

Combination of advanced 2D PIV and stereo technique

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Particle image velocimetry (PIV) is now applied with confidence in industrial facilities such as large wind tunnels. Many research and development programs have obtained benefits out of this measurement technique (CoJeN, Heliflow, Apian, C-wake, EuropPiv in Europe, among others). Even though this indicates a broad application of PIV at industrial scale setups, a significant effort is still dedicated to increase its applicability, capabilities and accuracy. This includes the development of new algorithms and techniques. Among them, two branches are of interest for this work:

- The conventionally named “advanced algorithms” that deal with the improvement of two-dimensional PIV, which is designed to measure two-components of the velocity (2D-2C PIV). The main objectives of these algorithms are the increase of the spatial resolution, the ability to cope with large displacement gradients and an enhancement of the robustness (i.e. capability to avoid outliers) when dealing with reduced signal to noise ratios.
- The Stereo PIV technique. This technique combines the information of different planar views of the field under study to obtain the three components of the velocity (2D-3C PIV).

The combination of these two branches is a domain that has to be fully explored. This work deals with the Stereo implementation of the local field correction PIV algorithm (LFC-PIV) (Nogueira et al. 2001). This advanced algorithm is able to extract in-plane flow features in the order of 25 pixels size with 10% errors (Lecuona et al. 2004). It is important to note that this improved resolution could be useless for particular flow conditions and experimental stereo setups. This is related to the fact that to successfully apply stereoscopy, the laser sheet width is usually larger than in 2C velocimetry, in order to acquire the out of plane displacement of the particles. If some other factors concur the measurement

of small scale features of the velocity along the laser sheet can be spoiled by the velocity variations across it, caused by the flow structures. This is so mainly due to the out-of-plane overlapping of information.

Being the spatial resolution capabilities of LFC its main advantage, this paper focuses in establishing if there are advantages left for LFC-PIV in situations where only large scale features are of interest, thus making it difficult for this technique to show its attractiveness. The remaining metrological aspects still to be analyzed are the ability to cope with large displacement gradients and the robustness (especially when dealing with the out-of-plane loss of particle pairs). Both aspects allow increasing the time between laser pulses and consequently the dynamic range of the velocity measurement with the same subpixel accuracy. For both aspects, the performances of Stereo-LFC-PIV are explored and characterized. Using synthetic PIV images, this algorithm is compared with conventional PIV algorithms applied in a Stereo configuration and with Stereo Multigrid PIV enhanced with image distortion. In addition, the coherence between these results and those coming from experimental PIV images is presented and discussed.

References

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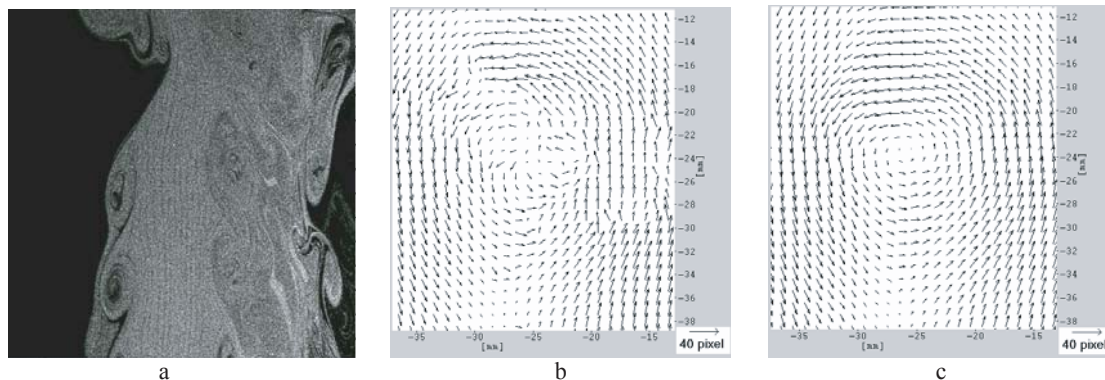


Fig. 1. a) Example of real image used in this study (2k by 2k pixels). b) Measurement of one of the vortex (440 by 400 pixels) obtained with Multigrid Stereo PIV enhanced with image distortion. c) Same vortex measured with Stereo LFC-PIV. The peak vorticity corresponds to $\omega_p \sim 1.2 \text{ At}^{-1}$.