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Monitoring and measuring river flows using image analysis: from concept to operational applications

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The monitoring and measuring of river flows is a key aspect for the implementation of the EU Flood Directive (2007/60/EC). The use of non-contact approaches is essential given the nature of flood flows and the advent of powerful and cost effective imaging devices opens news trends for the development of intuitive and verifiable measurement systems.

Traditional approaches rely on the continuous monitoring of the water level using pressure or radar sensors and frequent field campaigns to remote sites in order to establish and update the state-discharge relationship (rating curve). Water level measurements, critical for flood warning, can be subject to caution during extreme events (sensors can be disrupted, damaged, destroyed or flooded) and the estimation of a reliable rating curve requires manual discharge measurements over many years, which represents a significant cost and effort for hydrological services. Moreover, hydrological extremes are mostly ungauged because using the currently available techniques, operating during flood is risky and the estimates are very uncertain.

Network cameras or mobile imaging devices can be seen as alternative or complementary sensors for the monitoring and measuring of river flows. Using computer vision and image processing techniques, an operational solution was developed. Water level and surface velocity measurements are operated on images sequences.

Given the accuracy, robustness and frequency of surface velocity measurements, numerous discharges estimates can be carried out during a single flood. This enables the rapid establishment and/or updating of rating curves. Moreover, substantial modifications of the river bathymetry can be detected using the monitoring of the cross-section profile of surface velocities (e.g. for a given water level, we observed a change of cross-section profile of surface velocities due to the riverbed erosion/material deposit after a significant flood).

By providing quantitative and verifiable information, the previously mentioned developments contribute to the improvement of flood flows knowledge, which is critical for flood control and early warning systems (e.g. design of hydraulic works, flood alert, calibration and real-time data assimilation of operational hydrological forecasting models). Furthermore, since citizens are equipped with performing and connected imaging systems like smartphones, they can provide essential information for crisis management and/or post-event analysis.