Contribution ID: **8** Type: **oral presentation**

Development of an integrated Sensor System for Real-Time Measurement of Particulate Pollutants and Environmental Parameters

Wednesday 8 November 2023 10:35 (15 minutes)

Air pollution, notably the presence of particulate matter, poses substantial hazards to both human health and the natural environment. The current particulate matter monitoring systems suffer from a practical limitation that they can measure particulate matter concentrations at only a single spatial point. This limitation constrains the ability to comprehensively understand the dynamics of particulate matter distribution. This study developed an internet of things-enabled sensor system to infer spatial particulate matter concentrations. Data collection nodes measured particulate matter concentrations across three scales (PM10, PM2.5 and PM1.0), the three weather parameters (wind speed, ambient temperature, and humidity), and spatial information (latitude and longitude), which were logged into a cloud-based server. Various machine learning models, such as Long Short-Term Memory, Artificial Neural Networks, Support Vector Regression, and RandomForest were trained using these datasets to predict spatial particulate matter distribution. The study found that Artificial Neural Networks exhibited superior accuracy based on Mean Absolute Error values, with high Rˆ2 scores (>0.99) and low Root Mean Square Error values. However, beyond 100 meters from the reference node, prediction accuracy declined (<75%), highlighting the importance of spatial proximity. The findings of the study provides insights into a new approach for designing particulate matter sensors with capabilities extending beyond the limitations of the current single-point measurement approach. Moreover, the research shed light on the significance of including different weather parameters in the training process of machine learning models for predicting the spatial distribution of particulate matter within a specified radius.

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Session Classification: Design & Testing of IoT-based Air Quality Monitors

Track Classification: Design & Testing of IoT-based Air Quality Monitors