DEVELOPMENT OF AN HYBRID PIV-PTV METHOD AND APPLICATION TO SEPARATED FLOWS

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The present works constitutes the study and the development of an integrated PIV-PTV method, which combines the advantages of the two approaches. The technique is a hybrid algorithm that starts by statistical tracer's displacement evaluation (PIV analysis) and further refines the measurement resolution with the tracking of individual particles (PTV). This concept was introduced by Keane et al. (*Measurement Science and Technology*, 1995) and referred as the Super Resolution analysis (SRPIV). Other authors have also discussed this subject, focusing on the way to perform the correct association between particles images but this strategy is still not generalized. The present work is addressing the accuracy issue of such methods. The improvement in the determination of particle displacement respect to the classical methods is discussed. The usual method consists to estimate the position of every tracer in each frame. Another approach that correlates individual images of particles is investigated and it is referred as the IPC method. The accuracy and the spatial response are validated on synthetic images of reference flow fields. The robustness of the method is considered by examining several validation criteria for the association of the tracer's images. The identification process of identification of the particle image is also considered. After reviewing the available literature, it comes out that no method is universal. A method based on the search of local maximum of intensity in the images and the determination of the background noise of the recordings is investigated with the purpose of studying single phase flows.

Developments were also made to apply such method to simultaneously measure concentration and velocity, which is a challenging task in many applications: droplets in combustion, dispersion of pollutant gas…. The advantage is that it proposes an alternative method that needs less equipment than others techniques such as PIV-LIF. The main idea consists in using all the information available on the image to measure the concentration. Image processing provides an instantaneous velocity field for each couple of images and analyzing the spatial distribution of the particle images gives simultaneously a concentration field. A method based on counting particles is investigated and characterized. The effect of the limit in the performance of the extraction algorithm is then modeled, explaining one of the sources of the measurement scatter. The error made on the localization is also identified as another source of scatter. On another hand, systematic tests on synthetic images showed that the tool has a non-linear response. Good agreement is obtained with experiments held in channel flow operated with a low speed wind tunnel. It comes out that the mean measurements present self-similar profile. Hence, a correction of the bias is possible if experimental parameters such as the particle image diameter are determined.

The implementation of the investigated methods to real applications is also considered. The flow over a backward facing step (BFS) is a generic case of separated flows. PIV and SRPIV are compared on instantaneous measurement and averaged ones. An assessment on a 2-dimensionnal flow with isotropic fluctuations is also presented. The ability of the technique to characterise the vortices of a flow field is investigated on synthetic images as well as on real recordings of the flow over a BFS. The software developed within this research took part to the first international PIV challenge, organised by PIVnet and the Japanese Society of Visualisation (VSJ). The results of this extensive comparison showed that the current approach is highly performing. This new method has been applied to the study of the effect of dispersed particles in a cavity flow and also to the determination of concentration within a free jet

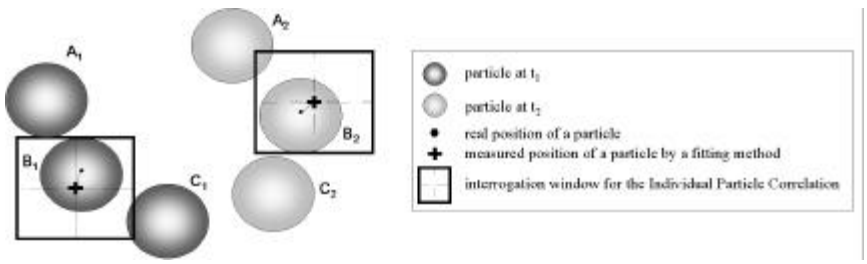

Figure 1: Principle of the IPC method.