ABSTRACT

With the fast developing economy, industrial park construction and production processes, there is increase in the probable issues related to environmental pollution, especially air pollution accidents. Air pollution may be explained as the contamination of the atmosphere by gaseous, liquid, or solid wastes or by-products that can danger human health and welfare of plants and animals or produce undesirable odors. The air pollution monitoring has been emerged as a critical issue in developing countries such as India. Recently, in Delhi, AQI has crossed the bar of 1000, which may cause enormous breathing problems, cancer-like diseases and chronic respiratory conditions to the citizens of the country. Therefore, availing air pollutant concentration information in real time (monitoring) to citizens with handy tools like web and mobile interface help citizens to avoid any health hazards. Along with monitoring air pollutant concentration forecasting is an effective method of protecting public health by providing an early warning against harmful air pollutants. IoT has the potential to monitor air pollution by providing real-time updates related to sudden changes in the air quality. The main motive of this work is to develop complete air quality monitoring system for real time reporting of air pollutants using IoT, along with efficient method for prediction of such air pollutants from the historical data.

Many efforts have been made to monitor air quality using IoT based technologies, still, the air quality monitoring system using IoT is an open research area because of the challenges of IoT discipline such as complex architecture, no standardization, less memory, power consumption, interfacing of sensors, reliable delivery and security. The proposed research work makes the use of light-weight protocol and compatible devices to transmit air quality parameters to the remote server without building or setting up complex network. There are various kinds of "Things" used in the proposed monitoring system that includes NodeMCU (controller), HiveMQ (cloud broker), Sensors, Python Script (Paho MQTT subscriber) and Android. These things coordinate with each other for the purpose of air quality parameter (temperature, humidity, Carbon Monoxide, PM 2.5 and PM 10) collection, transmission, storage and retrieval individually towards the implementation of the complete air quality monitoring system. The proposed research work represents the implementation of power consumption reduction scheme during sensing (reading) phase. Also we have proposed event based transmission method to reduce number of transmissions (messages) which further reduce power consumption. Proposed system is implemented and tested with a variety of Quality of Service levels to confirm the reliability of the system under employed architecture. A

customized web interface and mobile application are designed to represent updates of pollutants at different indoor and outdoor sites. The system also avails data logging in the data base for further analytics and prediction purpose. In this work, deep learning based framework is also proposed to predict air quality parameters such as particulate matters (PM 2.5 and PM 10) and carbon monoxide(CO). Long short term memory(LSTM) neural network based model that processes sequences in both forward and backward direction to consider influence of time steps(observations) in both directions is employed. For further learning and to improve the prediction performance, the stacking of unidirectional layers is implemented. The performance of the model is optimized by fine-tuning of various hyperparameters like epochs, regularization techniques for overfitting resolution, and various merging options for the bidirectional input layer. The proposed model achieves good optimization and performs better than a simple LSTM and RNN based model. Moreover, attention-based mechanism is adopted to focus on timesteps that are more significant for prediction purpose. The addition of self-attention mechanism improves the performance further and works well for longer sequences and extended time horizons also. Experiments are conducted using the recently collected real-world data and results are evaluated using mean square error(MSE) loss function metric.