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Surface flow observations from a gauge-cam station on the Tiber river

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Understanding the kinematic organization of natural water bodies is central to hydrology and environmental engineering practice. Reliable and continuous flow observations are essential to comprehend flood generation and propagation mechanisms, erosion dynamics, sediment transport, and drainage network evolution. In engineering practice, flood warning systems largely rely on real-time discharge measurements, and flow velocity monitoring is important for the design and management of hydraulic structures, such as reservoirs and hydropower plants.

Traditionally, gauging stations have been equipped with water level meters, and stage-discharge relationships (rating curves) have been established through few direct discharge measurements. Only in rare instances, monitoring stations have integrated radar technology for local measurement of surface flow velocity. Establishing accurate rating curves depends on the availability of a comprehensive range of discharge values, including measurements recorded during extreme events. However, discharge values during high-flow events are often difficult or even impossible to obtain, thereby hampering the reliability of discharge predictions.

Fully remote observations have been enabled in the past ten years through optics-based velocimetry techniques. Such methodologies enable the estimation of the surface flow velocity field over extended regions from the motion of naturally occurring debris or floaters dragged by the current. Resting on the potential demonstrated by such approaches, here, we present a novel permanent gauge-cam station for the observation of the flow velocity field in the Tiber river. This new station captures one-minute videos every 10 minutes over an area of up to $20.6 \times 15.5\,\mathrm{m}^2$. In a feasibility study, we demonstrate that experimental images analyzed via particle tracking velocimetry and particle image velocimetry can be used to obtain accurate surface flow velocity estimations in close agreement with radar records. Future efforts will be devoted to the development of a comprehensive testbed infrastructure for investigating the potential of multiple optics-based approaches for surface hydrology.