International Journal of Computing and Artificial Intelligence

E-ISSN: 2707-658X
P-ISSN: 2707-6571
IJCAI 2022; 3(1): 50-54
Received: 20-11-2021
Accepted: 23-12-2021

Saraswati Kumari
Assistant Professor,
Department of CSE,
Quantum University,
Roorkee, Uttarakhand, India

Reena Rauthan
Assistant Professor,
Department of CSE,
Quantum University,
Roorkee, Uttarakhand, India

Corresponding Author:
Saraswati Kumari
Assistant Professor,
Department of CSE,
Quantum University,
Roorkee, Uttarakhand, India

Air quality monitoring system for IOT based smart city applications

Saraswati Kumari and Reena Rauthan

DOI: https://doi.org/10.33545/27076571.2022.v3.i1a.47

Abstract
It is critical to keep essential air pollutants within the World Health Organization's (WHO) prescribed levels in order to counteract the rising number of people killed by the accompanying health concerns. This is particularly true in enclosed spaces, wherein poor ventilation can amplify the impacts of pollutants. Knowing the amount of contaminants in the air would be a good starting point for taking measures to mitigate. This paper proposes a domestic air pollution monitoring system based on the Internet of Things framework. Two CO_2 and PM2.5 sensor that are essential for air pollution monitoring with adjusted air quality forecasting are being sent to the cloud via a LoRaWAN protocol compatible gateways that connects the sensor to the server side of the network. The designed Web-based user interface dashboards enable the users to query the system and retrieve data as well as analytical data. Baseline techniques are designed and deployed to make it easier to configure triggers for each sensor node and transmit notifications when a measured parameter surpasses a defined threshold value.

Keywords: Air quality monitoring and control, internet of things, LoRa protocol, and smart city applications

1. Introduction
IoT is prevalent because it is a network of various devices that are linked through the internet. IoT refers to a collection of several sorts of everyday products and devices utilized in various industries that are widening the aspect of the internet. Because these gadgets are connected to the internet, they may exchange and receive data with other items. The internet of things refers to a network of gadgets that may exchange and receive data from other devices over the internet [1, 2, 3].

A smart city is a concept for urban development that combines information and communication technology with IoT in a safe way to manage municipal assets. The key objectives of the smart city vision are as follows.

- To make use of public resources effectively.
- To increase the quality of service offered to citizens by the government.
- To reduce operational cost and public administrations.

An urban IoT which is a communication infrastructure that provides simple, unified and economical access to the citizen is employed to achieve the above objectives of smart city. The features that are taken in the development of smart city are discussed below.

1.1 Structural health of buildings
- In smart city proper maintenance of historical buildings is achieved by incorporating suitable sensors in buildings such as vibration sensors, deformation sensor, temperature sensor, humidity sensor and atmospheric agent sensor. The information from those sensors are collected and stored in distributed data base provided by IoT to monitor building stress, pollution level and environment conditions. These sensors are interconnected and connected to controller to maintain buildings.

1.2 Waste Management
- The cost of service and the problem of storage leads waste management complex. In IoT based waste management intelligence waste containers are employed, which detect the level of load and allow optimizing collector truck's route to reduce cost of waste collection. These containers are connected to control centers to determine the optimal management of collector truck.

1.3 Air quality

- Pollution sensors incorporated for monitoring air quality in crowded areas, parks and fitness trails. The communication is provided between sensors and jogger's devices that allow people to find the perfect path without pollution.

1.4 Noise Monitoring

- Urban IoT offers a noise monitoring service which uses a noise detector or an environment microphone to measure the amount of noise produced by particular area. A space-time map of noise pollution is constructed in an area to prevent noise pollution.

1.5 Traffic congestion

- In order to reduce power consumption of available camera based monitoring system, IoT suggest the using of GPS enabled vehicles with noise detector and air quality detector for traffic monitoring.

1.6 Smart parking

- The smart parking service is realized by incorporating rad sensors and intelligence display. An electronic verification based smart parking system is achieved by short range communication technologies such as RFID, Near Field Communication (NFC).

1.7 Smart Lightning

1. This service is included in smart city infrastructure to optimize street lamp intensity according to the time of day, environment, climate condition and presence of people by incorporating sensors.

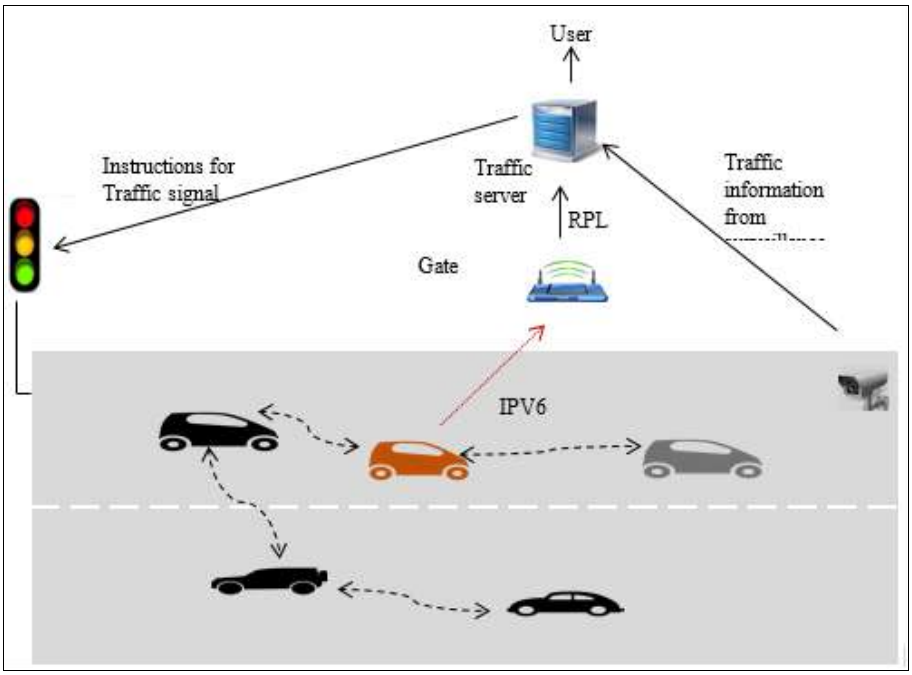

Fig 1: IOT based smart city traffic management

IOT based smart city is realized by integrating these features using IOT to provide seamless services for citizens as shown in Figure 1. The data aggregated from sources is sent to the user and government for smart city management through the internet.

2. Literature Survey

The IOT based data logger for air quality monitoring with the wireless sensor networks are used to monitor the air quality and provide alerts. In the digital era, the novel technology and applications are used to analyze and measure various air parameters in the distance and remotely monitor the quality of air. The applications of IOT have its own characteristic domains to affect all the general functions. The monitoring system is has the huge and significant role in every data process [4]. The automation in air quality monitoring system permits to include the real time and dynamic papers in the process. The internet of things and embedded system technologies are developed to measure the various parameters related to the air quality monitoring system. The environmental monitoring system includes humidity, temperature, pressure sensors and etc. The sensor used in this process includes the functions of capturing the physical and chemical air quality values and convert then to an electrical signal and then to an electronic card. The system is completely functioning through technology based on internet of things. The drawbacks in IoT based data logger for air quality monitoring system with the wireless sensor networks are

- Can't completely predict the value
- Impossible to calculate the future with certainty

The satellite soil moisture data is function through monitoring the impacts of climate change. The influences of climate change are increased and that become more predominant in the previous era and the change impacts that consists some hurricanes and that are destructive, severe droughts, damaging wildfire seasons, increased coastal flooding and many more. The air quality monitoring system includes the alerting process for the day of being and processing the default functions and it is beneficial for the farmers and other resource persons to complete that in detail [5]. The monitoring impacts of climate change includes the developments in soil moisture estimates and it is possible to enhance the monitoring and early warning systems based on the relay and for the better mitigation process of extreme air

quality events. It has the functions to prevent soil moisture through providing the alert messages with the help of the monitoring system. The satellite soil moisture data through air quality monitoring has some drawbacks such as

- Limited power of computer
- Lack of ability to reproduce the atmospheric occurrences

The nature has its own power and it creates various disasters and the world has to face such disasters. The air quality and climate create the disasters such as winter storms with freezing temperatures, cyclones and storms, droughts and wildfires and more. In this state, air quality forecasting and forewarning to the people about the air quality alerts is even more essential to save the lives and properties of the people. The audio transmission is used for the purpose of alerting the people and this process requires the finest quality and clarity in audio. The proposed work states the design, testing and building the audio quality forensics system and that is functional for network measurements, radio and equipment parameters to monitor the quality of audio [6]. When this process occurs in failure, the transmitter stations are used with its multiple connectivity features for the functions and alert the transmission operators. The analysis process supports at the problem transmitter sites in improving audio quality. The air quality forecasting and forewarning the public with the air quality alerts and that save the lives and property immensely. The audio transmission for alerting the local infrastructure and the process of being intensity functions in the directional concept of the data functionalities in the crucial data functions to the preceding data quality implementation. The objective skilled listener techniques are also used in this system. The following is about the limitations of proposed system

- Variations
- Uncertainty

The synthetic aperture radar (SAR) is used to provide the accurate monitoring about earth surface deformation and the data about troposphere and in addition this synthetic aperture is considered as the significant technique in this field. The developments in air quality forecast accuracy are formed with the main intention to restrict the social and economic destruction. Notably, the numerical air quality prediction models are functional in the development of their capabilities with the provision of high resolution description of the atmosphere [7]. The planetary boundary layer, radioactive transfer and microphysics are the significant physical processes which are provided with the high resolution description of the regional scale atmosphere in the numerical air quality prediction and in addition with the large growth of computational resources. The satellite remote sensing is used to provide the various kinds of data in both the atmosphere and earth surface. The interferometry (INSAR) is also considered as the notable technique. It is used to measure the earth surface displacements along with the meticulousness. The boundaries in the system are listed out in the following

- Incomplete understanding of the climate system
- In accurate representations of complex natural interconnections

Air quality is required for building energy simulation and the energy efficient retrofitting subsequently with the energy building in high air quality dependent. The generated data about air quality is used in the process with simulation tools through the urban climate stations. The spatial and temporary variations in air quality and the gaps are exists in typical year air quality and peri-urban area air quality. The creations of simulation technologies are the most popular and efficient methods in the absence of actual energy and with the input parameters such as air quality, load profile data, building physical parameters and occupancy. The difference among the urban micro climate in SEU, station and EPW are calculated through the characteristics of air quality datasets. The solar radiation is influenced with the building energy usage through the interaction among heat transformation and the provision of solar energy such as the electricity production of solar energy and the solar hot water [8]. The temperature is considered as the significant climatic parameter with the thermal perception and energy building demand. The process of subsection is extracted and that is compared with the characteristics of average, maximum and minimum temperature level in every day process. The disadvantages in the air quality monitoring system are noted down.

- Limits in the computing power
- Resulting in model breakdowns

3. Air Quality Monitoring System

In recent days, there is various automated air quality forecasting systems and satellite based air quality observations are available to collect the environmental parameters. The collected data have to be functional as soon as possible which means the immediate process and that includes the data transformation process. Air quality monitoring system is used to track the data based on air quality conditions and transfer the data to the cloud servers. This system is used to monitor and update the air quality conditions which are surrounding the environment. In addition, the environmental conditions are tracked and the data is collected from the sensors and storing the cloud for analysis process to send the alerts messages when the situation is abnormal. The IOT application is even more efficient to monitor the environmental conditions through its speedy process. It is beneficial in monitoring the real time air quality conditions and system includes several sensors to monitor the temperature of rain value, pressure of the system, humidity, region and etc.

Air quality monitoring equipment is used to keep track of the ever-changing climatic conditions. The data collected by such sensors is used to forecast air quality as well as to keep track of environmental changes at a given place. Such data is especially useful in the study of the earth and the analysis of changing climatic and environmental variables at a given area. Furthermore, the collected data and analytics may be used to a variety of applications such as agriculture, geology, mining, and air quality predictions. This project involves the development of a simple air quality monitoring system capable of detecting a location's temperature and humidity.

Because of the IOT devices, the system is fully functioning. The DHT 11 temperature and humidity sensor is linked to the Raspberry Pi, the Microsoft Azure IOT Hub, and the Microsoft Azure IoT Edge solution. The sensor detects temperature and humidity, and the findings are displayed on an LED screen mounted on top of the device. The board is still connected to a remote server and is sending sensor data to the cloud service for further analysis. The air quality

monitoring system monitors data from the cloud service, providing for real-time data access and operation without the need for human involvement.

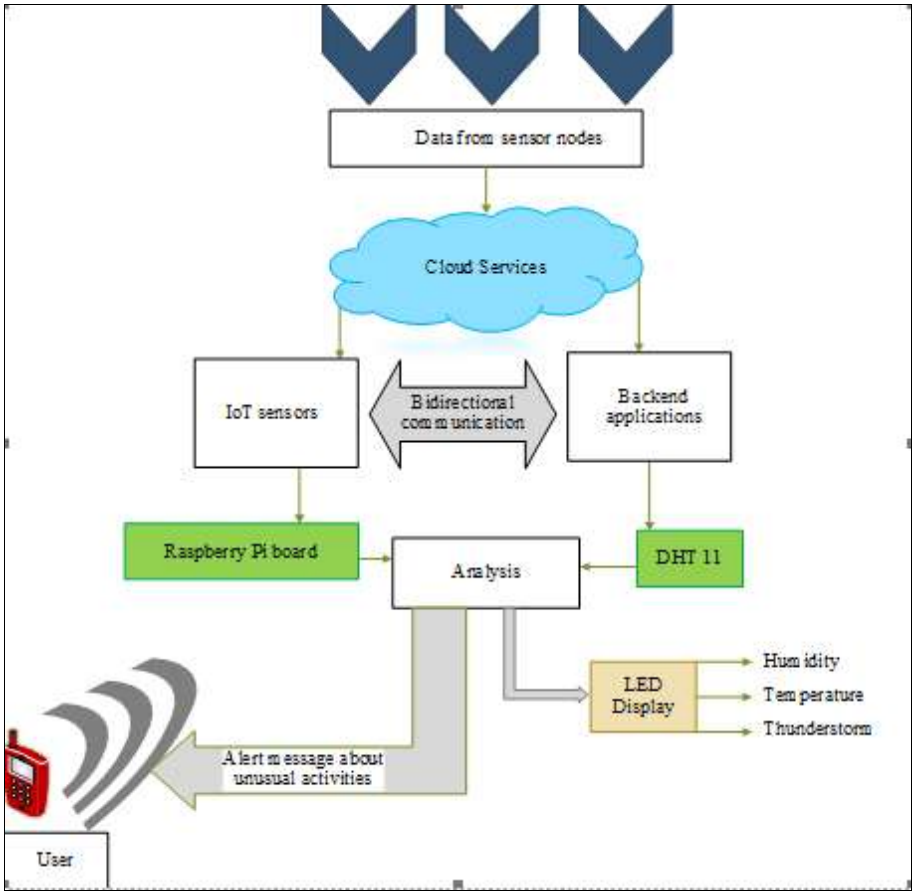

Fig 2: Architecture for Air quality Monitoring

4. Experimental Results

As all of the nodes deployed are energy restricted, energy is one of the important metrics to consider. Data transmission is enabled on nodes that have a certain amount of energy deployed until the energy level is totally depleted. The main cause of increased energy consumption is the choice of a longer route to reach a destination and increased mobility. The reduction in overall energy usage leads to an increase in network lifespan.

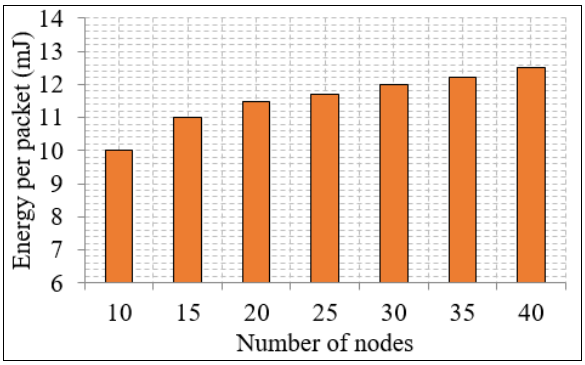

Fig 3: Energy utilization vs. No of Sensors

Delay is a QoS statistic that is used to evaluate the proposed network's performance. This measure rises as the number of hops grows, as does the time it takes for a packet to arrive. Traditionally, multi-casting packets have a specific waiting period to avoid collisions, however this results in a larger latency.

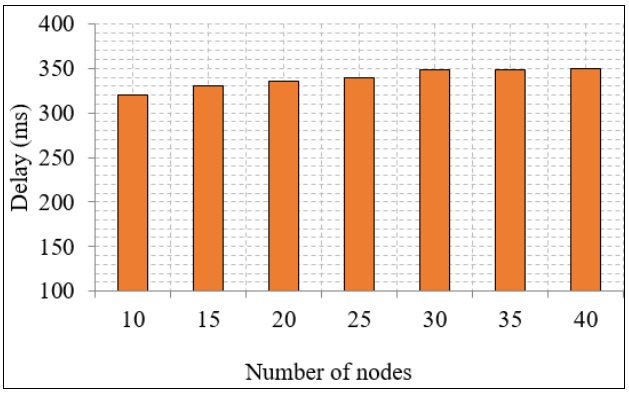

Fig 4: Delay vs. No of Sensors

5. Conclusion & Future Work

Internet of Things is materialized as a novel technology which can be make use of data stuck between the sensors node and accumulating data from environment and the cloud computing service. This is the smart way to monitor the air quality; in addition an efficient and low cost edge computing system is presented with different functions in this research paper, enabling edge computing in an IoT based air quality monitoring application. To implement this method need to organize the sensor nodes in the rural areas for collecting the data and analysis process. In addition, it has significant prospective construction of the IoT applications with the well-organized work. In this proposed system we have introduced a novel framework for the

functions of air quality monitoring application. This is used to develop the system which provides alert message for end users about the abnormalities in the air quality parameters.

6. References

1. Kaiyi L, Hengyuan K, Huansheng M, Fan Z. Design of a New Generation of Weather Radar Intelligent Temperature and Humidity Monitoring System Based on Zig Bee. 2019 International Conference on Meteorology Observations (ICMO), 2019, 1-3.
2. Peuch V, Engelen RJ, Ades M, Barre J, Inness A, Flemming J, *et al*. The Use of Satellite Data in the Copernicus Atmosphere Monitoring Service (Cams). IGARSS 2018 IEEE International Geoscience and Remote Sensing Symposium, 2018, 1594-1596.
3. Carlson DE, Hsieh Y, Collins E, Carin L, Cevher V. Stochastic Spectral Descent for Discrete Graphical Models. IEEE Journal of Selected Topics in Signal Processing. 2016;10:296-311.
4. Forgotson C, O'neill PE, Carrera ML, Belair S, Das NN, Mladenova IE, *et al*. How Satellite Soil Moisture Data Can Help to Monitor the Impacts of Climate Change: SMAP Case Studies. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. 2020;13:1590-1596.
5. Mishra A, Bagui S, Compo J. Design and Testing of a Real-Time Audio-Quality Feedback System for Weather Broadcasts and a Framework for a Weather Broadcast Transmission Technology Switch. IEEE Access. 2019;7:158782-158797.
6. Pierdicca N, Maiello I, Sansosti E, Venuti G, Barindelli S, Ferretti R, *et al*. Excess Path Delays From Sentinel Interferometry to Improve Weather Forecasts. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. 2020;13:3213-3228.
7. Wang W, Li S, Guo S, Ma M, Feng S, Bao L. Benchmarking urban local weather with long-term monitoring compared with weather datasets from climate station and Energy Plus weather (EPW) data. Energy Reports, 2021.
8. Halbach K, Möder M, Schrader S, Liebmann L, Schäfer RB, Schneeweiss A, *et al*. Small streams-large concentrations? Pesticide monitoring in small agricultural streams in Germany during dry weather and rainfall. Water research. 2021;203:117535.