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GPU-based, parallel-line, omni-directional integration of measured acceleration field to obtain the 3D pressure distribution.[1] JIN WANG, CAO ZHANG, JOSEPH KATZ, JHU — A PIV based method to reconstruct the volumetric pressure field by direct integration of the 3D material acceleration directions has been developed. Extending the 2D virtual-boundary omni-directional method (Omni2D, Liu & Katz, 2013), the new 3D parallel-line omni-directional method (Omni3D) integrates the material acceleration along parallel lines aligned in multiple directions. Their angles are set by a spherical virtual grid. The integration is parallelized on a Tesla K40c GPU, which reduced the computing time from three hours to one minute for a single realization. To validate its performance, this method is utilized to calculate the 3D pressure fields in isotropic turbulence and channel flow using the JHU DNS Databases (http://turbulence.pha.jhu.edu). Both integration of the DNS acceleration as well as acceleration from synthetic 3D particles are tested. Results are compared to other method, e.g. solution to the Pressure Poisson Equation (e.g. PPE, Ghaemi et al. 2012) with Bernoulli based Dirichlet boundary conditions, and the Omni2D method. The error in Omni3D prediction is uniformly low, and its sensitivity to acceleration errors is local. It agrees with the PPE/Bernoulli prediction away from the Dirichlet boundary. The Omni3D method is also applied to experimental data obtained using tomographic PIV, and results are correlated with deformation of a compliant wall.

[1]ONR

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None

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