Real-time measurements and analysis of air pollution parameters

Nikola ZARIC [1], Velibor SPALEVIC [2], Branislav DUDIC[3], Nikola BULATOVIC [1], and Nikola PAVLICEVIC [4]
[1] University of Montenegro, Faculty of Electrical Engineering
[2] University of Montenegro, Faculty of Philosophy
[3] Comenius University in Bratislava, Faculty of Management, Slovakia
4 ZTE Corporation, Technical Support Office in Montenegro

INTRODUCTION

Outdoor air pollution is among the four major causes of mortality worldwide and it was responsible for more than 5 million of deaths per year at global level according to World Health Organization. Additionally, European Environmental Agency reports from 2018 and 2019 tell us that the most polluted countries in Europe are Balkan countries. It is important to mention that during 2018 some of the Balkan countries lack the official PM10 or PM2.5 measurements (Particulate Matter), including Montenegro.

In this paper we are presenting the analysis and results of the PM10 and PM2.5 parameters measurements using custom-designed and developed EcoMaR monitoring and reporting system. Measurements were performed in Montenegrin capital city of Podgorica at four locations, during several months in 2018. EcoMaR's measuring system performance is analyzed in terms of reliability, data validity, measurement precision and operating stability.

MATERIALS AND METHODS

The structure of the EcoMaR system is based on the novel Internet of Things standards which comprise basic functional parts such as control logic (microcontroller unit), air quality PM sensors, communication wireless module and solar power supply (Figure 1). The microcontroller unit controls the data flow and it serves as a link between the air qualities PM sensors and cloud based web application. Particle sensor SDS011 was used for PM2.5 and PM10 measurements. The SDS011 is a low cost PM sensor, classified as an optical sensor as it measures PM10 and PM2.5 through the principle of light scattering. Collected and processed data are then sent by communication module to the web application so it can be visualized and displayed in real-time.

RESULTS

EcoMaR system is designed to continuously collect several PM measurements within one hour period. Data are averaged upon finished hour and stored in cloud database. Daily one-hour measurements are then displayed as box plot diagrams. Also, daily mean PM values are calculated and plotted as blue solid circles in figures 2 and 3. Podgorica 1 Data values are confined from 0 to 200 μg/m^3 and all the values outside this range are considered as outliers. EcoMaR system was installed near one of the most frequent boulevards in the city. Figures show us some proportionality in the PM10 and PM2.5 measured values. The values are becoming lower reaching the end of spring.

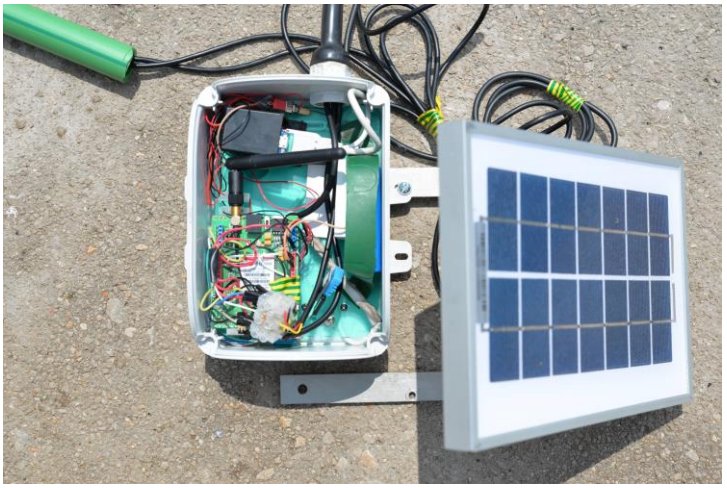

Figure 1. EcoMaR air pollution electronic system design with solar power supply.

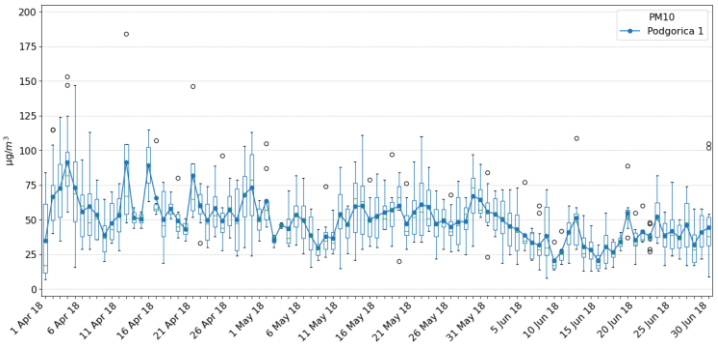

Figure 2. Box plot diagram of PM10 parameter measured in Podgorica, Montenegro, during April, May and June 2018.

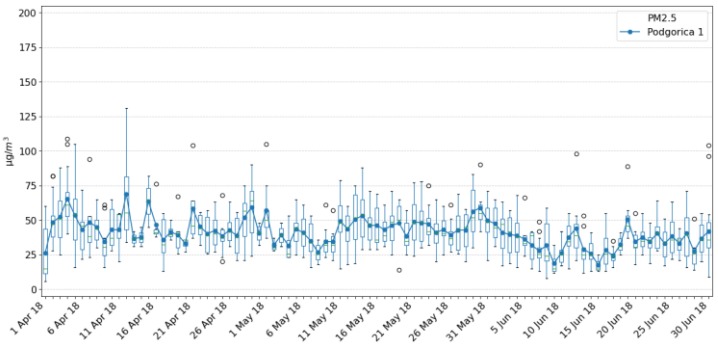

Figure 3. Box plot diagram of PM2.5 parameter measured in Podgorica, Montenegro, during April, May and June 2018.

CONCLUSIONS

We may conclude that measurements of the low-cost sensor based systems could provide a rough estimation of the PM level with higher spatial and temporal resolution, which could be of high importance.