6. CONCLUSION AND ROAD-MAP

6.1 CONCLUSION

In the proposed work, we have presented a low-cost air quality monitoring system based on the Internet of Things to monitor the air pollutants such as particulate matter 10 and 2.5, carbon monoxide, along with the temperature and relative humidity for indoor and outdoor environments. We have proposed standardized layer architecture(framework) and addressed complex architecture (no standardization) design issues in IoT. The proposed architecture supports features like no relay node requirement or network setup dependency, publisher authentication at broker during the registration phase, and physical level integrity check while reading data from sensors. The architecture uses a cloud broker, which makes it scalable. The architecture uses a topic-based hierarchy for storing published messages at broker that enables support for subscribers with different platforms, i.e., Python script, Android, etc. Also, due to such a topic-based hierarchy, site-specific data distribution to the relevant subscribers can be handled easily. The developed monitoring system is also experimented and tested with a various quality of service levels at the two deployment sites. The motive of quality of service level experimentation is to validate the system's accuracy in terms of data delivery, which is critical for such a real-time air pollutant monitoring system. The obtained results have recorded accuracy of 98% at site 1(outdoor) and 96% at site 2(indoor). A web and mobile interface has been designed to display the measured parameters in near real-time. The implemented monitoring system also decreases the power consumption of the smart node by switching the node into five different modes. With the given power consumption reduction scheme, the battery's lasting life can be increased to 1.7% of the battery's lasting period without any such scheme. Furthermore, the novel event-based data transmission approach is proposed and implemented to reduce the number of transmissions. The reduction in the number of MQTT messages transmission by applying the event-based transmission scheme is demonstrated.

Reliable and precise prediction of air pollution or air quality parameters is of great importance. In the presented work, LSTM based deep learning framework is also proposed to predict air quality parameters. The framework includes forward and backward LSTM based model for learning the influence of other observations on current prediction in two directions. The proposed model is using bidirectional learning with unidirectional further stacking to improve the performance. Optimum performance is achieved with two hidden layers and the CONCAT merging function (out of four merging function alternatives available in Keras) in the proposed model. The model outperforms the simple RNN and LSTM based model. The proposed work is also solving the overfitting issue by applying L2 regularization and dropout methods. The best fit for validation is found with a 0.3 dropout value and 10-5 lambda value under dropout and L2 regularization methods, respectively. The dropout method performs better and achieves a lower value of MSE with good convergence compared to L2 regularization. Finally, self-attention is applied as the last layer in the model. The effect is assessed on two dimensions, for various extended time horizons (Tx,4Tx,8Tx, and 12Tx) and varying input windows (60,80 and 120). The results show significant improvement in the performance with both dimensions. Future work of the current study includes an extension of attention application and model capability in learning the influence of temperature and humidity (recorded at same timesteps) in predicting air quality parameters.

6.2 ROAD MAP FOR FUTURE WORK

We have represented QoS analysis which can assist in implementing an adaptive transmission algorithm during the transmission of the proposed monitoring system in the future. The adaptive transmission algorithm can auto switch the smart node between the various quality of service levels as and when demanded based on the identified critical pollution duration or hours from the analysis.

Moreover, in our implementation the authentication is based on unique client ID which is the only security parameters addressed looking at the limited processing capability of IoT node. However, more security features can be incorporated address in implementation with the help of edge computing in future.

In predicting air quality parameters, we have not applied any mechanism to assess the influence of temperature and humidity recorded over the prediction of particulate matter or carbon monoxide. Future work of the current study includes an extension of attention application and model capability in learning the influence of temperature and humidity (recorded at same timesteps) in predicting air quality parameters.