An immersed boundary-lattice Boltzmann method based on velocity correction and its application

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Abstract

An immersed boundary-lattice Boltzmann method (IB-LBM) based on velocity correction is presented. The present method is inspired from immersed boundary method (IBM) and lattice Boltzmann method (LBM) since they have a common characteristic that they all employed cartesian mesh. In the conventional IBM, the all solved region was treated as fluid, the effect of immersed body on the surrounding flow is modeled through a forcing term, which is in turn used to correct the surrounding velocity field. This process is actually an iterative procedure to satisfy the non-slip boundary condition at the immersed boundary (IB). One challenging issue of IBM is that some streamlines may pass through the solid body. Thus, in this work, a simple IB velocity correction approach is proposed, which directly enforce the physical velocity condition on IB and internal body. The velocity filed and pressure filed were solved rapidly by LBM. Volume of fluid, velocity interpolation and implicit direct force methods were provided for modeling the effect of immersed body. The main advantage of the this method is that it is simple in concept and easy for implementation. In order to identify the effectiveness and validity of this numerical method, flow around cylinder and flow around foil were simulated.

Keywords: Incompressible flow; Immersed boundary-lattice Boltzmann method; Velocity correction; Flow around cylinder; Flow around foil