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Low cost precipitation measurement in remote areas

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Accurate measurements of atmospheric precipitation play an important role in solving a large variety of water management problems. The relatively low spatial and temporal resolution of the monitoring network in remote areas puts significant constraints on its use in small-scale studies, where a high spatial and temporal resolution is a must. Until quite recently, the high cost of the commercial devices that have to be deployed to fill in the gaps in space and time domains was very often the main factor restricting the focus of both scientific research and commercial applications on larger scales. The first decades of the 21st century brought about massive advancements in the field of low-cost electronics, sensors, and rapid prototyping techniques. Moreover, a number of open source software solutions came into existence that provides ready-to-use tools to store, analyse and transfer data. This inspired a large community of scientists and makers to build their own prototypes of measuring instruments or dataloggers, often for a fraction of the cost of the commercial devices that comply with their specific needs.

This study presents the process of the development and calibration of a low-cost rain gauge for measuring atmospheric precipitation. The prototype was designed as a two-chamber tipping-bucket rain gauge built around the Arduino open-source electronics platform. The advent of 3D printing enabled the rapid prototyping of the mechanical parts of the rain gauge, which are made of a durable ABS thermoplastic material. The study also presents the process of rain gauge calibration, with both volumetric and dynamic calibration procedures used. The rain gauge was set at a resolution of 0.5 mm with a standard deviation of ±0.01 mm. The results of the dynamic calibration also showed that the behaviour of the rain gauge complies with that of the commercial devices.

The low cost and precision of this type of instrumentation make it ideal for applications in which there is a high risk of its being damaged or even lost. In addition, the open-source aspect of the project, its low-cost, and the relatively minor requirements for its construction make it a good candidate for use in citizen-science partnerships, which are becoming very popular, mainly due to their popularization benefits.