as a situation in which substances are present in the atmosphere at concentration sufficiently high above their normal ambient levels to produce a measurable and undesirable effect on humans, animals, vegetation, or materials (Seinfeld and Pandis, 2006). The concentrations of pollutants in the atmosphere are a measure of air quality.

Clean air is the foremost requirement to sustain healthy lives of humankind and those of the supporting ecosystems which in return affect the human wellbeing. Release of various gaseous emissions and particulate matter (PM) has been on the rise due to rampant industrialized growth Anthropogenic emissions of various kinds are being pumped into the atmosphere (called primary pollutants) and lead to the formation of new pollutants due to chemical reactions in the atmosphere (called secondary pollutants).

These are building up the concern of ambient air pollution (AAP) as a prominent global threat to human health in many ways. For instance, according to the Fifth Assessment Report of the IPCC 'nearly all the non-CO2 climate-altering pollutants are health damaging, either directly or by contributing to secondary pollutants in the atmosphere'.

The atmosphere is an invisible cover of gases that envelops the earth. The air present in the atmosphere is a mixture of gases such as nitrogen, oxygen, argon, carbon dioxide etc. Air pollution refers to contamination of air by waste products and other impurities which are harmful to human life, other creatures, vegetation and buildings [1].

The primary cause of air pollution is both human activities and natural processes. The sources responsible for air pollution are of two categories which are natural sources and man-made sources. The natural sources include forest fires, volcanic eruption, and wind erosion of soil, natural radio activity and decomposition of organic matter by bacteria.

Any use of normal resources at a higher rate than nature's capacity to restore itself can realize defilement of plants, air, and water. Other than human activities, there are a few discontinuous trademark cycles that also bring about the arrival of dangerous stuff. Next to human-made exercises, a cataclysmic event, for example, volcanic emission may bring about the defilement of air. Globalization is a noteworthy explanation behind defilement. As a rule air poisons can be:

- **Carbon Monoxide:** A gas that starts from the expending of the consuming of petroleum products, for the most part in automobiles. It can't be seen or took note. It influences people feeling lightheaded and tired and gives them cerebral pains.

- **Poisonous air toxins:** are made in substance plants or are produced when petroleum products are singed. They are the reasons for malignancy. Different toxics can likewise cause birth defects.

- **Ozone (O3):** Secondary poison encircled by the manufactured reaction of shaky common mixes inside seeing daylight. It limits the lung capacity and causes breathing side effects, for example, hacking, asthma, and breathing related issues.

It has a terrible effect on human wellbeing, amphibian life and creatures. Pollution in urban areas isn't a new issue. The consumption of coal has led to contamination. Amid foggy conditions, the contamination transforms into exhaust clouds. Exhaust cloud causes interruption of traffic which may prompt conveyed urban communities to a stop and ascend in death rates to drastically rise. General Health Act segment endeavored to decrease smoke contamination. In the twentieth century, higher measure of modern controls diminished exhaust cloud contamination [2].

Smoke Abatement Act diminishes smoke outflows. Contamination is a bothersome change in physical, concoction or organic qualities of air. Land or water which influences the life of person or makes wellbeing perils to living creature. Air contamination is a noteworthy hazard factor for wellbeing incorporating diseases in skin and eye. Aggravation of the nose. Throat and eyes. Coronary illness. Lung malignancy, Bronchitis. Trouble in breathing. The fundamental drivers of contamination are Carbon dioxide (C02) gas.

2. LITERATURE SURVY

Yildirim and Bayramoglu (2006) [10], have proposed a new methodology based on neural fuzzy method to estimate the concentrations of daily SO2 and TSP pollution over an urban area. Effective input variables in the model are ranked as temperature, pollutant (SO2 or TSP) concentration of the previous day, wind speed, relative humidity, pressure, solar radiation and precipitation. It is demonstrated that the temperature and previous day's pollutant (SO2 or TSP) concentrations are indispensable parameters for an acceptable performance of the model.

Zhang et al. (2018)[25] found that the particulate matters such as PM10, PM2.5 may contain heavy metal oxides and harmful substances that threaten human health and environmental quality. An integrated neural network algorithm which based on Elman, echo state network (ESN) and cascaded BP neural network (CBP) has been designed to predict PM10 and PM2.5.

To improve the performance of the prediction result, the simulated annealing algorithm (SA) has also been

used to optimize the parameters in the combination method to form the optimal combination model.
E. Rezk, A. Kadri, K. B. Shaban at.el , In this paper they applied three machine learning (ML) algorithms are investigated to build accurate forecasting models for one-step and multi-step ahead of concentrations of ground-level ozone (O3), nitrogen dioxide (no2), and sulfur dioxide (SO2).

These ML algorithms are support vector machines, M5P model trees, and artificial neural networks (ANN). Two types of modeling are pursued: univariate and multivariate. The results show that using different features in multivariate modeling with M5P algorithm yields the best forecasting performance.

Xia Xi, Zhao Wei, RuiXiaoguang, Wang Yijie, BaiXinxin, Yin Wenjun, Don Jin at el. In this paper the air pollution prediction works by air quality index using the machine learning algorithms. From experiments, for different city, the best result can be obtained by different group of feature selection and model selection. I personally suggest that it is better to use real time sensors.

ShwetalRaipure. Deepak Mehetre Conference/journal – IEEE International Conference, 2015 In this paper the uses AVR ATmega-32 Microcontroller and sensor grid to detect the sensor values from different sensor like parameters MQ5, MQ7, temperature and humidity dataset. The simulation results show that performance of the quality of service increased in the network.

Jalpa Shah, Biswajit Mishra at el, IoT enabled environmental monitoring system for monitoring temperature, relative humidity and CO2 [3].

Pollution Detection Sensors:

a) **MQ-2 Gas Sensor:** The MQ-2 Gas Sensor module recognizes gas spillage in the home and industry. The MQ arrangement of gas sensors utilizes a little radiator inside with an electrochemical sensor.

They are delicate to a scope of gasses and are utilized inside at room temperature. The yield is a simple sign and can be perused with a simple contribution of the Arduino.

Features

a) Wide recognizing extension
b) High affectability and quick reaction
c) Long life and stable
d) Simple drive circuit

Because of its quick reaction time and high affectability, estimations can be taken at the earliest opportunity. The sensor affectability can be balanced by utilizing the potentiometer.

Application

They are helpful in gas spillage discovery of LPG, propane, methane, I-butane, liquor, Hydrogen and smoke.

Figure- 1: MQ2 Gas Sensor

b) **MQ-3 Gas Sensor:** Sensitive material of MQ-3 gas sensor is SnO2, which with lower conductivity in clean air. At the point when the objective liquor gas exists, the sensor's conductivity is higher alongside the gas fixation rising. It would be ideal if you utilize basic electro circuit, Convert change of conductivity to compare yield sign of gas fixation.

MQ-3 gas sensor has high affectability to Alcohol and has great protection from irritating of fuel, smoke, and vapor. The sensor could be utilized to distinguish liquor with various focus, it is with ease and reasonable for various application.

Character: Good sensitivity to alcohol gas, Long life with low cost and simple drive circuit

Application: Vehicle alcohol and Portable alcohol detectable identifier.

Figure-2: MQ-3 Gas Sensor

c) **MQ-6 Gas Sensor:** Responsive material of MQ-6 gas sensor is SnO2, which with lower conductivity in clean air. At the point when the objective flammable gas exists, the sensor's conductivity is higher alongside the gas focus rising. It would be ideal if you utilize basic electro circuit, Convert change of conductivity to compare yield sign of gas focus.

MQ-6 gas sensor has a high affectability to Propane, Butane, and LPG, additionally a reaction to Natural gas. The sensor could be utilized to identify distinctive ignitable gas, particularly Methane, it is with minimal effort and reasonable for various application.

Characters: Good affectability to Combustible gas in a wide range, High affectability to Propane, Butane, LPG and Long life with low cost and simple drive circuit

Applications: Domestic gas spillage identifier, Industrial Combustible gas identifier and Portable gas identifier

Figure-3: MQ-6 Gas Sensor

d) **NodeMCU Board:** which is utilized to interface the MQ2 gas sensor, ESP8266 WLAN connector is inserted inside the gadget. Fig.3 is the MQ-2 Gas Sensor, which is utilized in this work to get the diverse centralization of gas

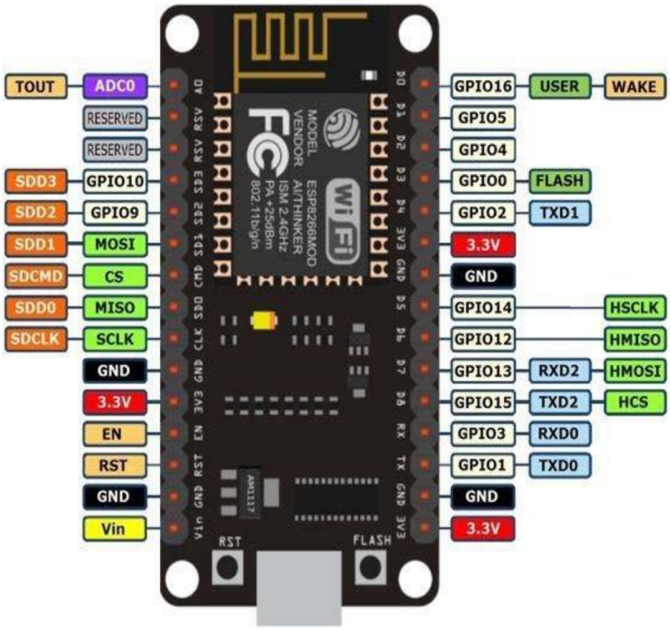


Figure-4: NodeMCU Board with PIN arrangement

3. EXISTING MODEL

Nowadays there are large varieties of different air monitoring and alarming devices are available in the market. Due to the massive size, high weight, and expensiveness constitute the failure of conventional monitoring system which leads to the insufficient deployment of the monitoring stations [4].

As we all know that air pollution in metropolitan cities is due to human activities like construction works, locations with traffic jams have the worst air quality than average.

By the help of air pollution monitoring system using IoT, the quality of air can be detected on the web server using the internet by triggering the alarm when it crosses the certain threshold value means when certain harmful gases like CO2, smoke, benzene, etc. are present in the atmosphere. The system can also be detected and monitored the temperature and humidity.

Using the MQ6 sensor and MQ135 sensor for the purpose of monitoring the air quality, this system can detect the injurious gases and measures its amount precisely.

It can also display the pollution level from any place using the PC and smart phones. The IoT based system can be installed anywhere and when the quality of air goes beyond a certain level, it triggers the alarm and send message to the receiver so that the air quality can be controlled and Planning Management for Air Quality [5].

4. PROBLEM STATEMENT

During last some decades, due to progress in urbanization and civilization, there is a wide increase in the industries which causes pollution, burning of waste materials in open space and heavy amount of dump materials produced at construction sites, substantial decrement in number of forests and vehicles (specially diesel vehicles) on roads which increase in health hazards related to pollution.

Hence, it is necessary to monitor and control air pollution and reduce the hazardous effect of air pollution which causes the health-related problem [6].

This proposed system introduced advanced techniques to display air quality with the help of new technologies. Harmful pollutants present in the environment like CO2, CO, availability of smoke, alcohol, LPG, humidity, and temperature can be monitored by some technology such as GSM, Bluetooth, Wi-Fi, Wireless Sensor Network, etc.

Random Forest

Random forest classifier creates a set of decision trees from randomly selected subset of training set. It then aggregates the votes from different decision trees to decide the final class of the test object. Suppose training set is given as:

[X1, X2, X3, X4] with corresponding labels as [L1, L2, L3, and L4], random forest may create three decision trees taking input of subset for example,

- [X1, X2, X3]
- [X1, X2, X4]
- [X2, X3, X4]

So finally, it predicts based on the majority of votes from each of the decision trees made.

Economic costs of air pollution

Air pollution leads to a significant amount of mortality and morbidity. The economic cost of mortality and morbidity due to air pollution is necessary to estimate in order to determine the health costs arising from air pollution.

Such cost estimates can serve as effective indicators of the economic burden of air quality-related health impact on people and on the national exchequer.

Cost of mortality is estimated using Value of Statistical Life (VSL) as a measure -derived from individuals' valuation of their willingness to pay to reduce the risk of dying.

India with its rapid rate of growth over this five-year period also registers a 60% increase in value of a statistical life (VSL).

5. ANALYSIS AND RESULTS

Air pollution is a threat for the environment affecting a wide range of ecosystems through a variety of processes including acidification, eutrophication or vegetation oxidation that can ultimately lead to a biodiversity and ecosystem services loss (Lovett et al., 2009; de Vries et al., 2014) [7].

As an example, trees exposed to acute or chronic high O3 concentrations can be affected by reduced photosynthesis, damage to reproductive processes, lowered carbon transport to roots, as well as visible physiological effects on leafs that correlate with reductions in growth in deciduous and evergreen species such as poplar and pine trees (Felzer et al., 2007).

As a consequence, O3 pollution leads to a reduction on the provision of ecosystem services such as carbon sequestration – which in turn, enhances climate, change [8].

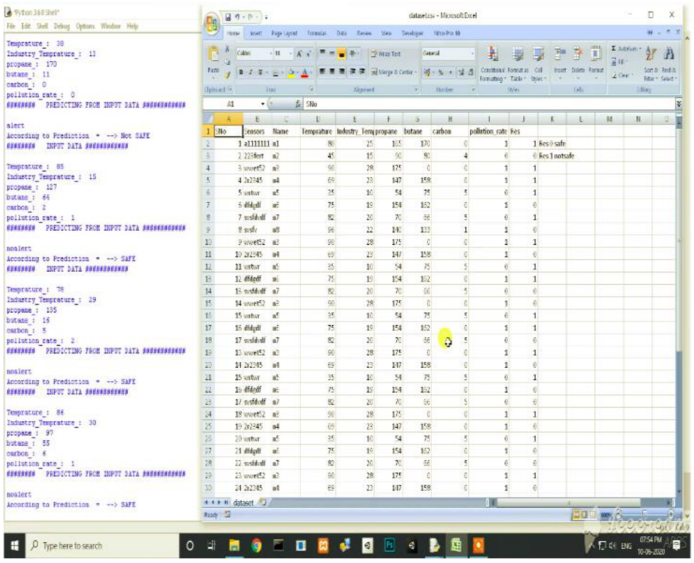


Figure-5: Output of various Air pollutions

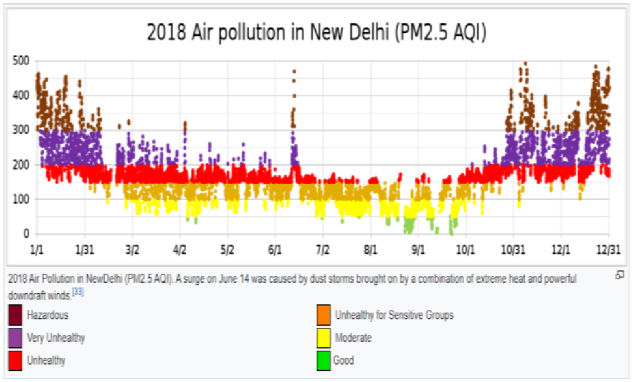


Figure-6: Air pollution in New Delhi 2018(Source Internet)

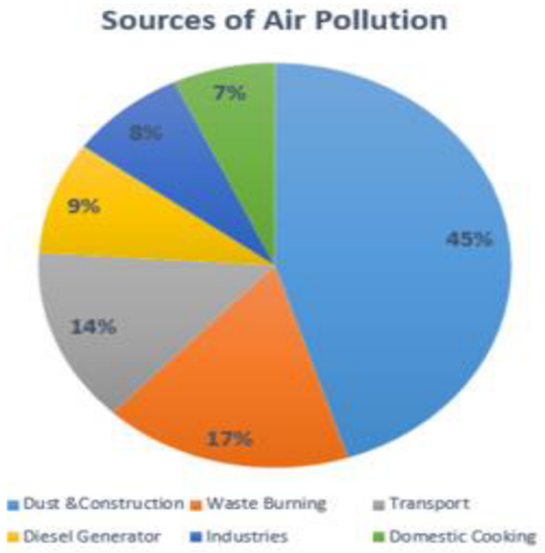
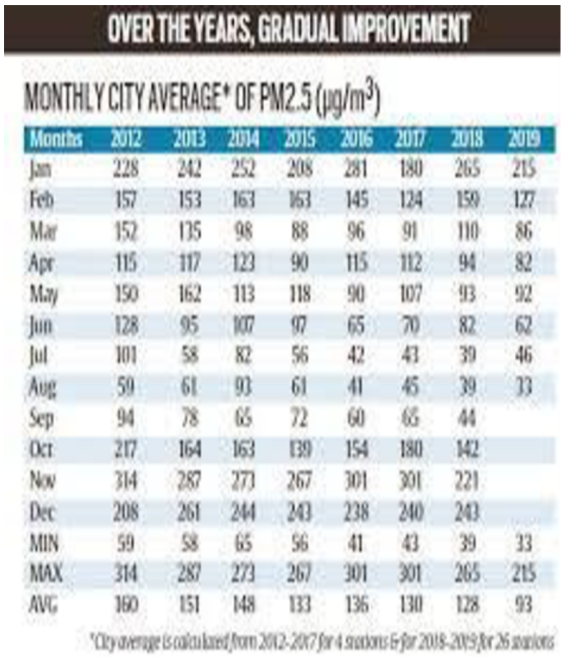


Figure-7: Dust & Construction contribute about 43% to the air pollution in India, which is followed by Waste Burning. Dust & Construction activities are mostly in the urban areas while Waste Burning is in the rural areas (agriculture).



Months	2012	2013	2014	2015	2016	2017	2018	2019
Jan	228	242	252	208	281	180	265	215
Feb	157	153	163	163	145	124	159	127
Mar	152	135	98	88	96	91	110	86
Apr	115	117	123	90	115	112	94	82
May	150	162	113	118	90	107	93	92
Jun	128	95	107	97	65	70	82	62
Jul	101	58	82	56	42	43	39	46
Aug	59	61	93	61	41	45	39	33
Sep	94	78	65	72	60	65	44	
Oct	217	164	163	139	154	180	142	
Nov	314	287	273	267	301	301	221	
Dec	208	261	244	243	238	240	243	
MIN	59	58	65	56	41	43	39	33
MAX	314	287	273	267	301	301	265	215
AVG	160	151	148	133	136	130	128	93

*City average is calculated from 2012-2017 for 4 stations & for 2018-2019 for 26 stations

Figure-8: Monthly wise report from 20112 to 2019 (Internet Source)

6. CONCLUSION

The accuracy of classification techniques is evaluated based on the selected classifier algorithm. An important challenge in data mining and machine learning areas is to build precise and computationally efficient classifiers for Air Quality Check.

Air pollution monitoring and prediction framework structured in this paper proposed a decent answer for the multifaceted nature of air contamination. The utilization of countless sensors guarantees observing precision diminishes checking cost and makes observing information in the observing region increasingly orderly and flawless.

Countless field information given by the front-end sensor system makes enormous information examination out of sight application layer more straightforward and compelling, giving a genuine and successful basic leadership reason for crisis reaction after contamination mishap occurs.

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