Cyber-Air Quality Monitoring System: A Review

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Abstract **- There is always a significant amount of challenges associated with waste and its disposal, which can be essentially mitigated by the use of technology. As the urban population increases, the amount of waste disposal is also increasing at an unprecedented rate. The inappropriate disposal of this waste will lead to many hazards including the risk of fires in the dump yards that leverages poisonous smoke in the atmosphere by adversely affecting the safety of nearby residential areas. Monitoring the occurrence of fire in huge dumping grounds manually is a tough task and thus developing an automatic fire extinguishing system is highly required. The advanced technologies can be leveraged to ensure the protection and safety of people by eliminating such hazardous risks. The air quality index (AQI) is an indicator of daily air quality report that shows how air quality affects a person's life in a very short time. AQI plays a key role in ensuring the safety of residential areas. The proposed system aims to aid the possible hazardous risks associated with the dump yard and waste management.**

Dealing with air pollution is one of the major environmental challenges in a smart city environment. Real-time monitoring of pollution data enables the metropolitans to analyze the current traffic situation of the city and take their decisions accordingly. Deployment of the Cyber Physical System based sensors has considerably changed the dynamics of predicting air quality.

Index Terms **- Air Quality Index (AQI), Cyber Physical System, Sensors, Fire Detection, Machine Learning Algorithms.**

I.INTRODUCTION

Air pollution is one of the main detriments to human health. According to World Health Organization, 7 million people are at health risk due to air pollution. It is a leading risk factor for majority of health problems like asthma, skin infections, heart issues, throat and eye diseases, bronchitis, lungs cancer and respiratory system's diseases. Besides the health problems related to air pollution, it also poses a serious threat to our planet.

Cyber physical systems are physical engineered systems whose operations are monitored, coordinated, controlled and integrated by a computing communication core which is expected to transform the physical world around us (Lokesh M R en. al. 2014). Cyber-physical system is modelled with Multi Agent Paradigm and biological inspired Danger Theory based-Artificial Immune Recognization2 Algorithm Methodology towards developing healing process [Lokesh M R en al 2015.Next State Prediction" is used for the predication of the possible states that the system can exist. [Lokesh M R en al 2015]. Markov models and hidden markov models can be used for the prediction of the state in which the system exist based on which it could be stated if it is in a safe state. (Lokesh M R en. al 2015). State awareness plays major role in developing resiliency in cyber-physical system where the environment is diverse in nature (Lokesh M R en. al 2015).

The objective of this project is to measure the quality of air in real time and sending this data of air quality through a Wi-Fi module to mobile phone and various other devices. The value of the AQI along with the severity of pollution is continuously reported to the android application. Various other devices also could be connected and controlled through this Wi-Fi module and necessary steps could be taken depending upon the quality of air reported such as if the air quality gets severely poor, the buzzers could be turned on through the mobile devices so that other people living nearby gets alerted.

The system constantly monitors the level of gases in the dump yard and acts if the gases reach the threshold thereby ensuring the safety of people first and foremost. Fire detection is also implemented in case of emergency thereby notifying the authorities about the situation with the exact location in the dump yard along with starting the fire sprinklers at the area of fire to prevent the fire from getting severe. Machine learning is being used for predicting the AQI of the

surrounding and thereby notifying the user about the harmful environment. This aims to mitigate the situation by all the possible preventive measures, alerting the nearby areas of residential about the hazards

The paper flow as section 1 discuss about air quality monitoring, cyber-physical system application and exiting state of work with problem definition and objective of work. Section II discussed exiting work methods, solution for the problem addressed in air quality monitoring system. Section III defines the proposed architecture that is cyber-air monitoring system. Section IV analysis the possible results need to be discussed in the domain of cyber-air quality monitoring system. Section V discuss the state of work by comparing related work results with the propose need to be results and inference were analysis. Section VI concludes with the work objective and further enhancement.

II. RELATED WORKS

Sharafat Ali en. al. 2020 discussed on Low-Cost Sensor with IoT LoRaWAN Connectivity and Machine Learning-Based Calibration for Air Pollution Monitoring. "The work reported the development of a functional LoRaWAN based low-cost sensor node. The developed node can measure common ambient pollutants along with temperature and humidity. Three sensor nodes were manufactured and deployed for testing. The CO sensors were calibrated with the aid of a collocated accurate reference sensor using multiple calibration methods. ANN based calibration method seems quite promising resulting in high R2 values and low MAPE for ten-minute sampling interval. Therefore, the sensors calibrated by neural networks-based method may be able to facilitate near real time monitoring of air pollution over a large area. Dhingra, Swati en. al. 2019 analyze the Internet of Things mobile–air pollution monitoring system (IoT-Mobair). This proposed air pollution monitoring kit along with the integrated mobile application can be helpful to people suffering from respiratory diseases. The app had following features, indices of air quality for a specific city using real-time computation, air quality daily forecasts, timing outdoor activities for different recommendation of generation, air quality dips related to health risks, specific reports for air quality measures based on locations, air quality maps generation.

Han en. al.2019 a wireless sensor network for monitoring environmental quality in the manufacturing industry. Accurate monitoring and prediction of pollution and electricity consumption by enterprises can greatly relieve the pressure of urban pollution. Our study showed that in factories without active pollution monitoring, prediction, and an enterprise production monitoring system, it was very difficult to restrict the production of enterprises in the city and to forecast and alarm the pollution so as to improve the quality of urban environment. Based on our results, we concluded that in the real world, these pollutants would not only accumulate and spread in a city, but if a linkage were to form between several key polluted cities, the air quality in the corresponding region would become worse and worse, which would have a huge impact on the health of citizens living in the region. Cities, therefore, must take the initiative to monitor air quality and maintain a good quality of urban air environment.

III. ARCHITECTURE OF CYBER-AIR QUALITY MONITORING SYSTEM

In our proposed system the analog inputs are received from the analog input pins of the Arduino Uno from various gas sensors such as MQ135, GP2Y1010AU0F dust sensor, MQ7 etc. These data are converted into digital form by the ADC of the Arduino Uno. These data received are first converted into ppm of the gases and then using this ppm of gases Air Quality Index is calculated.

These data after calculations are send to the transmit pin of Arduino which is connected to the receive pin of the Wi-Fi module ESP8266.With the help of this Wi-Fi module, real time data is sent to online server of ubidots, where this data could be analyzed. Using API keys, this data can be accessed in a web application which uses past air quality data of places to calculate the condition of air in that area at that time and constitute an alert mechanism. The mobile application displays the condition of air into categories such as Good, bad, Severe etc. based on the AQI. The robust object database management system and it acts like establishment of compatibility amongst model elements of OOT and NDBMS (R Bhavya en al.2016)

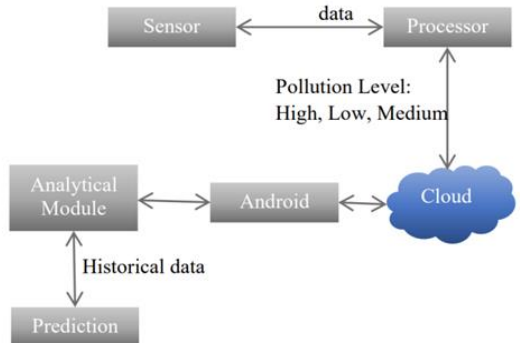

Figure 1: System Design

Using API keys, these data are sent to the web application The Web application categorizes the air based on the air quality data and the AQI of that area into Good, Bad, Severe etc. and displays it along with ppm of gases and AQI. The application allows us to refresh the data to get fresh data from the server and this fresh data is automatically updated on ubidots. The data along with time is visible on the online server. The backend web server then predicts the future Air Quality Index (AQI) based on these parameters using the Naive Bayes Algorithm and KNN for classifications.

IV. RESULTS DISCUSSION

The Proposed Air Quality Monitor based on low-cost sensors and using low power communication by IoT devices storing data in the cloud. It also illustrates how, by combining IoT technologies, real time monitoring of the data can be achieved from any browser capable device. A key aspect was to monitor pollution levels at a user location and use this data to create a profile of city or region to more accurately predict risks at an individual level. If levels are too high the it give alert notification for the respective authorities. A Fire alarm system get activated in case of emergency thereby notifying the authorities about the situation with the exact location in the dump yard along with starting the fire sprinklers at the area of fire to prevent the fire from getting severe. Further a Machine Learning algorithm is implemented to predict the data.

Table 1: Air Quality Index(AQI) Colour Code

O_3	PM_{10}	$PM_{2.5}$	CO	SO_2	NO_2	AQI	Level of Health Concern
0.000-0.059	0-54	0.0-15.4	0.0-4.4	0.000-0.034	-	0-50	Good
0.060-0.075	55-154	15.5-40.4	4.5-9.4	0.035-0.144	-	51-100	Moderate
0.076-0.095	155-254	40.5-65.4	9.5-12.4	0.145-0.224	-	101-150	Unhealthy for Sensitive Groups
0.096-0.115	255-354	65.5-150.4	12.5-15.4	0.225-0.304	0.65-1.24	201-300	Very Unhealthy
0.116-0.374	355-424	150.5-250.4	15.5-30.4	0.305-0.604	0.65-1.24	201-300	Hazardous
-	425-504	250.5-350.4	30.5-40.4	0.605-0.804	1.25-1.64	301-400	Hazardous

VI. COMPARATIVE STUDIES

Information regarding new low-cost sensor performance is only beginning to be publicly available. Recent studies have demonstrated promising performances for some low-cost sensors monitoring O3, NO and NO2.However, there are more and more sensor platforms in the market and their performance has not been characterized. Due to the high sensitivity of this kind of instruments to the electronics, when operating a sensor, it is not only necessary to know the sensor specifications, but also how it performs once it is integrated on an electrical board and platform. Additionally, numerous studies show that laboratory characterization is not enough and that it is absolutely essential to test sensor performance under real-world. Only recently the performance in real-world conditions is beginning to be assessed but the long-term reliability of low-cost sensors is still unknown. In the course of this work, comparisons between conventional and sensor technologies were only found for gaseous pollutants, thus suggesting that sensor technologies for particulate pollutants are still under development.

Functionality

Methods → / author ↓	Platform	Prediction	Efficiency
[Sharafat Ali,en., al. 2020]	Website	Yes	High
[Dhingra, Swati en. al. 2019]	Android application	No	Low
[Han en. al.2019]	Website	No	Low
[ameer en.al.2019]	Web application	Yes	High
[Dan en., al. 2020]	Android application	Yes	High

VII. CONCLUSION

The proposed design was tested successfully, and it was able to sense and send air quality data to ubidots server and from there using wi-fi gets transmitted to the web application. Using past and present air quality data, the condition of the air could be predicted given the concentration of various pollutants. This system can be utilized to design a warning system when the air quality gets severe and measures could be taken to prevent it.

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