Influence of number of cameras and preprocessing for thick volume Tomographic PIV

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Keywords: Tomographic PIV, image pre-processing, thick volume PIV, vector post-processing

Measurable depth of Tomographic PIV in air is about 20 mm. This depth is not enough to understand 3-dimensional vortex interactions, especially in the case of application to industrial flow. One of the reasons of this limitation is the influence of ghost particles at high particle density or thick measurement depth. The number of cameras improve signal to ghost ratio and its effect is studied by using numerical simulation (Elsinga 2006). According to these previous studies, there is less advantage to increase cameras more than 5-camera. These method based on numerical simulation has advantage of quantitative assessment. However it is difficult to evaluate all of effects like camera noise, laser profile, optical transfer function and etc. In this study, the effect of number of cameras, image pre-processing and vector post-processing are experimentally investigated by measurements of cylinder wake flow.

The effect of number of camera is investigated from 4 to 8-camera at several particle densities for thick measurement volume conditions. At first, effect of image pre-processing is studied. In the case of high particle density conditions (0.12 ppp, 0.45 ppp and 0.53 ppp), particle image overlaps frequently, therefore spatial filter for particle image induced higher SGRs but noisier velocity vector map to compare with the result of time-series minimum subtraction filter without any spatial filter.

For the vector post-processing, spatial filter in physical domain and low-pass filter in frequency domain are effective to reduce measurement error. Fig. 1 shows “Polynomial filter” reduce noise at mid to high frequency region. Remaining noise at high frequency region is eliminated by low-pass filter. By using these filters, resolved wave number for each direction in x, y, and z are 1-45, 1-55 and 1-13 respectively for the case of 50 mm volume thickness. Fig. 2 shows the effect of number of camera to the results of Reynolds stress profile. This effect is more clearly shown in velocity fluctuation and Reynolds stress than mean velocity profile. To understand velocity fluctuation and Reynolds stress, more than 6-camera are needed for 0.12 ppp and 50 mm volume thickness condition and 8-camera is needed for 0.45 ppp. As shown in Fig. 3, this 8-camera Tomographic PIV can visualize 135 x 230 x 50 mm3 of flow field and resolve the interaction of ‘roller’ structure and ‘finger’ structure.

References


Acknowledgements

This study was supported by Dr. Dirk Michaelis from LaVision GmbH and Dr. Andreas Shröder, Dr. Daniel Schanz, Dr. Reinhard Geisler from DLR. Prof. Scarano gave the valuable suggestions. Their support is greatly acknowledged.