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Purdue Air Sense: A Methodology for Improving the Accuracy of Ambient Aerosol Mass Concentration and Size Distribution Measurement with Low-Cost Optical Sensing Techniques

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ABSTRACT

There is a global lack of a means for monitoring air pollutant levels at a local level due to expensive and bulky instrument requirements. It is important to monitor toxic gas levels, as well as particulate matter levels, in the atmosphere to study their effects on human health and to further develop city- and community-level air pollution solutions. In this study, with the means of a Raspberry Pi, low-cost Alphasense Optical Particle Counter and gas sensors, and methodical calibration techniques, we built a portable 3-D printed module powered by clean electricity generated by an on-board Voltaic solar cell that measures concentrations of ozone, NOx, CO and CO2 as well as coarse and fine particulate matter (PM) in ambient air. To calibrate these sensors, we used laboratory-grade reference instruments as the benchmark and set it up so that the calibrated data is displayed on the Purdue AirSense website in real time. We also accounted for temporal and humidity variations and generated PM size distribution plots under 0.3 microns in diameter, which the low-cost sensors are not able to detect, using regression techniques. This module can be used in many remote areas for air monitoring and implementing localized solutions to the air pollution problem. Moreover, due to portability, it can also be used on vehicles for vehicle pollution monitoring, and in classrooms, for educating the public about air quality monitoring.

KEYWORDS

Ambient Air Quality Monitoring, Data Integration Platform, Big Data, Data Visualization, Low-cost Sensing, Air pollution, Environment, Sensors, Low-cost, Software, Internet of Things