PARTICLE IMAGE VELOCIMETRY APPLIED TO VERY LARGE FLOW FIELDS

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Structural Particle Image Velocimetry is a technique, which employs image analysis based on smoke structures for measuring large flow fields of at least 1 x 1 m size in a velocity range from 0.2 m/s up to 1.5 m/s. A number of image couples is analysed by means of ensemble average of correlations to retrieve a mean flow field.

Structural Particle Image velocimetry uses common smoke from a smoke generator as seeding and white light for illumination, rather than individual tracers and laser sheets as in traditional PIV.
The purpose of this project was the further development and improvement of experimental components of the setup as well as an experimental validation of the potential and limits of the technique. The illumination of the flow field had been optimised by modifying the light source. To retrieve clear smoke patterns a new smoke delivery system was designed and tested, consisting of a smoke rake with adjustable vanes. The experimental assessment was performed in the closed wind tunnel WG 1 for a field of view of 1 x 1m. The experimental investigation involved the study of a parallel flow and the measurement of von Karman vortices behind a cylinder (Re= 5900). During these experiments the different parameters of the setup were studied aiming at optimal results.
The next step was a scale-up of the technique to a field of view of 3 x 3m at the wind tunnel L1. A jet exiting L1 was investigated in the open test section with and without a wing profile submerged in the flow. Due to temperature gradients between the air leaving L1 and the laboratory rising or falling flows could be observed.

Figure 1 gives the example of a rising jet at an exit velocity of 0.19 m/s. While the smoke seeding allows a visualization of the flow the result of the analysis is a vector field displayed in figure 2.
The accuracy of the obtained results in this velocity range is +/- 0.005 m/s (+/- 2.3%) respecting the uncertainty of the reference measurement with a hot sphere anemometer of +/- 0.01 m/s.

The outcome of the project showed the capability of Structural PIV to measure large flow fields in the range of 0.2 m/s up to 1.5 m/s. In addition, large flow structures as the von Karman vortices are measurable applying phase-locked ensemble correlation.

Figure 1: rising jet exiting L1 at a velocity of 0.19 m/s

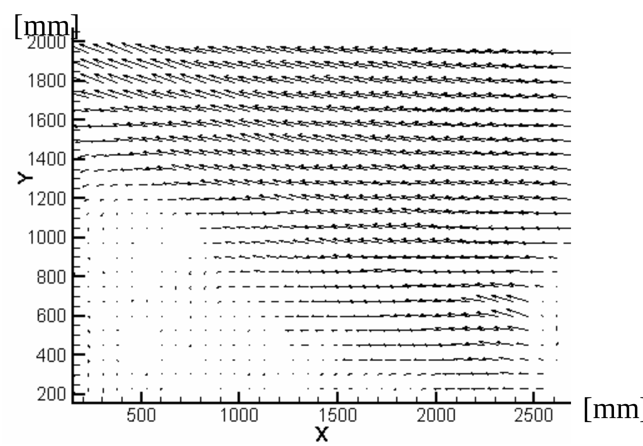

Figure 2: vector field of rising jet obtained by ensemble correlation (91 pairs) initial window size: 300 x 300 mm 1 refinement step and 75 % overlap