IAHS2017-250
IAHS Scientific Assembly 2017

Measuring surface flow in natural streams through optical methods: large scale particle image velocimetry or particle tracking velocimetry?

Flavia Tauro (1), Rodolfo Piscopia (1), and Salvatore Grimaldi (1)

(1) University of Tuscia, Department for Innovation in Biological, Agro-food and Forest systems, Viterbo, Italy (flavia.tauro@unitus.it), (2) New York University Tandon School of Engineering, Department of Mechanical and Aerospace Engineering, Brooklyn 11201, New York, USA

Optical methods and image analysis have proved efficient approaches to tackle surface flow measurements in difficult-to-access environments and challenging hydro-meteorological conditions.
Even if several experimental applications demonstrate the promise of such approaches, numerous methodological issues still need to be solved for these techniques to provide reliable and repeatable measurements.

Most importantly, the selection of the appropriate image-based velocimetry algorithm plays a key role for optical measurements. Until now, large scale particle image velocimetry (LSPIV) has been widely utilized in the literature. However, recent experimental analyses suggest that particle tracking velocimetry (PTV) may provide a more robust alternative to LSPIV. In this presentation, we present data from twelve experimental videos recorded with an action camera on the Brenta River, Italy, and processed with both LSPIV and PTV. Videos depict a stream reach of the Brenta River on the order of 10 m and, to emphasize surface flow, massive quantities of buoyant tracers are continuously deployed across the entire river cross-section. We compare velocity estimations to benchmark measurements performed with a current meter.

Further, we adopt a similar approach to analyze a video recorded during a moderate flood event on the Tiber River from a gauge-cam station in the city of Rome, Italy. The gauge-cam station is a novel permanent camera-based monitoring apparatus for large scale and continuous observations of surface flows. It enables the remote acquisition and calibration of video data by capturing one-minute videos every 10 minutes over an area of up to 20 x 15 m2 oriented along the Tiber river cross-section. It comprises a system of a wide-angle lens camera and two laser modules for remote image calibration. In accordance with experiments on the Brenta River, the video is analyzed with both LSPIV and PTV, and data from a nearby radar are utilized as benchmark measurements.

Based on our findings, even if ideal experimental settings are artificially imposed (such as abundant and continuous tracers on the Brenta River), videos analyzed through LSPIV consistently lead to underestimated velocities. Conversely, PTV data are in closer agreement with benchmark measurements. In case of more complex settings, such as during the flood on the Tiber River, only PTV estimations yield meaningful results. Generally, PTV is less affected by uneven lighting and is less sensitive to image pre-processing than LSPIV. Moreover, our analyses suggest that PTV-based velocity estimates can be easily verified and validated by appropriately filtering particle trajectories, thus opening novel perspectives for reliable observations in complex settings.