Journal of Informatics
Electrical and Electronics Engineering, 2021,
Vol. 02, Iss. 02, S. No. 023, pp. 1-14
ISSN (Online):2582-7006

A Proposal for Architectural Framework Using Internet of Things with Fog Computing for an Air Quality Monitoring System

Aarti Rani[1], Vijay Prakash[2] and Manuj Darbari[3]

[1,2]School of Computer Applications Babu Banarsi Das University, Lucknow, (Uttar Pradesh), India
[3]Department of Computer Science & Engineering, Babu Banarsi Das University, Lucknow, (Uttar Pradesh), India
[1]aarti.singh18oct@gmail.com, [2]vijaylko@gmail.com, [3]manujuma@gmail.com

How to cite this paper: A. Rani, V. Prakash, M. Darbari (2021) A Proposal for Architectural Framework Using Internet of Things with Fog Computing for an Air Quality Monitoring System. *Journal of Informatics Electrical and Electronics Engineering*, Vol. 02, Iss. 02, S. No. 023, pp. 1-14, 2021.

https://doi.org/10.54060/JIEEE/002.02.023

Received: 02/04/2021
Accepted: 23/05/2021
Published: 04/06/2021

Abstract

Air Monitoring becomes a systematic approach for sensitivity and finding out the circumstances of the atmosphere. The major concern of air quality monitoring is to measure the concentration of pollution and other important parameter related to the contamination and provides information in real-time to make decisions at right time to cure lives and save the environment. This paper proposes an Architectural Framework for the air quality monitoring system based on Internet-of-Things (IoT) and via Fog computing techniques with novel methods to obtain real-time and accurate measurements of conventional air quality monitoring. IoT-based real-time air pollution monitoring system is projected to at any location and stores the measured value of various pollutants over a web server with the Internet. It can facilitate the process and filter data near the end of the IoT nodes in a concurrent manner and improving the Latency issue with the quality of services.

Keywords

Air Quality Monitoring, Significant Air Pollutants, Air Quality Index, Internet- of-Things (IoT), Cloud Computing, Air Quality Management

1. Introduction

Air contamination is the existence of substances in the environment that are injurious to the health of humans also the reason for damaging to the atmosphere. There are various types of air pollutants, such as Carbon monoxide, Nitrogen dioxide, Sulfur

dioxide, methane, Toxic air pollutants particulates, etc. Because of air pollution many diseases like allergies, lung cancer, chronic obstructive pulmonary disease, ischemic heart disease, stroke, and it may also cause harm to the atmosphere in the form of Global Warming, Climate Change, Deterioration of fields, and death of animal species, Deterioration in building materials. Air contamination is generally basic in enormous urban communities where outflows from a extensive range of sources are concentrated. In our life air is the one of most important elements and for the healthier life human need a contaminants free air. The air which contains mostly nitrogen, argon and oxygen and some other gases, such as helium, methane and neon. Duo to the existence of high quantity of air pollutants in the ambient air, the health of the people is getting unfavorably exaggerated [1]. At times, mountains or tall structures forestall air pollution from spreading out. This air pollution regularly shows up as a cloud making the air dim. It is called exhaust cloud. "Smog" comes from joining the words "smoke" and "haze."An estimated seven million people approximately in the world die due to air contamination. WHO information shows that 9 out of 10 individuals inhale air that surpasses WHO rule limits containing elevated levels of toxins, with low- and center pay nations experiencing the most noteworthy introductions, and WHO is supporting nations to address air pollution. Huge metropolitan areas in poor and non-industrial countries will in general have more air contamination than urban communities in created countries. As per the World Health Organization (WHO), a portion of the universes most dirtied urban areas are Karachi, Pakistan; New Delhi, India; Beijing, China; Lima, Peru; and Cairo, Egypt. Be that as it may, many created countries likewise have air contamination issues. Los Angeles, California, is nicknamed Smog City. Beside with a respiratory issue, hospitalization for heart or lung illnesses likes bronchial asthma, constant bronchitis, and respiratory sickness that deteriorate their infections. If air quality remains to deteriorate, the bridle of contamination cost may change over critical trouble for governments. Hence, checking frameworks of air eminence were useful in observing air contamination proficiently preceding the circumstance changes over basic. Traditionally, air quality observing stations are particular of excessive costs to the establishment and huge sizes and support that limit its high conceivable insignificant organization in metropolitan areas [2]. Due to polluted air various health and environmental issues arises. For controlling these problems we required to monitor air quality. The air monitoring system is to deliver accurate data of air quality on time because on the basis of collected data to make decisions for the safety of environment and people [3]. Concentration of air pollutant is required for the checking of air quality status in to the real time. For the real time monitoring and Geographic coverage area IoT with the Fog computing play a important role and it make possible for the various health departments by the using data collected from the sensors to take appropriate decisions related to health and environment issues [4].

2. Significant Air Pollutants Ease of Use

Air pollution is genuine general wellbeing and natural issue that can prompt in addition to other things an unnatural weather change, corrosive downpour, and the weakening of the ozone layer. There are some regular toxins, their sources, and their effects on the climate.

2.1 Ozone

Description A gas can be found in two spots. Near to the ground (the lower atmosphere), it is a important piece of exhaust cloud. The destructive ozone in the inferior air ought not to be erroneous for the defensive layer of ozone in the upper climate (stratosphere), which screens out hurtful bright beams.

Basis Ozone isn't made straightforwardly yet is framed when nitrogen oxides and unstable natural mixes blend in daylight. That is the reason ozone is generally found in the mid-year. Nitrogen oxides come from consuming gas, firewood, or other non-renewable energy sources. There are numerous kinds of unstable natural mixes and come from sources going from plants to trees.

Effects Ozone can prompt more incessant asthma assaults in individuals who have asthma and can reason sore throats, hacks,

and breathing trouble.

2.2 Carbon Monoxide

Description A gas that comes from the consumption of petroleum products, generally in vehicles. It can't be seen or smelled.
Basis Carbon monoxide is delivered when motors consume petroleum products. Discharges are higher when motors are not tuned appropriately, and when fuel isn't copied.
Effects Old individuals with coronary illness are hospitalized all the more regularly when they are presented to higher measures of carbon monoxide.

2.3 Nitrogen dioxide

Description comes from the consumption of petroleum products. This gas has solid smell at elevated levels.
Basis comes from power plants and vehicles and Nitrogen dioxide can likewise respond in the temperature to frame ozone, acidic rainstorm, and particles.
Effects Individuals who are presented with nitrogen dioxide for quite a while have a higher possibility of getting respiratory diseases.

2.4 Sulfur dioxide

Description A destructive gases that can't be seen or smelled at low levels it smell like a "spoiled egg" at elevated levels.
Basis Sulfur dioxide generally comes from the consumption of coal or oil in force plants and likewise synthetic compounds, paper, or fuel.
Effects This gas can influence individuals who have asthma and infect eyes, noses, and throats. Sulfur dioxide can hurt trees and harvests, harm structures, and make it harder for individuals to see significant distances.

2.5 Toxic air pollutants

Description synthetic compounds are known or suspected to cause malignancy. Some significant poisons in this classification incorporate arsenic, asbestos, benzene, and dioxin.
Basis is made in synthetic plants or is radiated when petroleum derivatives are scorched. Some poisonous air toxins, similar to asbestos and formaldehyde, can be found in building materials and can prompt indoor air issues. Numerous harmful air poisons can likewise enter the food and water supplies.
Effects harmful air contaminations can likewise cause birth surrenders, skin and eye bothering and breathing issues [5].

World Air Quality Report 2019, Air contamination establishes the most squeezing natural wellbeing hazard confronting our worldwide populace. It is assessed to contribute toward 7 million unexpected losses a year, while 92% of the populace is assessed to inhale poisonous air quality (WHO, 2016). In less-created nations, 98% of youngsters under five inhale harmful air. Subsequently, air stain is the fundamental driver of death for kids younger than 15, executing 600,000 consistently (WHO, 2018).

In monetary terms, unexpected losses because of air contamination cost about $5 trillion in government assistance misfortunes around the world (The World Bank, 2016), and overall encompassing air contamination accounts for:

- 29%, all things considered, and sickness from a cellular breakdown in the lungs
- 17%, everything being equal, and illness from intense lower respiratory contamination
- 24% of all passing from a stroke
- 25%, all things considered, and infection from ischemic coronary illness
- 43%, everything being equal and sickness from constant obstructive pneumonic infection [6].

So, the air contamination is the world's major health and natural issues. It creates in two settings: indoor (family unit) air

pollution and open-air contamination. Nonetheless, scientists, leading examinations to break down the consequence of better and then some risky kind of air impurities with sizes of 2.5 µm or less, have finished up that loss of living in Asian nations, for example, China and India might be a lot higher than in created countries. This, the specialists have decided, is reason because of inadequate ignition of non-renewable energy sources and consumption of wood and coal for homegrown purposes [7].

3. Air Quality Index

As a norm of estimation of air superiority, AQI is a quantitative portrayal of air contamination level. The significant poisons engaged with the investigation (as depicted by the Environmental insurance organization US incorporate fine particulate matter (PM2.5), inhalable particles (PM10), SO2, NO2, O3, CO. Here PM2.5 and PM10 are estimated in micrograms per cubic meter (_g/m3), CO in parts per million (ppm), SO2, NO2, and O3 in parts per billion (ppb). AQI is isolated into six levels.

Table 1. AQI classifications by United States Environmental Protection Agency (EPA)

AQI Values	Descriptor	Related Health Impacts
0 -50	Good	Air superiority is taken into the retribution to induce agreeably; air contamination influences not several or no danger.
51- 100	Moderate	Breathing problem
101 -150	Not health for sensitive groups	Members of perceptive teams might suffer health impacts. The taken as an entire people aren't attainable to be affected.
151- 200	Unhealthy	Everybody might initiate to feel health consequences; members of responsive groups could feel severe alternative health effects.
201- 300	Very Unfortunate	Health recommendation: everybody maybe will sense severe health effects.
301-500	Hazardous	Health concern of emergencies. The entire populace is extra to be probable to be pretentious.

To diminish presentation to air defilement (particularly Fog concentrates), new measures have been sought after, and including improvement of air quality assess devices and air purifiers. The Ministry of the Environment in Korea evaluated the adequacy of 17 generally utilized air quality assess gadgets by dissecting their precision and dependability. The outcome demonstrated that solitary two devices gave exact readings of internal air quality. Different gadgets didn't present exact estimations of vaporized and all-out unpredictable natural mixes aside from carbon dioxide. As referred by the report, the Ministry recommends that the low dependability of indoor air quality estimation esteems in many gadgets relied upon numerous components, for example, estimation techniques, gadget structure, and information transmission. Hence, a mechanically progressed air quality observing stage should be created dependent on an understanding of the prerequisite for more exact checking devices [8].

4. Internet of Thing (IoT)

Internet of Things refers to a diverse network of physical and virtual objects embedded with electronics, software, sensors, and connectivity to facilitate objects to accomplish better results and service by transferring data with other associated objects by the use of the internet. IoT is a fast-growing trend within major industries. Moreover, IoT systems are likely to be scattered diagonally in various application domains and geographical locations creating unknown dependencies crossways domains, platforms, and services. Some different examples of IoT are transport system, healthcare, smart city, agriculture and many more areas those are considered in IoT. The most important point of IoT devices used to supervise and manage energy use. [9].

In current years, IoT has gotten quite possibly the main advances of the 21st century. Since we can associate regular items like home appliances, transports, thermostats, child monitors—to the internet using embedded devices, faultless communication is feasible among people, processes, and things. By methods for ease figuring, the cloud, large information, investigation, and versatile innovations, real things can allocate and assemble information with insignificant human mediation. In this hyper-connected world, superior infrastructure can record, monitor, and modify each communication between connected things. The real world meets the programmed world—and they synchronize.

5. Cloud Computing

In today's era Cloud Computing is a developing and admirable promising technology and concerned about the computer society of the entire world. Cloud computing is Internet-based; it has various capabilities to share data, space, infrastructure, and software, according to the requirement or on- demand. This computing is the grouping of grid computing, distributed computing, parallel computing, and ubiquitous computing [10]. Cloud is a sign for the internet; several people call it the World Wide Computer. It is deliberate to work as an entire computer in the cloud and expected at a wider audience, including those who cannot afford their computer. The distributed computing model serves its customers with whatever they demand, programming applications, and their documents. It likewise permits clients to get to supercomputer-level force [11]. Utilizing cloud administrations implies organizations can move quicker on tasks and test out ideas without protracted obtainment and huge forthright expenses, since firms just compensation for the assets they devour. This idea of business readiness is frequently referenced by cloud advocates as a key advantage. The capacity to turn up new administrations without the time and exertion related to customary IT obtainment should imply that is simpler to start new applications quicker. What's more, if another application ends up being fiercely well known the versatile idea of the cloud implies it is simpler to scale it up quickly.

5.1. Cloud Computing in IoT

Cloud Computing (CC) is an effectual way out for Internet of Things service management and composition also for implementing applications and services that develop the things or the data produced by them and provide benefits from IoT by increasing its capacity to handle with real-world things in an additional disseminated and dynamic manner, and for delivering new services in a huge number of real-life scenarios. In lots of cases, Cloud can provide the midway layer among the things and the applications, hiding all the difficulty and functionalities essential to execute the latter. This will affect future application advancement, where data social occasion, handling, and transmission will create new challenges, particularly in a multi-cloud environment [12]. The combination of IoT with Cloud computing carries numerous favorable circumstances to various IoT applications. In several situations, as there are countless IoT gadgets with heterogeneous stages, the improvement of new IoT applications is a troublesome errand. This is because IoT applications create device measures of information from sensors and different devices. This huge information is in this mode investigated to decide choices concerning activities. Sending all this data to the cloud requires unreasonably high organization data broadcast. To improve these issues, fog computing becomes possibly the most significant aspect [13].

6. Fog Computing

Cloud computing (CC) introduced several new capabilities to the information technology (IT) world. However, with the appearance IoT concept, the number of end-users has increased, and limitations of Cloud computing exposed. As a centralized structural design, connectivity between cloud and end-users are vulnerable to several users. Presented by CISCO, Fog Computing (FC) is the worldview of moving a part of cloud layers errands to another layer (Fog Layer) that is put between Cloud layer and end- clients. The haze layer is made of various geologically conveyed and interconnected fog nodes [14]. Fog has one of the most significant quality is distributed computing standard that increase the services provided by the cloud. It facilitates management and programming of computing, networking, and storage services between data centres and end devices. Fog computing worked as a middle layer between the Cloud computing and end-user. It supports mobility, resource and interface heterogeneity, interaction with the cloud computing, and that requires low latency with a broad and dense geographical distribution. Fog as both advantages of edge and cloud computing [15]. There are different Capabilities of Fog computing are position at the edge, Location awareness, Real-time communications and service delivery, Edge analytics, Scalability. It is a distributed computing standard that provides services as Cloud at the edge of the network [16].

Table 2: Comparison of Fog and Cloud Computing [17].

Aspects	Cloud Computing	Fog computing
Structural design	Centralized	Distributed
Nodes	A small amount of	Large
Security	lesser	Higher
Transparency	High	High
Response Time	High	Low
Connectivity	Internet	Protocols and Standard
Awareness about location	No	Yes
Client and server distance	Single hop	Multiple hops
Mobility	Limited support	Supported
Data Processing	Lots of Distance	Near to the sources

6.1 Fog Computing with IoT

Due to expansion in IoT implementations, problems and challenges that are interrelated to them are also expanding. IoT devices produce a vast amount of diverse data and are necessary to be processed in a minimum time. However, it is not feasible

with the existing cloud models because the cloud is centralized and IoT devices are in a distributed manner so not compatible to the big amount, extensive range, and fast speed of data that are collected by IoT devices. A significant IoT application that may use the strength of Fog computing. Using this technology, the air quality can be checking with reference to the developing anxiety regarding the increasing level of air contamination crossways the world. The ramifications of the rising degree of air contamination square measure implausibly impeding in environment and that they represent a real danger to climate and human eudemonia. The basics contributing to taking off the air defilement significantly incorporates quick urbanization and industrialization, a developing number of vehicles, huge utilization of non-renewable energy sources, and raised expectations for everyday comforts [18]. The fog extent the potential of IoT by increasing its efficiency, presentation, and decrease this data quantity. After efficient processing, the information collected by the sensors is sent to edge devices for temporary storage and processing, instead of moving it to the cloud, while reducing network latency and throughput.

Fog computing accelerates responsiveness to events by reducing a round trip to the cloud. Provide help in avoiding the requirement for costly bandwidth and protects susceptible IoT data. Eventually, organizations that adopt fog computing expand deeper and more rapidly insights, foremost to increased business nimbleness, advanced service levels, and better security.

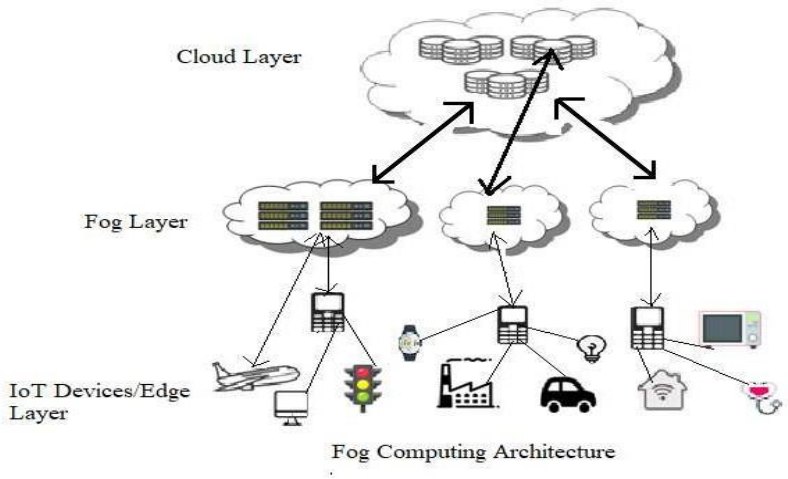

Figure 1. Fog Computing Structural Design

7. Air Quality Management

The expression "air contamination/pollution" has turn into so persistent that when anybody hears those words; they have a comprehension of what they mean. To a number of levels, it is an acknowledged actuality of the advanced world that the air we inhale is polluted somehow or another, yet the huge mainstream don't understand the seriousness of the issue, the impacts it can have on wellbeing, or the potential there is to battle the progressing plague. Air contamination is estimated through a mix of air monitoring stations and modelling. Modelling is the mathematical re-enactment of how air contaminations are scattered in the climate while monitoring stations quantify the centralization of pollutants perceptible approximately.

With the two normal structures estimated for air contamination is — PM2.5 and PM10. Both are a combination of strong particles and fluid beads, with PM10 being particles that are under 10 microns and more modest, PM2.5 being particles that are 2.5 microns and more modest. The air superiority index is estimated continuously around 70 nations on the globe and showed through aqicn.org [19]. Air quality measures are likewise possibly not going away to be powerful in seclusion given the complex and communicating factors that add to air contamination [20]. In Europe and North America, air quality management

depends on an always developing research premise that offers knowledge into every one of its components. Throughout the years, both hypothetical necessities and practical tools opened up for air quality administrators to viably address the difficulties. These encounters are converted into an Air Quality Management Plan (AQMP) [21]. The National Capital Region Air Quality Management Committee and Adjacent Areas Order 2020 were declared on October 28, 2020.

The Ordinance accommodates the formation of a Commission for improved co- appointment, exploration, recognizable proof, and goal of issues identified with air quality in the public capital locale (NCR) and connecting territories. Connecting territories alludes to zones in the conditions of Rajasthan, Uttar Pradesh, Haryana, Punjab, and Haryana where any wellspring of the contamination may cause an unfavourable effect on air superiority in the NCR [22].

8. Related Work

Air quality observant frameworks could be ordered because of the inside and outside contamination observant depends on wherever the incident happens. Outside air contamination means to the open and modern area. In inconsistency, the indoor case is the contamination of the air in a minuscule room inside homes, work environments, workplaces. There are an extensive variety of studies covering the monitoring of Air superiority and continuously developed to adopt required performance in the applications.

Air and noise contamination is an increasing problem these days. It is serious to monitor the air and noise defilement levels to convince a well-built and protected state of climate are discussed [23] and the author projected an IoT based technique to screen the Air Quality and the Noise strength in a particular region and to structure an IoT based noise and air pollution check, a framework is elected by the help of Wi-Fi and information access is configured with cloud for the review storage and access. Monitoring environmental parameters using the Raspberry Pi module has been discussed in this article. Air superiority is getting increasingly more significant step by step because of critical effects of air contamination on general wellbeing, worldwide climate, and overall economy are discussed [24] and the author proposed a smart real-time Air Monitoring System with urgent situation attentive based on the Internet of Things, this system users to track the nearby air quality of their home or office or industries from anyplace and also inform to the user of the system in urgent situation life intimidating circumstances.

Air pollution is a fundamental ecological issue due to the colossal effects on general wellbeing, worldwide climate, and on the whole economy. The author reviews and comparisons among Static Sensor Network (SSN), Community Sensor Network (CSN), and Vehicle Sensor Network (VSN) in the visualization of the transporters of the sensors and also discussed [25] 3D data on air pollution over time with high spatial potential can be gradually collected by mounting compact sensor concentrators on multi-cruise unmanned aerial vehicles (UAVs).With the constantly more requirement of concurrent monitoring for data broadcast impediment, the conventional cloud computing structural design can't gratify the requirement, and the fog computing structure emerges at a major moment is discussed [26]. The authors discussed about the problem of inadequate application support of cloud computing in the appearance of high data transmission in real-time and proposed server less architecture, and an environmental monitoring architecture and helpful in solving the shortage of conventional cloud computing architecture and better meets the requirement of instantaneous environmental monitoring.

Air quality checking is a vital instrument to decide on air contamination issues. It is additionally fields where IoT assumes an incredible job are discussed [27] and the author focuses on indoor air issues quality and manage indoor air quality observing and estimating by next the proposals of the W3C WoT Working Group to configuration, create and convey an encompassing sensor network which can be gotten to by any standard internet browser. The execution of two conventions, HTTP and MQTT, empowers the response to be additional adaptable for the ideal situation.

IoT is an taken as a whole arising method that contains "smart devices "that can ready to detect and interface with environmental factors and collaborate with the clients and different gadgets. The ecological contamination problem has been an

extraordinary danger to the advancement of society and people's life. IoT technology provides a successful technique for solving the ecological contamination trouble are discussed [28] and the author resolve the problem regarding air contamination a three-phase air pollution monitoring system with IoT proposed. By Using MQ gas sensors, Arduino UNO, and a Wi-Fi module (ESP8266) the IoT Kit was developed and also developed an Android-based application termed as Air-Monitoring

Giving precise constant ecological observing administrations is an important up till now hard job. Even as current advancements in the IoT and the fog computing worldview have approved novel opportunities to get better the administration, accomplishing precise ecological observing appearances faces difficulties and accomplishes truthful varied data synthesis and analysis in real-time[29] the author proposed an improved service framework. This framework includes a standard distributed modelling algorithm based on fog computation and association learning models.

Fog Computing expands the Cloud computing worldview by putting resources near the edges of the organization to manage the approaching development of related devices and provide facilities like low latency, local awareness, and different services given by numerous devices at diverse locations[30] and the author proposed fog node based board framework close by the predicted application layer Peer-to-Peer (P2P) fog convention related to the Open Shortest Path First (OSPF) directing convention for the trading of utilization administration provisioning data among fog nodes and the use case based on an air monitoring application.

Rapidly growth in technology, numerous innovations have been through in the different fields and out of communications that are transiting pioneering to the IoT. Air contamination is a significant natural change that causes numerous dangerous consequences for people that should be controlled. The field of Wireless device Networks (WSN) is one in all those autonomous sensing devices to watch physical and environmental conditions beside thousands of applications in different fields. Currently a day's one in the entire foremost vital field concerning health is pollution and pollution being a serious environmental amendment that causes several venturous effects on masses that require being controlled [31]. The author proposed WSN nodes for stable calculating the air contagion in the region of the metropolitan and the moving public vehicle transports and vehicles and technique gave us the checking data from the permanent hubs conveyed in the urban to the adaptable nodes on Public Transport transports and vehicles.

The increasing size of data reduces the manageability of all services and affects the performance of services in the form of QoS, and users cannot get real-time information. For getting better the air quality of the inside environment and decrease the awareness of pollution in the environment ideas integrated with a smart control socket are developed [32]. The author purposed a framework that proposed Intelligent Indoor Environment Monitoring System in Cloud (iDEMS) that has huge information investigation ability and backs up information simultaneously. After observing the performance of the three unique types in information exchange, the most suitable converter for the air pollution framework is to improve the information research capabilities of the first framework.

One of most important resources on our globe is air. But miserably the importance of air has deteriorated radically over the earlier period, particularly for urban cities. Individuals are finding for better approaches to observe the nature of air in their nearby climate to make fitting moves, for example, wearing covers or remaining at residence and the difficult issue of precise and reasonable PM2:5 checking from a novel cloud-based information examination indicatation of vision. Via cautiously planning and building our PM2:5 screens - AQM and miniAQM - we can get sensibly exact PM2:5 estimations continuously and requiring small to no effort [33]. The author discussed the plan, execution, and assessment of Air Cloud – a novel customer cloud framework for unavoidable and individual air-quality observing effortlessly and the structure, accomplishment, and assessment of AirCloud – a novel client-cloud system for persistent and personal air-quality monitoring at minimum cost.

With the rapid expansion of the trade areas and urbanization, the climate turns out to be extremely spoiled to the degree of displeasing the day-by-day life of the individuals. For resolving the air contamination there are various existing monitoring systems but the crucial problem is that these techniques or methods are not much effective due to their limited capabilities

[34]. The author determined on the problems related to structure and different difficulties related to computation by implementing real-time air quality monitoring systems with minimum cost and lesser power utilization. This architecture helped in gathering the air quality records in real-time and Algorithms helps improve from impermanent errors in sensor, and to supervise cross compassion troubles.

The surrounding air quality observing network includes the estimation of various air toxins at various places in the metropolitan to keep an economical air quality. It is the requirement of the hour to observe air quality to diminish air contamination. Air contamination has procured basic measurements and the air superiority in many urban areas that monitor outside air contamination neglect to meet WHO rules for secure levels [35]. The author purposed a platform for collecting information on a real-time basis for descriptive analysis and proposed a venturesome methodology where our openly moving WSN organization would be sent on the city's public transports. The information to be collected is diversified, covering more prominent areas in urban areas, which not only saves time and energy, but also reduces sensor traffic.

Air contamination (AP) is a significant Influence for public wellbeing. To diminish the impact of AP, air quality checking stations are conveyed all over the world. In any situation, notwithstanding checking, by anticipating air contamination levels, people group's openness to contamination can be additionally diminished [36]. The author survey air quality (AQ) and projected a structure for air quality prediction. This framework utilizes Complex Event Processing to execute the enormous number of data in close to real-time.

The IoT is a significant part of the new age of data innovation. It refers to a huge network formed by merging different data detection equipment with the Internet. The deployment of IoT terminal hardware has prompted a spray of terminal information and associations, requiring an all the additional computationally well-organized IoT network architecture to empower convenient information examination and handling. Simultaneously, IoT business is consistently inferred and broadly utilized in the smart house, health, agriculture, transportation, and different areas [37]. The author discussed acquiring high-exactness estimations, regular air quality checking and forecast frameworks receive high-exactness sensors and proposed a minimal effort air quality observing and constant forecast framework dependent on IoT and edge registering, which diminishes IoT applications reliance on distributed computing. Raspberry Pi with processing power, as an edge device, runs the Kalman Filter (KF) calculation. This improves the exactness of ease sensors by 27% on the edging.

9. The Requirement of Real-Time Air Quality Information

People should be worried about air contamination levels, particularly those with respiratory issues, heart issues and who have just been presented to perilous degrees of air toxins, for example, Carbon Monoxide (CO) need to look for additional openness of air contamination. The effects of air contamination aren't reversible predominantly for Carbon Monoxide (CO), so whenever presented to precise levels. Real-time observance helps in finding the extent of pollution concerning the close air quality principles tips square measure a regulative reckon to line the target for pollution decline and attain clean air. Real-time air monitoring helps prevent dire situations by warning people and initiating activities. The accessibility of constant air superiority data could improve drivers taught about driving patterns and how it impacts the climate and expands contamination. Better driving propensities will prompt diminished contamination. Additionally, more wellbeing-aware residents may pick substitute "healthy " routes based on the contamination data. It will profit them just like others by lessening contamination fixation in pinnacle streets so everyone inhales cleaner air [38]. Air pollution will reason equally short-run and long-run effects on physical condition and heaps of individuals square measure disquieted regarding pollution within the air they breathe.

10. Types of Sensors

Air quality monitoring system provides real-time data to the end-user in a simple format regarding environmental awareness and taking proper precautions with assist of sensors. There are variety of sensors are offered for collecting the atmospherically data. Temperature sensor, Humidity sensor, Rain sensor, Carbon dioxide gas sensor, Dust particle sensor, Carbon monoxide gas sensor, etc basically these types of sensors obtainable to gather the various gases from the road traffic emission like carbon dioxide sensor, NO2 sensor, SO2 detector, etc. Wireless detector network designed a node wherever every node is associated to at least one detector/sensor. The supplementary sensors might facilitate reinforcing the network and supervise the extra pollutants. With the assistance of sensors, it's going to attainable to gather the atmosphere-associated information.

11. Proposal for Internet of Things (IoT) With Fog Computing Based Air Quality Monitoring System

To acquire consistent and correct knowledge, typical monitoring systems use advanced algorithms and varied additional tools. Therefore, the unit of measurement of these electrical appliances is usually very expensive and power utilization, and the volume and weight are very large. Technical advancements determine these issues to some level, during this low-value close sensors with low size and quick response area unit merely out there. However, they cannot attain parallel information preciseness levels as typical observation devices. Will propose a three-layered framework for data processes and analysis for invigilate air quality monitoring system through fog computing. Basically in this architecture, Internet of Things and fog based air quality monitoring system will collect the information at the sensor layer and next to all the data related pre-processing

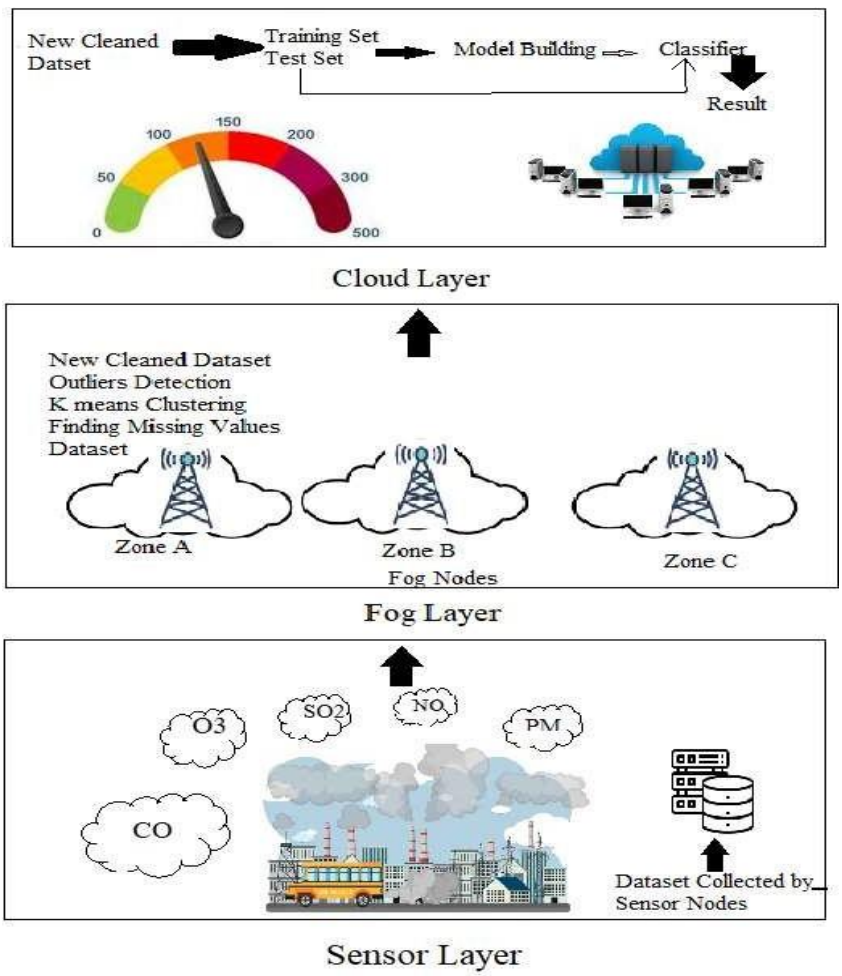

Figure 2. Air Monitoring System Architecture

where we will find out missing data and outlier detection done at the fog layer and classification and further methodology will use at cloud layer to find out the air quality in the form of AQI and another most important factor regarding this architecture it will focus on improving latency.

12. Conclusion and Future Scope

Significant growth has been made in improving air superiority in various cities and regions of the globe. This progress stems from understanding the importance of air quality and recognizing how air pollution affects the environment and health. From the enormous number of data, valuable information was created and distributed to the clients at the level to make understanding and outstanding way out for domestic, offices, and environment monitoring, existing ways necessary to be upgraded for superior accurateness. It is essential to measure accurate pollution level in air to provide information within time for the citizens specially who are facing many health issues. An Air Quality Monitoring system will be implemented by using Internet of Things with Fog Computing to decrease latency issues and provide information within time.

References

[1]. K. Okokpujie, E.N. Osaghae,O. Moduqe, et al., ”A smart air pollution monitoring system”. International Journal of Civil Engineering and Technology (IJCIET), vol.9, no.9, pp.799-809, Sep 2018.

[2]. R. Senthilkumar,P. Venkatakrishnan, N.Balaji, “Intelligent-based novel embedded system based IoT enabled air pollution monitoring system”, Microprocessors and Microsystems, vol.77, 2020.

[3]. S. Sirsikar, P. Karemore, “Review paper on air pollution monitoring system”, International journal of Advanced research in Computer and Communication Engineering, vol.4, no.1, pp.218-220, 2015.

[4]. P.D. Landge, R.R. Harne, “Air Quality Monitoring System for City: A Review”, Int. Res. J. Eng. Technol, vol.5, no.1, pp.521-522, 2018.

[5]. N.A. Jerry,”Cause and Effects of Pollutant Gases,”Available at: https://www.infoplease.com/math-science/ earth-environment /major-air- pollutants, july 2014.

[6]. “WORLD AIR QUALITY REPORT,”file:///C:/Users/lenovo/Downloads/world-air-quality-report-2021-en.pdf/ pp.1-43, July 2021

[7]. B. Deep, I. Mathur, and N. Joshi, “An approach toward more accurate forecasts of air pollution levels through fog computing and IoT,” in Information and Communication Technology for Sustainable Development, Singapore: Springer Singapore, vol.933, pp. 749–758, 2020.

[8]. J. Jo, B. Jo, J. Kim, et al., “Development of an IoT-based indoor air quality monitoring platform,” J. Sens., vol. 2020, pp. 1–14, 2020.

[9]. O. Uviase, & G. Kotonya, “IoT architectural framework: connection and integration framework for IoT systems”, arXiv preprint arXiv:1803.04780, 2018.

[10]. P. Srivastava,& R. Khan, “A review paper on cloud computing” International Journals of Advanced Research in Computer Science and Software Engineering, vol. 8, no.6, pp.17-20, 2018.

[11]. P.Y. Thomas, “Cloud computing”, The Electronic Library,vol.29,no.2, 2011.

[12]. A. Botta, W. D. Donato, V. Persico, et al., “Integration of Cloud computing and Internet of Things: A survey,” Future Gener. Comput. Syst., vol. 56, pp. 684–700, 2016.

[13]. H.F. Atlam, R.J. Walters, & G.B. Wills, ”Fog computing and the internet of things: a review”, big data and cognitive com puting, vol. 2, no.2, pp.10, 2018.

[14]. M. Guzel, S. Ozdemir, “A New CEP-based Air Quality Prediction Framework for Fog based IoT”, In International Symposium on Networks, Computers and Communications (ISNCC), pp. 1-6, 2019.

[15]. H. Gupta, A.V. Dastjerdi, S. K. Ghosh, et al., “iFogSim: A toolkit for modeling and simulation of resource management techniques in the Internet of Things, Edge and Fog computing environments: IFogSim: A toolkit for modeling and simulation of internet of things,” Softw. Pract. Exp., vol. 47, no. 9, pp. 1275–1296, 2017.

[16]. C. S. R. Prabhu, “Overview - fog computing and internet-of-things (IOT),” EAI endorsed trans. cloud syst., vol. 3, no. 10, pp. 154-378, 2017.

[17]. K.P. Saharan, A. Kumar, ”Fog in comparison to cloud: A survey”, International Journal of Computer Applications, vol.122, no.3,pp.10-12, 2015.

[18]. M. Ahmed, R. Mumtaz, S. M. H. Zaidi, et al., “Distributed fog computing for Internet of things (IoT) based ambient data processing and analysis,” Electronics (Basel), vol. 9, no. 11,2020.

[19]. Q. Liu, J.T. Harris,L.S. Chiu et al., “Spatiotemporal impacts of COVID-19 on air pollution in California, USA,” Sci. Total Environ., vol. 750, no. 141592, 2021.

[20]. S. Quarmby, G. Santos, and M. Mathias, “Air quality strategies and technologies: A rapid review of the international evidence,” Sustainability, vol. 11, no. 10, 2019.

[21]. B. Sivertsen and A. Bartonova, “Air quality management planning (AQMP),” Chem. Ind. Chem. Eng. Q., vol. 18, no. 4–2, pp. 667–674, 2012.

[22]. Notification, Coastal Regulation Zone. "Ministry of Environment & Forests." Government of India ,1991.

[23]. D. Ganeshkumar, V. Parimala, S. Santhosh kumar, et al., “Air and Sound Pollution Monitoring System using Cloud Computing”, International Journal of Engineering Research & Technology (IJERT), vol. 9, no.6, pp.81-85, 2020.

[24]. M. M. Ahmed, S. Banu, and B. Paul, "Real-time air quality monitoring system for Bangladesh's perspective based on Internet of Things," *3rd International Conference on Electrical Information and Communication Technology (EICT)*, pp. 1-5, 2017.

[25]. W. Y. Yi, K. M. Lo, T. Mak, et al., “A survey of Wireless Sensor Network based air pollution monitoring systems,” Sensors (Basel), vol. 15, no. 12, pp. 31392–31427, 2015.

[26]. H. Chen, S. Li, J. Zhang, et al.,“Indoor formaldehyde monitoring system based on fog computing”, In IOP Conference Series: Materials Science and Engineering, vol. 569, No. 4, 2019.

[27]. D. Ibaseta, J. Molleda, F. Díez, et al., “ An iot Platform For Indoor Air Quality Monitoring Using The Web Of Things”, Air Pollution Xxvii, vol.236, no.45,2019.

[28]. G. Manikannan, T. Vijayalakshmi, P. Prabakaran, “Mobile - Air Pollution Monitoring System using Internet of Things (IoT)”, International Journal of Scientific Development and Research (IJSDR), vol.11,no.4, pp:28-37,2019.

[29]. W. Wang, C. Feng, B. Zhang et al., "Environmental Monitoring Based on Fog Computing Paradigm and Internet of Things," in *IEEE Access*, vol. 7, pp. 127154-127165, 2019.

[30]. J. Santos, T. Wauters, B. Volckaert, et al., “Fog computing: Enabling the management and orchestration of smart city applications in 5G networks,” Entropy (Basel), vol. 20, no. 1, 2017.

[31]. M. S. Jamil, M. A. Jamil, A. Mazhar, et al., “Smart environment monitoring system by employing wireless sensor networks on vehicles for pollution free smart cities,” Procedia Eng., vol. 107, pp. 480–484, 2015.

[32]. P.L. Sun, J. Y. Weng, C.T. Yang, et al., "The Implementation of Air Pollution Monitoring Service Using Hybrid Database Converter," *7th International Conference on Cloud Computing and Big Data (CCBD)*, pp.269-274, 2016.

[33]. Y.Cheng, X.Li, Z.Li, et al., “AirCloud: a cloud-based air-quality monitoring system for everyone”. In Proceedings of the 12th ACM Conference on Embedded Network Sensor Systems pp. 251-265, 2014.

[34]. Z. Idrees, Z. Zou, L. Z. heng, “Edge computing based IoT architecture for low cost air pollution monitoring systems: A comprehensive system analysis, design considerations & development”, Sensors, vol.18, no.9,2018.

[35]. D. Saha, M. Shinde, S. Thadeshwar, “IoT based air quality monitoring system using wireless sensors deployed in public bus services” In Proceedings of the Second International Conference on Internet of things, Data and Cloud Computing, pp. 1-6, 2017.

[36]. M. Guzel, & S. Ozdemir, “A New CEP-based Air Quality Prediction Framework for Fog based IoT”, In International Symposium on Networks, Computers and Communications (ISNCC), pp. 1-6, 2019.

[37]. X. Lai, T. Yang, Z. Wang et al., “IoT implementation of Kalman Filter to improve accuracy of air quality monitoring and prediction,” Appl. Sci. (Basel), vol. 9, no. 9, 2019.

[38]. S. Devarakonda, P. Sevusu, H. Liu, et al., “ Real-time air quality monitoring through mobile sensing in metropolitan areas”, In Proceedings of the 2nd ACM SIGKDD international workshop on urban computing , pp. 1-8, 2013.