INVESTIGATION OF ALTERNATIVE ALGORITHMS TO IMPROVE LARGE SCALE PIV

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This report deals with the flow field estimation from large-scale images. Standard particle image velocimetry (PIV) is applied to obtain the velocity field and it is shown that standard correlation techniques have deficiencies with respect to the influence of aliasing and peak detection. These issues are negligible for standard particle images but become important for large-scale smoke-structure images which prevent high velocity field resolutions. Ensemble correlation averaging can overcome this problem but is not capable to capture instantaneous velocity fields. Thus alternative approaches as *optical flow* are presented and tested to achieve a better adaption to the special situation of smoke images. The algorithm was implemented in C++ for computational efficiency.

Authentic large-scale images were preciously produced at the VKI and show a 2.8m×2.06m investigation area like in Figure 1. Synthetic images were generated by distorting authentic large-scale images with a sinusoidal displacement function. This displacement was to be recovered by both techniques to compare the accuracy and spatial resolution. For more realistic investigation the distorted image was additionally superimposed with different levels of noise.

With respect to optical flow this investigation revealed a high sensitivity to noise but a better performance for noiseless image pairs than for correlation techniques. The latter show a very robust behavior to noise especially for large window sizes. An attempt was tried to combine the robustness of correlation and the high resolution and accuracy of optical flow into a hybrid approach. Correlation was used to capture large displacements and in a consecutive step optical flow was to determine the fine structures.

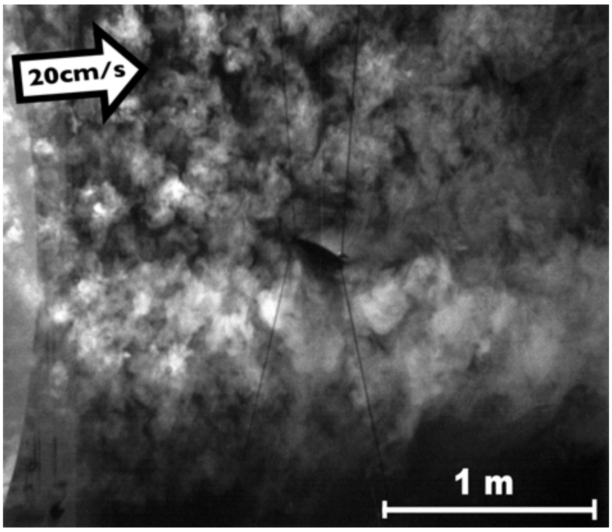

Figure 1: Large-scale flow2.8m×2.06m with an airfoil in the mainstream

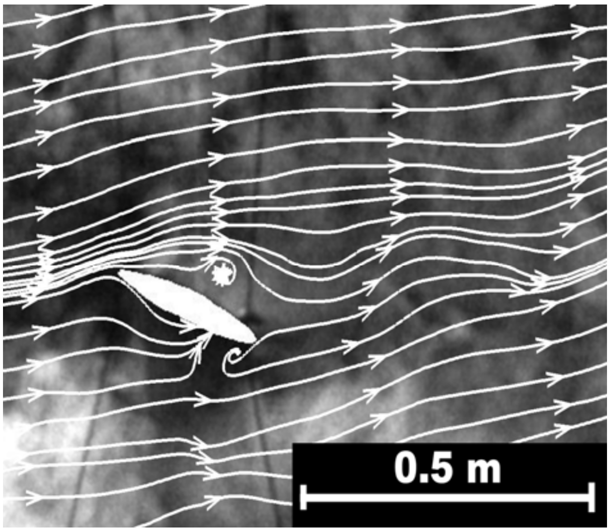

Figure 2: Close-up of the airfoil including streamlines that indicate the flowfield