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Fluorescent particle tracers for surface hydrology: development of a sensing station for field studies

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This work focuses on the development and testing of a sensing station for the detection and tracking of a new class of fluorescent particle tracers for surface hydrology. This tracing methodology is based on the release of microspheres that fluoresce at labeled wavelengths in natural streams. The particles are detected as they transit below a sensing station that comprises a light source and a digital camera. Video feed from the station is then processed to obtain direct flow measurements and stream reach travel times.

This novel tracing technology is a low-cost measurement system that can be implemented on a variety of real-world settings, spanning from small scale streams to few centimeters rills in natural hillslopes. In particular, the use of insoluble buoyant particles limits the tracer dispersion from adhesion to natural substrates and thus minimizes the amount of tracing material for experimental measurements. Further, particle enhanced fluorescence allows for non-intrusively detecting the tracer without deploying probes and samplers in the water.

The performance of the sensing station is assessed by conducting a large array of experiments under different flow and acquisition conditions. More specifically, experiments are performed for multiple flow velocities, camera acquisition frequencies, light sources, and distances of the sensing station from the flow surface. Particles are deployed in a custom built artificial water channel of adjustable slope to simulate varying flow conditions. A high definition bullet camera is used to detect particles that fluoresce either in green or red and two optical filters, corresponding to the emission wavelengths of the particles, are incorporated in the sensing station. In this implementation, green emission is elicited by using Ultra Violet lights, while white light drives the red emission.

Experimental results confirm the versatility and the effectiveness of the proposed methodology. Both particle types are found to be easily detected in a wide range of flow conditions. This evidence favors the use of red particles whose controlled fluorescent emission does not require costly Ultra Violet lamps and is rather based on commonly available light sources. Therefore, at a limited cost, powerful white lights can be used in the system and allow for increased fields of view.