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A Survey on Methods of Collecting Air and Noise Pollution Data Using IoT Sensors Integrated with Cloud Computing

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Abstract: Internet of Things (IoT) is a system of instruments that are linked to and are accessible through the internet. With improved sensors and integration of cloud technology we can profit from analytics, real-time insights; helping us to make wiser decisions. The paper discusses the present IoT architectures, implementation methods and states the evolution stages. This paper investigates the interrelation ship between air and noise pollution; traffic congestion and noise pollution. We have discussed the various impacts of prolonged noise and air pollution on mortality rate, observed how different research have found cardiovascular and strokes to be one of the major issues related to it. A detailed study of the already present systems using IoT sensors and models, cloud computing to collect air and noise quality; methods used to compute and work on collected data has been discussed here.

Keywords: IoT, Cloud, Air and Noise Pollution Correlation, Effects of Air and Noise Pollution on Mortality rate Ease of Use.

INTRODUCTION

India being the seventh largest nation is home to 1.35 billion people and has 3.5 million square kilometers area[1]. With development in automobile industries there has been a major increase in the number of automobiles on the road. In 2015, the number of vehicles were recorded as 24.5 millionin China, 9.3 millionin Japan, 4.2 millionin India, 4.1 millionin USA[2].With increase in the amount of vehicles on the road, the air and noise pollution have increased drastically. Understanding the influence of noise and air pollution on health as opposed to other environmental stressors is important. Many large-scale analyses of health and environmental noise; association of air pollution with health has been carried out [3], [4]. We need to realize which pollutants have the most adverse effects on our health to develop preventive measures. Results of different studies have suggested that air pollution increases blood pressure and might initiate cardiac arrhythmias. Risks for cerebrovascular events have increased due to long-term exposure to road and traffic noise and air pollution [5]. Studies have portrayed the relationship between brief exposure to air pollution and stroke. They have commonly expressed that more elevated amounts of air contamination can prompt hospitalization and even demise from stroke inside a couple of days. [6]., CO, particulate matter, O3, NO2 and SO2 are pollutants mainly accountable for health concern. The Pearson correlation coefficient for NO2 and Leq, 5min was0.53,and for NOX and Leq, 5min was 0.64 according to a study [7]. India's capital city, Delhiis one of the most polluted cities around the world according to WHO. Delhi has the highest concentration of particulate matter smaller than 2.5 micrometer[8].

These different data regarding air and noise quality are gathered using IoT sensors. Different environment monitoring sensors are used to collect data on carbon monoxide, LPG, methane concentration. Components such as Wi-Fi modules are integrated with Arduino board to connect to the internetor the use of Raspberry Pi is implemented.

Cloud Computing is the access of shared pool of resources to manage, store and process data rather using on-premise IT resources. Cloud computing is used here to store the vast environmental raw data from various devices on cloud resources and process it to perform future predictions.

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LITERATURE SURVEY

IoT Architecture

The IoT architecture comprises of mainly three layers which are network, perception and application layer. In real world application, different weather conditions like speed, wind direction, and geographical conditions have major consequences on the degree of air pollution.

The Perception layer usually deals with Field Sensor Network which is a hardware platform for network that hasa low power embedded microcontroller with sensors onboard [9]. Gagan et al [10] used Nucleo F401RE (32-bit micro- controller) to transmit collected data to Raspberry Pi. MQ7 (carbon mono-oxide sensor), MQ135 (CO2, NH3, Benzene and Smoke sensor) and MQ4(Methane sensor)are used in this and many other proposed systems. An array of numbers is given as output indicating the percentage of the gas which is in the environment, measured in Parts per Million.

In paper [11] exhaust gases and particulate matter are sensed by sensors on smart bike which acts as mobile sensor node. Terminal touch and Dock Station are used for data collection and visualization. Monitoring device consist of single-chip processor, micro GPS receiver (CM6B, Bonav), a particulate detector (Shinyei PPD42NS) and exhaust gas sensor (TGS22011), Bluetooth module (FBT06M) and microSD. In paper [12] RFID tags are integrated with cars and at monitoring locations RFID readers (Em-18), wireless gas sensors (MQ7, MQ2) are incorporated along with a microcontroller (ATmega328). At monitoring location, the RFID reader identifies the vehicle by its RFID tag and triggers sensors to collect that vehicle's data. The data collected in paper [7] is from 103 roadside sites in the Vancouver region of British Columbia where the short-term average noise levels exceeded 5 minutes. Paper [13] uses Beagle Bone Black interface with air pollution measuring sensors.

The network layer deals with transmission of sensed data to central sever or data center in real time. Paper [10] used low ESP8266 Serial-Wi-Fi module which has TCP/UDP stack as support where data being sent as TCP packets. Paper [14] uses XML whereas paper [10] used JSON as information data exchange language between sensors and servers. Paper [15] uses MQTT protocol to send the sensor data to the cloud IoT cloud platform through port 1883 and uses JSON format data exchange. Paper [16] talks about use of IPv6 to allocate unique IP to each and every sensor. In Paper [17] damaged resources are reached by backup resources by sending data into cloud resources and M2M client vehicle. This is achieved by use of ZigBee transport protocol using M2M client and server. Paper [18] discusses use of compression rate 1:30 which enables us to meet closed loop requirements and achieve low communication latency. Paper [19] uses MANET (Mobile Ad Hoc Network) routing algorithm. The system uses 28 mobile nodes and has a covers 300 meters in area. Paper [20] discusses use of VANET (Vehicular Ad-Hoc Network) over MANET as discussed in paper [19]. Paper [20] uses moving transport services creating an ad hoc network. Some advantages of VANET over MANET are high mobile node(vehicle), nodes adhere to traffic rules, dynamic and supports Vehicle to Vehicle communication and Vehicle to fixed Infrastructure communication. Some drawbacks of VANET are high cost, constrained communication due to high speed of vehicles/nodes.

The application layer is used for viewing, collecting, processing data and sending messages to clients or other devices in the network/system. In paper [10] the application layer deals with the processing and analyzation of air pollutant data and is used to determine and predict the air quality. It used NoSql Mongo DB set up in Raspberry pi for storing data. Webpage was implemented using MEAN stack. DNS was assigned to the IP of the board to allow ubiquitous access. The data sent by perception and network layer was mined using Neural network technology in Paper [14]. The strong non- linear processing ability improved the pollution prediction accuracy and air quality assessment. By evaluating quality indexes like harmful gas concentration, temperature; environmental factors as parameters and using genetic algorithm along with neural network technology, main pointers of air quality were chosen. Paper [12] developed the server using java language, including the Receiver Transmission Communication (RxTxComm) library which is used for serial communication between client and server. The server collected real time data of vehicle pollution levels and stored them using MySql. It also allowed the access of the data to users. Paper [13] uses Python SQL for uploading sensor data on AZURE cloud. It used a machine learning service to predict future pollution result using collected data. Paper [21] built a web-based notification system using PHP to collect data sent from Waspmote PRO. The notification was sent when threshold limit was crossed.

Paper [15] An open source tool Nodered is provide by IoT platform to manage andcontrol IoT flow devices. A NoSQL database in Bluemix (Cloudant) is used as a service DBaas. It used a dashboard tool for monitoring real time observation and an API securely connecting system devices depending on its usage application.

Cloud Computing

Cloud computing and IoT architecture's main difference is on-demand computing and dynamic scalability using shared infrastructure and virtualization technology. Paper [22] discusses about different realization models in cloud realization. The maps, vector data and raster data are sent to the network with Web-GIS server. The required data comes from within the system or data-cloud/ application-cloud which is an outcome of system processing and analyzing. Paper [23] discusses about cloud tier as service backend, which consist of a centralized database hosted by cloud service provider and a server hosting web server. By integrating cloud-server, it allows collection and monitoring of server data from WSN base station through-out the world to a centralized database. Interface layer has been used which works with Apache web server and PHP. It deals with the HTTP GET/POST request from web application clients and service tier devices. Database layer uses MYSQL database server for storing data received by Insert () command and providing data in response to fetch () command. It discusses development of web applications to allow dynamic viewing of weather parameters such. In paper [24] the author develops and hosts internet applications within the cloud using victimization associate application of the Google App Engine (GAE). Paper [25] talks about ThingSpeak, a cloud service, communicates with the assistance of net affiliation which works concerning as associate degree info packet carrier between connected sensors/devices and retrieves, saves/stores, analyze at the detected info from the connected detector to the host micro- controller. Paper [26] discusses about establishment of protection boundary using standard firewall and DMZ techniques. A Dual-Interface Trust Anchor is proposed in [27] to deploy only trusted software and devices into a local cloud. For ensuring data integrity and encryption IPSec [28] at IP layer level or DTLS [29] at protocol layer level is used.

Air and Noise Pollution Effects and Correlation

The purpose of different studies has been to examine the common relationship between exposure to road traffic noise and traffic air pollution, Industry air pollution in relation to risk for incident strokes and mortality rate. Irrespective of the adjustment of air pollution levels, Paper [30] did not find any connection between road traffic noise and cerebrovascular mortality. The risk of heart diseases and strokes were higher only before the adjustment of air pollution levels according to Paper [31]. Paper [32] excluded patients with diagnosis of cancer, stroke and missing data among the cohort participants. It found a correlation (Rpearson) between exposure of air pollution and Lden as 0.62 for NOx and 0.66 for NO2. The correlation between NO2 and NOX was 0.92. The risk for all strokes was mostly connected with NO2, whereas the data pertaining to NOX regarding the same (risk) was vague. Ischemic strokes were substantially related to road traffic noise, regardless of the adjustment of air pollution levels. Due to the results of the research regarding brief exposure to air pollution, Paper [33] negates the aforementioned information. Considerable association was found for total of highest exposure to the both noise and NO2. 10 dB higher traffic noise was associated with IRR's of 1.09. Fatal strokes were unaffected by road traffic noise levels. It was concluded that air pollution and road traffic noise meant a higher risk for stroke. Papers [34] and [35] concur with this for air pollution. However, the relationship was found to be accurate for both factors by only one study [31]. NOX and NO2 are good indicators of air pollution related to traffic. PM10 and particulate according to paper [36]. Another set of results may be obtained from PM2.5. The relationship between traffic on road and noise and air pollution is reasonable with an R2 of 0.40 When considering ischemic strokes, the human body is most receptive to the effects of air pollution when the noise level is high. Erroneous input data, the lack of information on distinctive factors, and the miscalculation of the associations have led to some limitations in paper [32].According to Paper [37], a portion of the important forecasters of differences in long term NO2 concentrations inside a city are traffic intensity and distance to major roads. Traffic related air pollutants which exhibit a stronger variation than aerosol and ozone, and are strongly connected with chronic morbidity which is the focal point of discussion in Paper [38]. The concentration of regional background was estimated by the distance inverse squared weighted interpolation of smoke(black) and concentrations of NO2. With the help of a geographic information system, the distance between home addresses to major roads was determined. The participants asserted exposed with a black smoke concentration of 4.4 μg/m3 and NO2 concentration of 11 μg/m3 were the ones within 100 m of a freeway roads within the 50 m of major urban roads. The interrelationship between black smoke and NO2 was found out to be 0.92. The model's relationship with air pollution exposure remained unchanged even after the addition of dietary and narcotic variables. There was no link found connecting any kind of exposures and non- cardiopulmonary, non-lung cancer mortality.

Engine noise (including induction), fan, exhaust, AC and detonation noise due to automobiles on the road are some of the key contributors of "urban traffic noise" according to Paper [39]. Automobiles also

create noises due to the following- rear axle, power driveline, main reducer meshing, transmission gear, transmission shaft unbalance. Noise is formed by the air disrupted by the fast rolling tyre. The engine noise in rail vehicles is greater than the electromotor dynamic system noise. The most significant source happens to be wheel noise due to railways. Since the dynamic system noise is one of the major sources of urban rail traffic, the amount and intensity of noise depends on vehicle performance. Some regulatory methods for urban traffic noise have also been proposed in this paper; standards should be set by the government in order to regulate road and rail vehicle noise which should be taken into account when creating the initial design of the vehicle. To reduce the sound intensity, the noise barrier technology uses absorption and reflection materials. The track structure of rails can be optimized to decrease the source of vibration which can reduce rail vehicle wheel noise. This coupled with the use of pneumatic tyres and elastic wheels can improve the noise spectrum.

CONCLUSION

This paper discussed about the changes in the IoT architecture and provided an in-depth discussion about the perception, network and application layer in the architecture. We discussed the different methods and the cloud architecture. The paper discussed the correlation between noise and air pollution; traffic congestion and noise pollution and the various impact of prolonged air and noise pollution on mortality rate, observed how different research have found cardiovascular and strokes to be one of the major issues related to it.

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