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Ice and thermal cameras for stream flow observations

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Flow measurements are instrumental to establish discharge rating curves and to enable flood risk forecast. Further, they are crucial to study erosion dynamics and to comprehend the organization of drainage networks in natural catchments. Flow observations are typically executed with intrusive instrumentation, such as current meters or acoustic devices. Alternatively, non-intrusive instruments, such as radars and microwave sensors, are applied to estimate surface velocity. Both approaches enable flow measurements over areas of limited extent, and their implementation can be costly. Optical methods, such as large scale particle image velocimetry, have proved beneficial for non-intrusive and spatially-distributed environmental monitoring.

In this work, a novel optical-based approach is utilized for surface flow velocity observations based on the combined use of a thermal camera and ice dices. Different from RGB imagery, thermal images are relatively unaffected by illumination conditions and water reflections. Therefore, such high-quality images allow to readily identify and track tracers against the background. Further, the optimal environmental compatibility of ice dices and their relative ease of preparation and storage suggest that the technique can be easily implemented to rapidly characterize surface flows.

To demonstrate the validity of the approach, we present a set of experiments performed on the Brenta stream, Italy. In the experimental setup, the axis of the camera is maintained perpendicular with respect to the water surface to circumvent image orthorectification through ground reference points. Small amounts of ice dices are deployed onto the stream water surface during image acquisition. Particle tracers' trajectories are reconstructed off-line by analyzing thermal images with a particle tracking velocimetry (PTV) algorithm. Given the optimal visibility of the tracers and their low seeding density, PTV allows for efficiently following tracers' paths in reasonable computational times. Measurements are in good agreement with values from a current meter.