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# A critical comparison of Large Scale Particle Image Velocimetry and Particle Tracking Velocimetry for streamflow observations

Flavia Tauro (1), Salvatore Grimaldi (2,3), Andrea Petroselli (4), and Rodolfo Piscopia (2)

(1) Centro per l'Innovazione Tecnologica e lo Sviluppo del Territorio, University of Tuscia, Viterbo, Italy, (2) DIBAF Department, University of Tuscia, Viterbo, Italy (salvatore.grimaldi@unitus.it), (3) Mechanical and Aerospace Engineering Department, New York University Tandon School of Engineering, Brooklyn 11201, NY USA, (4) DEIM Department, University of Tuscia, Viterbo, Italy

Streamflow data are essential for developing and calibrating rainfall-runoff models. However, since direct velocity and depth measurements are expensive and time-consuming, such streamflow surveys are performed once every several years depending on site complexity, existing number of gaugings, and funding availability.

Noncontact flow sensing approaches present several advantages with respect to traditional methodologies. In fact, instruments are not lowered into the stream, thus limiting flow disturbance and damages during floods. Optical methods based on the acquisition of digital images of the stream surface have been a promising opportunity for inexpensive and noninvasive streamflow monitoring. Image-based approaches rely on the use of low-cost commercial cameras, and information on stream surface velocity is inferred by applying a multitude of diverse algorithms. Popular velocimetry approaches involve the analysis of digital images with large scale particle image velocimetry (LSPIV) and particle tracking velocimetry (PTV).

Progress in image-based streamflow methodologies at the hydrological research level has not been paralleled by the implementation of similar prototypes in environmental monitoring practice. In our opinion, this can be attributed to the fact that technical software protocols for automated image processing are still missing; further, velocimetry algorithms tend to be sensitive to visibility conditions and the occurrence of floating materials on the stream surface. In particular, the accuracy of LSPIV, which is the most frequently adopted algorithm for streamflow observations, is dramatically reduced in case of dishomogeneous surface features, typical of low flow conditions, and adverse sunlight reflections.

In this presentation, we provide results of a study whereby both LSPIV and PTV are tested on a data set of 12 videos captured in a natural stream wherein artificial floaters are homogeneously and continuously deployed. Further, we apply both algorithms to a video of a high flow event on the Tiber River, Rome, Italy. In our application, we propose a modified PTV approach that only takes into account realistic trajectories. Based on our findings, LSPIV largely underestimates surface velocities with respect to PTV in both favorable (12 videos in a natural stream) and adverse (high flow event in the Tiber River) conditions. On the other hand, PTV is in closer agreement than LSPIV with benchmark velocities in both experimental settings. In addition, the accuracy of PTV estimations can be directly related to the transit of physical objects in the field of view, thus providing tangible data for uncertainty evaluation.