Multiple-eye PIV

E. Atsumi¹, J. Sakakibara²*
¹: Graduate School of Science and Technology, Meji university
²: Department of Mechanical Engineering, Meji university
* Correspondent author: sakakiba@meiji.ac.jp

Keywords: PIV, accuracy, dynamic-range, microlens array

HIGHLIGHTS

• We developed an imaging optics, which captures particle images viewing from \( n=7 \) different directions on a single image sensor.
• Velocity of turbulent pipe flow was measured by stereo PIV algorithm based on any combination of \( n \) images.
• Mean and rms velocity was computed from ensemble average of simultaneously-measured \( n \)C. velocities, and compared to DNS results.
• Random errors, estimated from the discrepancy of the measured rms velocity to the DNS, was successfully reduced by a factor of \( 1/\sqrt{n} \).

ABSTRACT

We developed a new PIV system, named multiple-eye PIV, which reduces error associated with measurement of particle displacement by computing an ensemble average of velocities evaluated from \( n=7 \) sub-images (Fig.1) captured on a single image sensor through micro-lens array. The system was applied to a fully developed pipe flow, and mean and rms velocity profiles were compared to that of DNS. The random errors were estimated from the discrepancy of the measured rms velocity to the DNS. The random error in the ensemble-averaged velocity was successfully reduced by a factor of \( 1/\sqrt{n} \).

Fig. 1 Raw image of calibration plate. We used the perfectly-round images \( (n=7) \) to compute velocities and other defected images are masked out.

Fig. 2 Streamwise component of RMS velocity profile plotted with DNS by Wu and Moin (2008)