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OpenRiverCam, open-source operational discharge monitoring with low-cost cameras

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River flow observations are notoriously difficult to sustain. A site's setup,operation and maintenance requires expensive equipment, repetitive field work, and physical contact of instruments and people with water. These issues compounded with the fact that rivers may change their course and behaviour in time, and sites are mostly bound to river crossings such as bridges, make equipment susceptible to theft and vandalism. Over the last decade, several contributors in science have pioneered the use of computer vision methods such as Particle Image Velocimetry, Particle Tracking Velocimetry, and Dense Optical Flow to measure stream velocities, and interpret river flow from short movie snapshots. This has resulted in research oriented software such as FUDAA-LSPIV and a limited set of proprietary software aimed for operational use.

In this contribution we will share and demonstrate the first version of OpenRiverCam, a new fully open-source, user-friendly, low cost and sustainable web-software stack with API to establish and maintain river rating curves (relationships between geometry and river discharge) in small to medium sized streams based on the aforementioned computer vision methods. The software is co-designed with practitioners from The Netherlands (Waterboard Limburg and KNMI) and Tanzania (Wami - Ruvu Basin Authority and TMA) with the principle that organizations should be able to establish and maintain operational flow monitoring sites and networks at low costs. We demonstrate it through operational feeds from two first sites (Geul River, Limburg - The Netherlands and Chuo Kikuu - Dar es Salaam, Tanzania).

The software stack will allow a practitioner in hydrology to monitor discharge and maintain a rating curve at low cost with simple yet robust equipment. The required set-up contains a permanent camera providing a view of the river surface and a permanent staff gauge for water level readings. Occasionally a bathymetric survey of the river's cross section is required that can be

performed with standard surveying equipment. The open source software stack is available at no costs and contains a separate python library for processing in case a researcher wishes to use the stack. The software operates with a web-client that connects to a locally or globally deployable server stack (laptop, desktop, local server or cloud) with database, front-end server and workers, so that scalability is warranted. Other than existing software, OpenRiverCam offers: adding and maintenance of sites and cameras; automated retrieval and processing of movies and rating curve analysis, all in a fully open-source code base. The software can therefore be operated with local people, local devices and open software at any scale leading to job creation and locally sustainable services for National Meteorological and Hydrological Services (NMHS) and their service providers. We plan to extend the software with operational water level measurements and possibly other relevant environmental parameters such as sediment deposit segmentation.