Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
XXXVI cycle

Supervisor
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Security and Reliability in Pervasive Computing

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1. Introduction / Context

Particulate Matter (PM) are microscopic particles suspended in the air. They can be the cause of strokes, heart disease, and lung cancer. Monitoring is usually performed by environmental agencies using sparse networks of high-cost, high-precision fixed devices, which achieve low spatial and temporal granularity. Low-cost light-scattering sensors can enable the creation of higher-resolution networks at lower costs. However, they suffer from low precision and accuracy and are subjected to frequent faults.

2. Goal / Objectives

The research concerns the development of a low-cost IoT system for monitoring PM. It focuses on the acquisition, transmission, and processing of measurement to obtain a reliable estimation of PM values.

3. Monitoring stations

Low-cost monitoring stations are composed of 4 PM sensors, 1 pressure sensor, 1 humidity and temperature sensor, and 1 GPS receiver. A high-precision ARPA station acts as a reference for calibration.

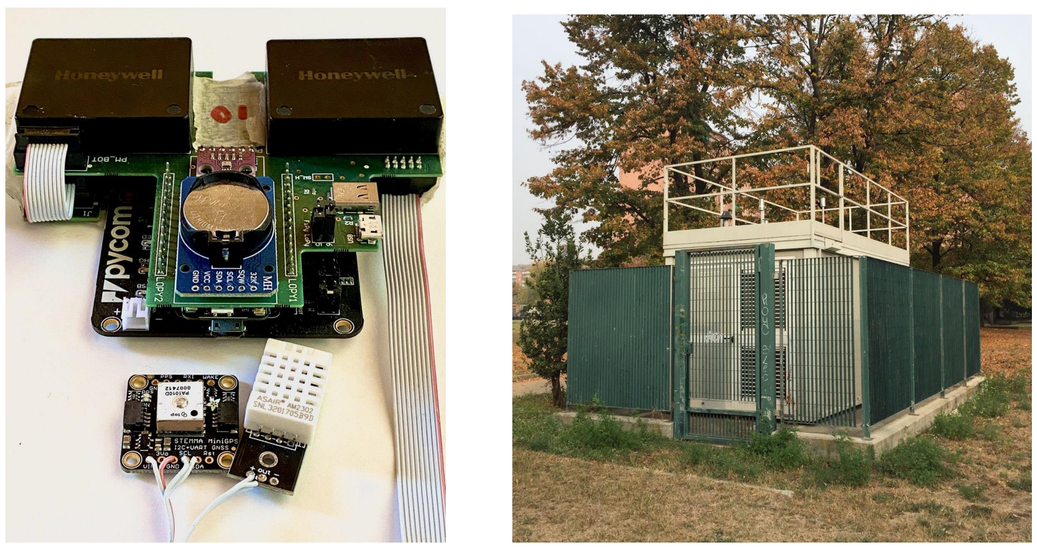

***Fig.1**: Low-cost monitoring station (left), ARPA reference station (right)*

4. Calibration

Calibration is performed with Multivariate Linear Regression, targeting the ARPA reference. Independent variables are PM and relative humidity. The model is influenced by outliers, so threshold, gaussian and z-score filters have been adopted.

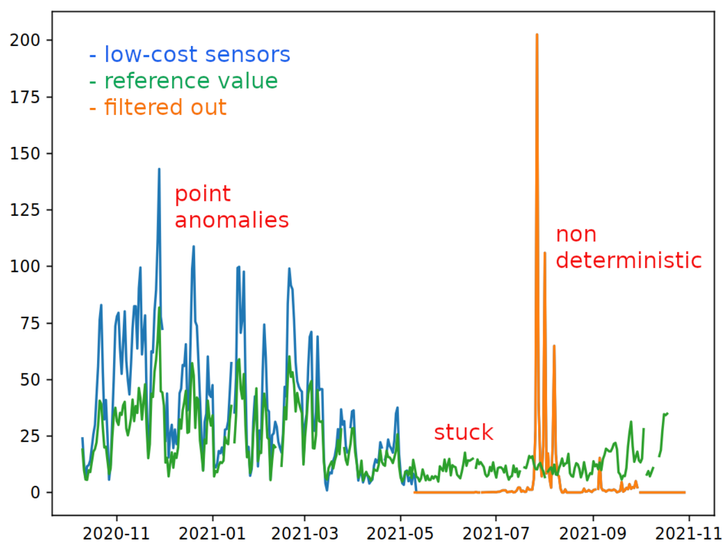

***Fig.2**: anomalies in low-cost light-scattering sensors*

5. Duty cycle analysis[1]

Duty cycle changes of the PM sensors have been simulated on a dataset containing 6 months of 1-second measurements, to evaluate how increasing power-off times influences the quality of hour aggregates, while reducing power consumption.

6. Participative system

A participative system has been prototyped where citizens' smartphones act as a BLE gateway between the sensors and the data storage server. The objective is to increase deployment possibilities while reducing the cost and complexity of the infrastructure.

References

1. P. Chiavassa, F. Gandino and E. Giusto, "An investigation on duty-cycle for particulate matter monitoring with light-scattering sensors," 2021 6th International Conference on Smart and Sustainable Technologies (SpliTech), 2021