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Evaluation of image-based velocity measurements for computing river discharge in real-time

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Quantifying key hydrological parameters, such as the river discharge, during high flow events frequently faces technical difficulties and is potentially dangerous to operatives. The application of novel hydrological monitoring techniques may reduce these risks, and offers the potential to rapidly advance our understanding of operating processes, which may reduce risk to society. We therefore propose a low-cost non-contact alternative method to determine river discharge in real-time. Our approach is an image-based technique, where video footage is subjected to optical flow tracking algorithms, enabling the displacement rates of naturally-occurring features on the water surface to be computed. This is achieved through the application of the Kanade-Lucas-Tomasi (KLT) particle image velocimetry (PIV) approach. We installed our real-time camera system at the Environment Agency's Austin's Bridge Gauging Station on the hydrologically responsive River Dart (SW UK). Our objective was to compare discharge measurement results obtained with our KLT-PIV method to those from an established and well-proven flow measurement station. We compared our measurements with 73 ADCP transects at discharges ranging from 3-101 m^3 s^{-1} and the official rating curve of the Environment Agency. We obtained promising results, our KLT-PIV surface velocity measurements were predominantly within 10% compared to the Environment Agency's discharge computation. This indicates that the KLT-PIV technique offers potential for the safe and cost-effective real-time assessment of river flows, even in potentially damaging high magnitude flood events. Therefore, it offers the opportunity for greatly improved flow monitoring in countries with established networks, and for the rapid development of monitoring where networks are less well developed.