



Performance of the Image Wave Velocimetry Estimation for physics-based non-contact discharge measurement in rivers

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Herein we present an analysis of the performance of the Image Wave Velocimetry Estimation (IWaVE), a python library for image-based river discharge calculations. IWaVE simultaneously performs a 2D velocimetry analysis and calculates the stream depth through 2D Fourier transform, exploiting the sensitivity of water wave dynamics to flow conditions. Unlike existing velocimetry approaches such as Particle Image Velocimetry (PIV), Particle Tracking Velocimetry (PTV) or Space-Time Image Velocimetry (STIV), the uniqueness of this approach lies in: 1) velocities that are advective of nature can be distinguished from other wave forms such as wind waves. This makes the approach particularly useful in estuaries or river stretches affected strongly by wind, or in shallow streams in the presence of standing waves. 2) The velocity is estimated based on the physical behavior of the water surface, accounting for the speed of propagation of waves and ripples relative to the main flow. This makes the approach more robust than traditional methods when there are no visible tracers. 3) If the depth is not known, it can be estimated along with the optimization of x and y-directional velocity. Depth estimations are reliable only in fast and shallow flows, where wave dynamics are significantly affected by the finite depth.

We analyzed 2 videos recorded from a drone on a site in the Netherlands over a tidal channel in Zeeland at Waterdunen - Breskens. One of the videos has strong winds, which creates waves moving upstream. ADCP measurements for both videos are available. The videos were taken at different moments during different tidal conditions, they were processed using IWaVE, a LSPIV and a STIV methods. The results show that the LSPIV, STIV and IWaVE are in good agreement with the ADCP measurements for the case where there is no wind. However when there is wind the LSPIV and STIV methods fail to obtain the correct surface velocity, while the velocity calculated with IWaVE is in good accordance with the ADCP.