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Reducing velocity error and its consequences by an iterative feedback immersed boundary method

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The immersed boundary method (IBM) has attracted growing interest in the computational fluid dynamics (CFD) research community due to its simplicity in dealing with moving boundaries in fluid-structure interaction (FSI) systems [1]. We present a study on streamline penetration, velocity error and consequences of a FSI solver based on an iterative feedback IBM. In the FSI, the fluid flows are solved by the lattice Boltzmann method; the solid structure deformation is solved by the finite difference method, and an iterative feedback IBM is used to realize the interaction between fluid and structure. The iteration can improve the no-slip and no-penetration boundary conditions at the fluid-solid interface. Four benchmark cases are simulated to study the reduced velocity error and its consequences: a uniform flow over a flapping foil, flow-induced vibration of a flexible plate attached behind a stationary cylinder in a channel, flow through a two-dimensional asymmetric stenosis and a one-sided collapsible channel. Results show that the iterative IBM can suppress the boundary-slip error and spurious flow penetration on the solid wall. While the iterative IBM does not have significant effect on the force production and structure deformation for external flows, it significantly improves the prediction of the force distribution and structure deformation for internal flows. The increased computational cost incurred by the iteration can be largely reduced by increasing the feedback coefficient. This study will provide a better understanding of the feedback IBM and a better option for the CFD community.

REFERENCES

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