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Exploring the Feasibility of Low Cost Technology in Rainfall Monitoring: The TREBOADA Observing System †

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Abstract: In order to characterize the spatial and temporal variability of the rainfall, we have developed an observation system to monitor the precipitation over the metropolitan area of A Coruña. The observation system (called TREBOADA) consists of a network of rain gauges, comprising gauges operated by the regional weather agency and rain gauges deployed specifically for TREBOADA. The latter ones are built using low cost technology, which significantly reduces the cost of each gauge. Data from the rain gauges are combined with rain observations from the meteorological radar to produce high resolution rain products.

Keywords: Environmental monitoring; low cost technologies; Arduino

1. Introduction

Urban environments are becoming more vulnerable to flood events due to multiple factors. On the one hand, the changes in the land use and the rapid urbanization have increased the amount of rainfall conveyed to the streams and drainage systems. On the other hand, the climate change has increased rainfall intensities and decreased rain frequency, resulting in higher peak discharges and more likely flash floods. Against this background, increasing the resilience of the cities is the recommended approach [1]. This strategy demands observing and forecasting systems capable of accurately monitoring the rainfall. To explore the feasibility of low cost technologies in this field, we have developed an observing system which combines data gathered using low cost devices with data freely obtained from the regional weather agency (MeteoGalicia).

2. System Description

The TREBOADA observation system computes the spatial and temporal evolution of the rainfall, combining rain data from three sources: low-cost rain gauges specifically developed for this observation system, rain gauges operated by MeteoGalicia and rain data from the meteorological radar also operated by MeteoGalicia.

To combine these data, the krigging with external drift methodology is used [2]. Every 10 min, this interpolation technique is performed to produce a map showing the distribution of the rain intensity over the metropolitan area of A Coruña. This map is made publicly available through a web app [3], which contains a GIS (Geographical Information System)-based viewer and graphs of the rainfall registered by the rain gauges during the last few hours.

The low cost gauges comprise a pluviometer, a processing module and a power supply module (Figure 1). The pluviometer used is an AeroCone tipping bucket gauge, manufactured by Davis. Tipping bucket rain gauges collect the rainfall with a funnel, which conveys water to one of two

calibrated buckets, balanced on a pivot. When the bucket fills up its weight tips the pivot, rising the other bucket and locating it beneath the funnel. The movement of the pivot also triggers a reed switch and empties the first bucket.

The processing unit consists of an Arduino MKRFOX 1200 and an external DS3231 real time clock (RTC). The power supply module consists of a 6 W 12 V solar panel (Fadisol C-0154B), connected to a Yuasa 12 V 4 A battery through a solar charge controller (Fadisol C-0189). The output of the battery is connected to the Arduino through a step-down, to power the device with the adequate voltage. The power module was designed to guarantee energy supply during long periods even in case of failure of the solar panel. The Arduino samples the number of pulses of the pluviometer's reed switch and sends the amount of rainfall registered and the corresponding time to a server located in the CITIC (Centre for Information and Communications Technology Research, University of A Coruña) using the Sigfox Communication Network.

Remarkably, the cost of the processing and power supply modules is around 150€, which represents around 15–20% of the cost of the equivalent modules provided by the most frequent manufacturers of meteorological instrumentation.

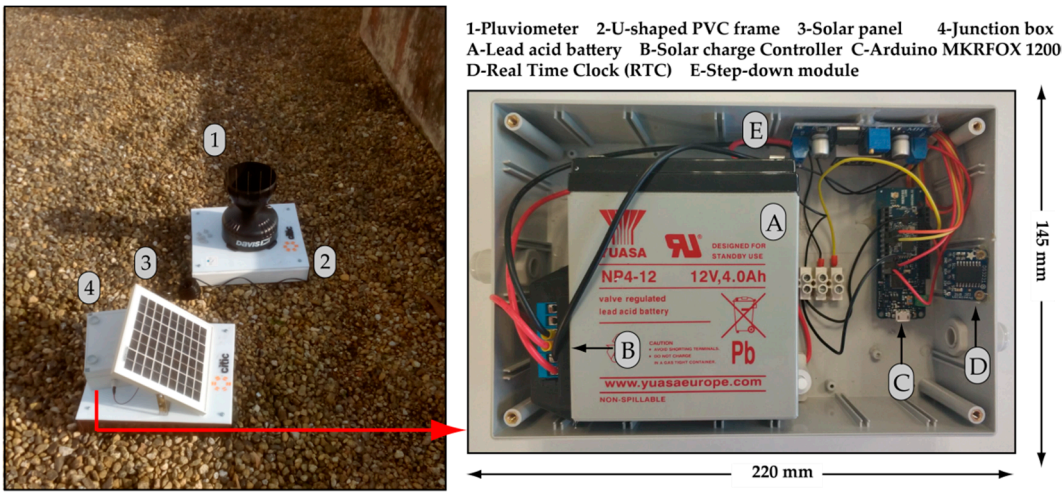

Figure 1. Low-cost rain gauges developed in the TREBOADA observing system.

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Conflicts of Interest: The authors declare no conflict of interest.

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