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Advances in flash flood monitoring using UAVs

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UAVs have the potential to capture information about the earth's surface in dangerous and previously inaccessible locations. Through image acquisition of flash flood events and subsequent object-based analysis, highly dynamic and oft-immeasurable hydraulic phenomenon may be quantified at previously unattainable spatial and temporal resolutions. The potential for this approach to provide valuable information about the hydraulic conditions present during dynamic, high-energy flash floods has until now not been explored. In this paper we adopt a novel approach, utilising the Kande-Lucas-Tomasi (KLT) algorithm to track features present on the water surface which are related to the free-surface velocity. Following the successful tracking of features, a method analogous to the vector correction method has enabled accurate geometric rectification of velocity vectors. Uncertainties associated with the rectification process induced by unsteady camera movements are subsequently explored. Geo-registration errors are relatively stable and occur as a result of persistent residual distortion effects following image correction. The apparent ground movement of immobile control points between measurement intervals ranges from 0.05 - 0.13m. The application of this approach to assess the hydraulic conditions present in Alyth Burn, Scotland during a 1:200 year flash flood resulted in the generation of an average 4.2 measurements/m2 at a rate of 508 measurements/s. Analysis of these vectors provide a rare insight into the complexity of channel-overbank interactions during flash floods. The uncertainty attached to the calculated velocities is relatively low with a spatial average across the area of ± 0.15m/s. Little difference is observed in the uncertainty attached to out-of-bank velocities (± 0.15m/s), and within-channel velocities (± 0.16m/s), illustrating the consistency of the approach.