Masters project 2021-2022

Particle image velocimetry inside a vegetation patch using refractive index matching technique

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In experimental fluid mechanics it is common that flow measurements have to be performed inside or in between solid objects, should that be a flow between models of rocks, plants, inside a turbine or a blood vessel. Modern flow measurement methods are predominantly based on optical techniques where a flow seeded with small particles, used as tracers, is filmed with one or several cameras. However, if it is relatively straightforward to perform such measurements around an obstacle, what happens inside or in between solid objects remains unknown. The goal of this work is to perform optical measurements or, more precisely, Particle Image Velocimetry (PIV), in between stems of flexible vegetation using a novel approach in refractive index matching technique to access regions that are not optically accessible through regular methods.

In Particle Image Velocimetry (PIV) the small particles seeded into the water flow are filmed while being illuminated by a laser sheet (Figure 1). The videos are then processed and analysed to extract the velocity data and other statistics through tracking of particles throughout the image sequence. This technique allows to obtain non-intrusive spatially and timely resolved information about the flow field.

The refractive index matching technique consists of preparing a fluid solution, refractive index of which, matches the refractive index of the solid objects (vegetation stems in our case) made out of transparent material. When the refractive index is matched correctly, the stems become invisible in the fluid, and undisturbed measurements can be performed using the cameras.

The measurements of the flow inside a vegetation patch are important for prediction of resistance and drag in natural streams and rivers. For example, these measurements can be potentially used to improve flood-predicting models.

The candidate is expected to perform PIV experiments inside vegetation patches using the equipment and the flume in the IfH laboratory, analyse the data, and write-up a Masters thesis. The starting date is flexible.

Requirements

The candidate must have background and, most importantly, curiosity in fluid mechanics, interest in experimental techniques, and willingness to tackle challenging problems.

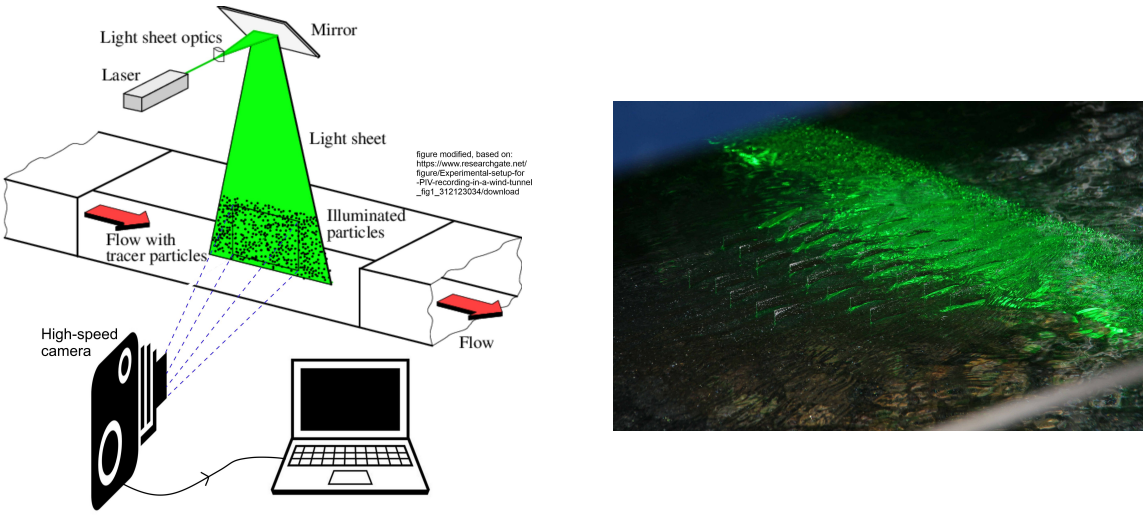

Figure 1: Left: Schematic of Particle Image Velocimetry setup. Right: A model of vegetation patch (e.g. group of glass blades) in a water flume illuminated by laser sheet for Particle Image Velocimetry.