AN INVESTIGATION OF AIR POLLUTION MONITORING SYSTEM– A REVIEW

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Abstract— **Air pollution in huge urban areas has a extreme effect on environment and the humans. Ecological issues in India are growing rapidly. Air contamination is mainly caused by automobiles and industries which cause various respiratory diseases such as lung cancer and pneumonia. The evolution of technology represented by the IoT can efficiently help in such problem in order to maintain a stable ecosystem and guarantee a healthy life for citizens. The available system faces issues such as computing complexity, low power requirement, which has to be carefully dealt in future while designing such systems. In this article we have presented an overview of various techniques adopted by pollution monitoring systems. The objective of this investigation is to analyses about the key factors involved in enhancing the performance of the system. A comparative study is carried out in the existing system and further improvement is reported.**

Keywords— ***Air Pollution, MQ135 Sensor, IOT, Arduino Uno.***

I. INTRODUCTION

AIR POLLUTION

Air pollution monitoring and controlling is the challenging problem of every country, whether it is developing or developed.[1] Problems   on health have been increasing at earlier particularly in urban areas of developing countries where industrialization and increasing number of vehicles leads to release of lot of gaseous contaminants.[1] Dangerous effects of air pollution include allergic reactions such as eyes irritation, irritation of throat and irritation nose as well as some severe problems like heart diseases, bronchitis, aggravated asthma, lung and pneumonia. According to a study, due to air pollution up to 1,50,000 premature deaths each year happen in the United States alone. Whereas in European Union number reaches to 200,000 and over 4,000,000 worldwide.[1]
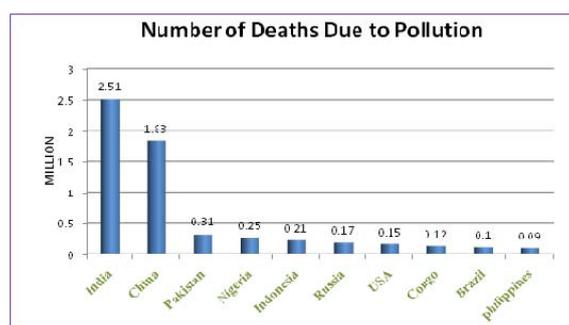

Fig.1.Statistics of death due to air pollution.[2]

The major factor caused by the air pollution are burning of fossil fuel, agricultural activities, exhaust from factories and industries, mining operation and indoor air pollution.[2] This will lead to deplete the ozone layer. To overcome these problems some of the solution will be provided such as use public mode of transportation, conserve energy, reuse and recycle the products, use energy efficient devices. But these solutions will not meet the current criteria. The challenges in air pollution are often caused by the following process (i) Combustion of fossil fuels like coal and oil for electricity and road transport, producing air pollutants like nitrogen and sulfur dioxide.[2] (ii) Discharges from industries and factories**,** releasing large amount of chemicals, organic compounds, carbon monoxide and hydro carbons into the air. [2] (iii) Agricultural activities, due to the use of insecticides, pesticides, and fertilizers that release destructive chemicals and affect the plants.[2] (iv) Waste production, mostly because of methane generation in landfills, usage of plastics, e-waste product these are the major challenges caused by the air pollution.[2]

II. REVIEW

Scope of the survey is to present the various techniques used in air pollution monitoring system. The highlights and challenges of the air pollution monitoring of various research works are also to be discussed.

A. IMPACTS ON AIR POLLUTION
The major impact of the air pollution are:

Global warming

In addition, air contamination is a significant supporter of global warming and environmental change. In fact, the larger amount of carbon dioxide in the air is one of the major causes of the greenhouse effect. Regularly, the nearness of ozone depleting substances ought to be helpful for the planet since they assimilate the infra-red radiation delivered by the outside of the earth. But the excessive concentration of these gases present in the environment is the cause of the recent climate.[3]

Health hazards

In terms of health risks, every uncommon suspended particles present in the atmosphere, which causes abandons in ordinary capacity of the human organs is categorized as air toxicants. According to existing data, the main poisonous effects of exposure to air contaminants are mainly causes

the cardiovascular, respiratory, dermatology, ophthalmologic, hematologic, neuropsychiatric, reproductive systems and immunology systems. However, the molecular and cell toxicity may also induce a variety of cancers in the long term. On the other side even lesser amount of air toxicants is shown to be hazardous for aged people and kids as well as patients suffering from cardiovascular and respiratory diseases such as asthma, liver cancer, pneumonia, pleural effusion, chronic obstructive pulmonary disease, Chronic Bronchitis, Emphysema and may also affect from nausea which may causes the severe breathing issues of human.[3]

On The Environment

Air toxicants majorly affects the procedure of plant development by preventing photosynthesis in many cases, with serious consequences for the purification of the air we breathe. It also provide to the formation of acid rain, atmospheric hails in the form of rain, frost, snow or fog, which are allow during the burning of fossil fuels and transformed by contact with water steam in the atmosphere.[3]

Cardiovascular dysfunctions

Numerous trial and epidemiologic investigations have demonstrated the immediate relationship of air toxin introduction and cardiovascular related sicknesses extortion. Air contamination is additionally connected with changes in white platelet checks which likewise may influence the cardiovascular capacities. Then again, an investigation on creature models recommended the   connection among hypertension and air contamination introduction. The traffic-related air contamination, particularly introduction to elevated levels of NO2, is related with both ways ventricular hypertrophy. Notwithstanding the antitoxin treatment that exists just for a couple cardio poisonous substances like CO, common treatment of cardiovascular infections ought to be completed.[3]

B.   TECHNOLOGY USED IN EXISTING SYSTEM

There are a number of techniques and algorithms already have been introduced which are in use in monitoring the pollution level. IoT helps a major role in monitoring the polluted air level present in the environment.

- *Cloud Based System*: In this system two methods are used for data handling. Develop Bluetooth low energy technology as the communication module for data transmission to the cloud database. Alternatively, 4G Dongle can be used for transmitting data directly to the cloud and the mobile application from the Raspberry pi.[11]

- *Machine Learning Algorithm*: Machine learning algorithm uses [K-Nearest neighbor (KNN) and Naïve Bayesian algorithm] algorithm for predicting the vehicle condition and life prediction of Engine, Coolant, etc. With the help of engine condition they take the action towards pollution.[11]

- *ZigBee Based Wireless Sensor Network and GIS*: ZigBee based wireless sensor nodes are spread in the area of air pollution monitoring, and these nodes constitute wireless network through the way of self-organizing. Sensor node will send monitoring data to the sink node through the ZigBee module. The sink node is not only integrated ZigBee wireless modules, but also integrated computer network protocol, which enables sink node can send data to the computer network. Besides to sending the monitoring data, the sensor nodes also send the location of each monitoring node. These data is read by the GIS. Based on these monitoring data and the node location data, coupled with related air pollution model, GIS can implement spatial analysis, simulate temporal and spatial distribution of air pollution monitoring area, and then to carry out air quality assessment and decision support.[12]

- *Artificial Neural Network*: Right now database are utilized to prepare the neural system compares to recorded time arrangement of meteorological factors (wind speed, wind course, temperature and relative moistness) and concentration of toxins in the industries. The estimation execution is resolved utilizing the Roots Mean Square Error and Mean Absolute Error. Results will show the significance of the meteorological variable set on the expectation of pollution focuses and the neural network efficiency.[13]

- *Convolution Recurrent Neural Network*: This methodology is utilized for transboundary air contamination observing (I) Divide the forecast contributions to expectation areas and transboundary air contamination sources; (ii) Use two diverse convolutional repetitive neural systems to solve the spatial-temporal feature of every information. (iii) Through transboundary forecast system to coordinate the spatial-temporal component of expectation areas with the spatial-temporal element of transboundary air contamination sources in a unique strategy. At that point utilize those blended highlights to foresee the air contamination. Then use those mixed features to predict the air pollution.[14]

III. RESEARCH WORK

The recent research work has been comprised in the following section. This section illustrates an elaborate research work of an individual author and their success and failure of their work in the Air pollution monitoring system.

S. Kumar and A. Jasuja (2017), proposed a Air quality monitoring system based on IoT using Raspberry Pi. In this system presents a real-time standalone air quality monitoring system which includes various parameters: PM 2.5, carbon dioxide, carbon monoxide, humidity, air pressure and temperature. Nowadays IoT is a key factor to finding the air pollution in each and every sector. Internet of Things converging with cloud computing offers a novel technique for better management of data coming from different sensors, collected and transmitted by high power, high cost ARM based minicomputer Raspberry pi. The system is tried in Delhi and the estimations are contrasted and the information gave by the nearby condition control authority and are introduced in tabular structure. The values of the parameters measured are shown in IBM Blue mix Cloud.[4]

Muthukumar (2018), developed a IOT based air quality monitoring control system. He considers contamination because of vehicles and gives a real time solution which screens contamination levels as well as think about control measures for decreasing traffic in highly polluted regions. The solution is given by a sensor based equipment module which can be put along streets these modules can be put on light posts and they move data about air quality remotely to remote server. This information can be used for traffic control. The proposed system additionally gives data about air quality through a mobile application which empowers workers to take up courses where air quality is acceptable.[5]

Temesegan Walelign Ayele (2018) research work is based on IoT based air pollution monitoring and prediction system is proposed. This system can be used for checking air pollution of a specific zone and to air quality investigation just as forecasting the air quality. Their system focus on the monitoring of air pollutants focus with the combination of IoT with a machine learning algorithm called Recurrent Neural Network more specifically Long Short Term Memory (LSTM).[6]

The research work addressed by Ghoneim (2019) proposed a IoT based system for Air pollution monitoring system. The objective is not only just accomplishing a smart city yet to understand a smart sustainability city to accomplish the equalization of nature alongside the balance of the city's technology evolution. From this point, This Article proposes a green IoT based effective system that identifies and monitor the outside air contamination level the system is controlled by sustainable conventional source. The system monitors the contamination level if the contamination level surpasses the satisfactory contamination level it takes a decision to notify the authorities who can utilize this information in arranging preventive moves and make measures to stop the continuous harmful..[7]

By using the IoT based vehicle Anti-collision and pollution control system Abhi.B.Amin and Harsh P patel (2019) proposed system in this system Every vehicle emits hazard gases but environmental problems arises when the percentage of emitting gases exceeds the standardized limit defined by Pollution Control Board (PCB). This problem occur due to incomplete combustion of fuel due to improper maintenance of vehicle. This emission cannot be avoided but it can be controlled. This system measures the ppm level of emitted gases and display it as well as alerts the user when vehicle is not moving and pollution level exceeds the threshold value. Nowadays accidents are occur due to lack of concentration. The system can avoid the occurrence of collision but up to some extent. This system detects the nearby obstacle within the predefined range and alert the user by displaying the direction of obstacle.[8]

Pradotiya (2019) contributed an Indoor air quality monitoring system based on IoT AND Fuzzy Logic system. This investigation examined indoor air quality monitoring and controlling system that can monitor the air condition and control the air condition by using the exhaust fan. This system utilized the IoT concept in conducting real time monitoring of CO2 gas and ppm10.The proposed framework has fuzzy controls that could alter the working interval of exhaust fan automatically depends on the concentration of each pollutant. Experimental results show that the proposed system shows excellent performance in controlling indoor air quality in terms of pollutant concentrator, AQI, and processing time to remove the pollutants.[6]

Swati Dhingra, (2019) developed a three-phase air pollution monitoring system. An IoT kit was prepared using gas sensors, Arduino IDE (Integrated Development Environment), and a Wi-Fi module. This device can be placed in different urban areas to observing air pollution the gas sensors collects the information from air and send the information to the Arduino ide the Arduino ide transmits the information to the cloud by means of the wi fi module. He also built up an android application named iot mobair with the goal that user can get to significant air quality information from the cloud. If a user is traveling to a destination the whole course is anticipated pollution level of the warning is displayed if the pollution level is too high the the proposed system is similar to google traffic or the route use of google maps. Moreover air quality information can be utilized to anticipate in future air quality index levels.[9]

Gaikwad Varsha Bhagwan, (2019) proposed a real time monitoring system using IoT. This system comprises of air pollution sensors cluster global positioning system of mobile phone single chip microcontroller Bluetooth modem. Sensors are hardware devices that produce quantifiable reaction to an adjustment in a physical state of air pollution the analog signal send by the sensors is digitized by a analog to digital converter send to controller for additional processing. CO, NOX, smoke and temperature detects the gas and discuss the information with microcontroller Bluetooth modem is utilized for transmitting the information to lpc2138 to mobile GPS modem of the mobile itself is utilized to send the location data. The primary goal of this system is to continuously monitor the contamination level gave by the distinctive sensor by means of Bluetooth modem at the control section Hence specific plan of action should be taken to control the air contamination.[10]

In this article, A. R. Muppalla et al (2019) present an end to end prototype solution for monitoring of air contaminant. Low cost LoraWAN CO2, CO and PM 2.5 sensors are utilized in this application. He also executed a continuous observing system utilizing web dashboards with the ability to perform constant investigation utilizing open source open source software elastic search and kibana. A prototype web dashboard showing the real time values of the sensor values along with temperature and humidity is also developed.[15]

The research work addressed by A. S. Handayani (2019) presents an automatic air monitor by measuring the level of exhaust gas of a motorized vehicle that will be applied in the indoor parking area. This research is Real Time Operation System, accurate, low-resource, portable and reliable at low prices and connected to networks based on IoT applications. This research will provide information that is needed by people, especially whose will visit crowded places, so they can avoid air pollution. This system utilizes the latest advances in multi-sensor technology, setting several sensors in one device with Wireless Sensor Network (WSN) technology.[16]

TABLE I.   SUMMARY   OF   AIR   POLLUTION
MONITORING USING IOT

AUTHOR	OBJECTIVE	TECHNOLOGY (or) MODULE USED	DISTANCE	ALERT	LOCATION TRACKING	DISADVANTAGES OF THE SYSYTEM
S. Kumar and A. Jasuja (2017)	It will display only the level of air quality using Raspberry pi. It predict only within the small area.	Raspberry pi	NA	NA	NA	It cannot able to predict long term pattern of air pollution. Predict only the small amount of polluted area.
Muthu kumar (2018)	The module is place on the lamp post. It uses the Wi-Fi module within the certain distance only it can able to sense the pollution. The value will be displayed in the mobile application.	Wi-Fi based module	NA	A	NA	This system uses the Wi-Fi module. Within the certain distance only the data can be transmitted. The maximum range of WiFi-ESP 8266 is only about 92 meters.
Ghoneim (2019)	The system monitors the pollution level; if the pollution level exceeds the acceptable pollution level, the corrective and preventive measures will be taken by the concern authorities.	Air Pollution Detection System	NA	A	NA	This system uses the Wi-Fi module. Within the certain distance only the data can be transmitted. Only the concern authorities will access the data.
Abhi.B.Amin and Harsh P patel (2019)	The system will measures the ppm level of emitted gases and display it as well as alerts the user when vehicle is not moving and pollution level exceeds the	Arduino Uno R3	NA	NA	NA	It will detect only the nearby obstacles. And it will detect only up to with the predefined range

	threshold value.					
Pradotiya (2019)	This system follows a fuzzy logic based air pollution monitoring system, monitors only the indoor air quality.	Fuzzy logic System	NA	NA	NA	The indoor air quality monitoring system monitors only the indoor air contamination. This will detect only air produced by the Air conditioner exhaust fan.
Temesegan Walelign Ayele (2019)	System will focus on the monitoring of air pollutants by using the machine learning algorithm.	Machine leaning algorithm	NA	NA	NA	In this system the value detected by the sensor stored in the web server, there may be a chance to data loss if the server get crash and failure.
Swati Dhingra, (2019)	The objective of the system is analogous to Google Traffic or the Navigation application of Google Maps. Air quality data can be used to predict future air quality index (AQI) levels.	Wi-Fi module	NA	NA	NA	This system faces the computational complexity while dealing with big sensors
Gaikwad Varsha Bhagwan, (2019)	The main objective of this system is to continuously monitor the pollution level provided by the different sensor via Bluetooth modem at the control section.	Bluetooth Modem	NA	NA	NA	By using microcontroller the cost of the devices is too high. It uses the Bluetooth module the signal will be available up to only certain distances

NA – Not Addressed   A -Addressed

IV.DISCUSSION

The above table [1] gives the comparative study of the literature study done on the various techniques and devices that have been used for detecting air pollution. These systems are compared based on the parameters such as distance covered, devices used, sensors and their efficiency.

Along with the functionality i.e., identifying or monitoring air pollution. This study gives the wide understanding of how the existing systems have not produced accurate results and they have addressed solutions for indoor locations or distance on a short range.

These aspects have been clearly inferred from the table. Thus challenges still prevail in identification of air pollution in a long range of distance, and provide immediate alert along with location tracking ability as listed out below.

V. CONCLUSION

This articles reviews the various research attempts in air pollution monitoring system and summarizes their significant outcomes. The summary of contributions by various researchers highlights the different, techniques and other features handled for air pollution monitoring system. In our future work we will focus on continuing the study of air pollution monitoring to improve current system with an improved accuracy.

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