

Development of a smart rain gauge system for continuous and accurate observations of light and heavy rainfall

Byungjoo Han*, Yeontaek Oh**, Hoang Hai Nguyen***, Woosung Jung****, Daeyun Shin*****

.....

Substance

Improvement of old-fashioned rain gauge systems for automatic, timely, continuous, and accurate precipitation observation is highly essential for weather/climate prediction and natural hazards early warning, since the occurrence frequency and intensity of heavy and extreme precipitation events (especially floods) are recently getting more increase and severe worldwide due to climate change. Although rain gauge accuracy of 0.1 mm is recommended by the World Meteorological Organization (WMO), the traditional rain gauges in both weighting and tipping bucket types are often unable to meet that demand due to several existing technical limitations together with higher production and maintenance costs. Therefore, we aim to introduce a newly developed and cost-effective hybrid rain gauge system at 0.1 mm accuracy that combines advantages of weighting and tipping bucket types for continuous, automatic, and accurate precipitation observation, where the errors from long-term load cells and external environmental sources (e.g., winds) can be removed via an automatic drainage system and artificial intelligence-based data quality control procedure. Our rain gauge system consists of an instrument unit for measuring precipitation, a communication unit for transmitting and receiving measured precipitation signals, and a database unit for storing, processing, and analyzing precipitation data. This newly developed rain gauge was designed according to the weather instrument criteria, where precipitation amounts filled into the tipping bucket are measured considering the receiver's diameter, the maximum measurement of precipitation, drainage time, and the conductivity marking. Moreover, it is also designed to transmit the measured precipitation data stored in the PCB through RS232, RS485, and TCP/IP, together with connecting to the data logger to enable data collection and analysis based on user needs.

Preliminary results from a comparison with an existing 1.0-mm tipping bucket rain gauge indicated that our developed rain gauge has an excellent performance in continuous precipitation observation with higher measurement accuracy, more correct precipitation days observed (120 days), and a lower error of roughly 27 mm occurred during the measurement period.

Keywords : Weighing type, Tipping bucket type, Loadcell, Precise continuous observation, AI quality control

* Non member·Manager, Sejong Rain Co., Ltd, Graduate student, Mechanical system engineering, Chungnam national university·E-mail : hjae9334@gmail.com

** Non member·Manager, Sejong Rain Co., Ltd·E-mail : lab_777@nate.com

*** Member·Junior research engineer, Sejong Rain Co., Ltd·E-mail : hai.nh1812@gmail.com

**** Non member·Senior research engineer, K-water research institute·E-mail : usjung@kwater.or.kr

***** Corresponding author·Member·CEO,Sejong Rain Co., Ltd, Graduate student, Smart farming graduate school, Chungnam national university·E-mail : pushindy@gmail.com