

Mechanical Engineering Master's Defense

Multi-pulse PTV: evaluation on spatial resolution, velocity accuracy, and acceleration measurement

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abstract

Multi-pulse particle tracking velocimetry (multi-pulse PTV) is a recently proposed flow measurement technique aiming to improve the performance of conventional PTV/PIV. In this work, multi-pulse PTV is assessed based on PTV simulations in terms of spatial resolution, velocity measurement accuracy and the capability of acceleration measurement. The errors of locating particles, velocity measurement and acceleration measurement are analytically calculated and compared among quadruple-pulse, triple-pulse and dual-pulse PTV. The optimization of triple-pulse and quadruple-pulse PTV are discussed and concluded to minimize the combined error in position, velocity and acceleration.

Experimentally, the velocity and acceleration field of a round impinging air jet are measured to test multi-pulse technique. High speed beam-splitting camera and custom 8-pulsed laser system are utilized to achieve good timing flexibility and temporal resolution. A new method to correct the registration error between CCDs is also presented. Consequently, the velocity field shows good consistency between multiple-pulse and dual-pulse measurements. The centerline acceleration profile comparison verifies the capability of multi-pulse PIV/PTV to measure acceleration field.



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