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A low-cost 3D printed system for monitoring meteorological characteristics in citizen-science projects

Peter Valent, Roman Výleta, Michaela Danáčová, and Mihaela Labat

Slovak University of Technology in Bratislava, Faculty of Civil Engineering, Department of Land and Water Resources Management, Bratislava, Slovakia (pevalent@gmail.com)

Monitoring of meteorological characteristics plays an important role in solving numerous water resources management tasks including the estimation of water balance, the building flood warning systems, or the design of smart irrigation schemes. High spatial and temporal variability of these characteristics puts an increasing demand on sampling frequency and density of monitoring network. This is especially important in case of small-scale applications in which higher sampling frequency is a must, and the data from remote locations have a small informative value. Until quite recently, the relatively high cost of the commercial automatic data collection, transmission, and management systems was the main reason restricting a broader deployment of such applications in both scientific and commercial domains. Over the last years, smart solutions in water management have gained importance with advancements in low-cost open-source electronics, sensors, and ready-to-use communication platforms.

This study presents a low-cost solution for monitoring basic meteorological characteristics such as air temperature, relative humidity, atmospheric pressure, and precipitation totals. The electronics and the software of the station are based on an open-source Arduino platform, which maintains the communication between the individual sensors, controller, and an external database for data storage. The station enables to perform the monitoring in an arbitrary time step, pre-process the data, and store it either locally on a memory card or send it to a database server using the means of wireless communication. In order to further decrease the cost of the station and to speed up the process of its prototyping its body was printed on a 3D printer using a fused filament fabrication technology, and an ABS thermoplastic material. A calibration of a tipping-bucket rain gauge, measuring the precipitation totals, was also conducted, and its precision and accuracy were evaluated in laboratory conditions. The results showed that a good agreement could be achieved when compared to a commercial rain gauge for only a fraction of its cost.

The low cost of this type of instrumentation makes it possible to use it in applications in which there is a high chance of it being damaged or even lost (observation of, e.g., flood events, landslides, sediment flux). Moreover, the open-source aspect of this project favours its use in citizen-science partnerships, which are becoming very popular for their supplementary role in modelling, monitoring, and management of water-related applications.

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