Improvement of PIV dynamic range in the presence of velocity gradients using multiple correlation peak analysis and self-adaptive windows

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HIGHLIGHTS

• Velocity gradients in a correlation window may produce multiple peaks in the cross-correlation map.
• In case of multiple distinct correlation peaks, an advanced analysis proposed in this work to resolve the gradients.
• Displacement vectors are collocated according to the particles that constitute each peak.
• A self-adaptive window size and aspect ratio helps to reduce the measurement error.
• The proposed methodology, tested with synthetic and experimental images, shows a reduced error in the measurement and an increased dynamic range up to a factor of 4.

ABSTRACT

A novel algorithm to analyse PIV images in case of strong gradients is proposed. The proposed methodology allows the detection of multiple peaks in a correlation map and automatically collocates vectors according to the match of each peak with the particles that contribute to it. The algorithm constitutes two main parts: first, an automatic peak detection system based on the histogram of the cross-correlation map and the signal to noise ratio, and second a peak matching system that identifies which particles participate to which peak by use of a sub-correlation window and a defined matching function. An adaptive windows size based on the flow predictor and the quarter rule is also implemented to help the resolution of flow gradients. Synthetic and experimental results are proposed and show a strongly reduced error in the measurement and a velocity dynamic range improved up to a factor of 4.

Fig. 1 An example of correlation window with multiple displacements (left) and resulting correlation map with multiple peak (right)