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Performance of an Image-based Flow Measurement Method in Alpine Rivers and in Wide Rivers

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Image-based methods for river volumetric flow rate measurements possess several advantages under complex hydrological conditions. Herein we present two cases where a DischargeKeeper, an image-based system for discharge measurements, has been installed, one at an alpine river and a second one at a wide river.
A DischargeKeeper was installed in 2015 at the outlet of the Oberaletsch glacier in Switzerland. The Oberaletsch glacier is located on the southern side of the Bernese Alps, in the canton of Valais at an altitude of 2130 m.a.s.l. It is located within a protected area, therefore it was required that the system has a minimal impact on the environment. Additionally the river is inside of a steep gorge where rockfall is common, therefore the system should be safe from natural hazards. For these reasons it was decided to measure the discharge by means of a non-intrusive method based on image processing. Alpine rivers are characterized by steep slopes, coarse bed material, unstable cross-section, high velocities and turbulence. Under these conditions it is difficult to measure the discharge by means of conventional methods.
The system has been taking measurements once an hour, day and night for 4 years during the melt season. For the purpose of verification, but also for system calibration, tracer tests were performed. A sensitivity analysis was performed in order to assess the accuracy of the method under such conditions. The estimated error for the average discharge during the measurement period, was found to have a standard deviation of 0.28m3/s or 4.2%. The system proved to be accurate, robust and cost-effective.
The second site is at the Rhine River approximately 20 km before Lake Constance. At this river section, it has a width of around 100 meters. In order to measure such a wide river a Pan Tilt Zoom (PTZ) camera was installed and a DischargeKeeper with a multi-view setup was implemented. By using a PTZ camera, one can zoom to smaller regions of the river surface which allows to have a better resolution of its surface patterns, which are used by the Surface Structure Image Velocimetry (SSIV) algorithm to calculate the surface velocity. To have image sequences with enough resolution of the whole river width, 3 views were chosen, one looking close to the left shore, another one looking to the middle of the river and the third one close to the right shore of the river. Each one of the views are processed independently and once the surface velocities per view are calculated, the information is ensambled to calculate the river discharge in real-time. To calculate the discharge, the river stage is also needed, in this case it was measured optically. For this purpose a fourth view was setup which zooms in to the right shore to identify the intersection between the water line and the bathymetry. This methodology has proven to be very powerful since it can be used in rivers of any width.