PIV spectral optimization for the study of turbulent flow

by
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ABSTRACT

The use of Particle Image Velocimetry for the study of turbulent flow allows to obtain quantitative information on the spatial structure of the velocity field (see Adrian et al., 2000). To characterize a turbulent flow, the spatial resolution has to be as large as possible in order to catch a large range of scale. A difficulty is that the spatial resolution depends both on the interrogation window size and on the noise level. Foucaut et al. (2003) propose a method to optimize the spatial resolution based on a model which take into account these two parameters. This method has to use the Fourier space. In fact, the model is build from a real spectrum of the flow (obtained from hot wire anemometry). The noise level is deduced by a comparison between this real spectrum and a PIV one computed from an analysis of a sample of two hundred fields with any interrogation window size. The optimization is based on the evolution of the noise level which decreases when the interrogation window size increases. It allows to obtain the window size which gives the largest width band. The drawback of this method is that it needs a spectrum of the flow.
The present contribution presents a method to optimize the interrogation window size without a known spectrum. It is based on the model proposed by Foucaut et al. (2003). In this approach, the spectrum necessary for the optimization is modeled from an analysis of the field sample with a small window size giving a high noise level. This noise level is then estimated from this analysis. A spectrum, which is very close to the real one, can be build from the inverted model. It allows to optimize the interrogation window size in order to obtain the best compromise between the spectral response and the spatial resolution. This optimization method has been tested on two experiments in the plane parallel to the wall of a turbulent boundary layer. The first experiment is done with a Pulnix CCD camera and the second one with a Kodak numerical photographic camera. In both cases, the window sizes has been optimized and the spectrum is checked as giving the largest range of frequency.