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Optical techniques: non-intrusive river monitoring approach

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Technological advances over last decades gave an innovative impulse to development of new streamflow measurements techniques, making possible to implement remote flow monitoring methods that allow for non-intrusive measurements. Here, we focus on image-based techniques that involve the use of digital camera, either installed on a bridge or equipped by a drone (UAVs – Unmanned Aerial Vehicles). The most widely known and used optical techniques are the Large-Scale Particle Image Velocimetry and the Large-Scale Particle Tracking Velocimetry. Optical techniques are based on four main steps: (i) seeding and recording, (ii) images pre-processing, (iii) images processing, and (iv) images post-processing. Tracer, naturally present on the water surface or artificially introduced, is assumed to move jointly with the surface liquid particles. Tracer dynamic is recorded and the resulting videos are processed by specific software, applying a statistical cross-correlation analysis to detect the most probable frame-by-frame tracer displacements. To obtain river discharge, it is then necessary to combine the geometry of the river cross-section with the assessed surface velocity field, often adopting simplified assumptions about the vertical velocity profiles.

The accuracy of these techniques depends on several factors, such as the size of the interrogation area, the seeding density, the video length, and many other aspects related to environmental and hydraulic conditions, that are less investigated in the scientific literature. The aim of this work is to exploit the results of an extensive field measurement campaign on several Sicilian rivers (Italy) to infer useful insights for the parametric setting of the two most popular open-source processing LS-PIV software (i.e, PIVlab and FUDAA-LSPIV). The field campaign includes discharge measures carried out at different sites, taking into account different roughness conditions and cross-sections, and, for each site, in different seasons, accounting then for different environmental and hydraulic conditions. Topographical surveys were preliminary performed on each site to obtain detailed DEMs, which are used in the pre-processing phase for image stabilization and orthorectification. Video sequences were acquired from both bridge and drone, using wood chips as tracer. Benchmark measures were also retrieved by ADCP.