The immersed smoothed point interpolation method (IS-PIM) for fluid-structure interaction problems

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Abstract

The immersed smoothed point interpolation method (IS-PIM) has been proven to be an efficient method for fluid-structure interaction (FSI) problems. Under the framework of immersed method, the deformation and re-meshing of fluid mesh can be avoided using fixed Euler mesh. Using the gradient smoothing technique, smoothed point interpolation method (S-PIM) enhances the performance of mesh distortion insensitivity for nonlinear solids with large deformation. Since the coupling interface is implicit in IS-PIM based on nonconforming mesh, different correction algorithms have been employed to improve the imposition of nonslip velocity boundary condition. Semi-implicit characteristic-based-splitting (CBS) algorithm is used to solve incompressible viscous fluid flow in the original IS-PIM. Given that CBS algorithm needs to solve pressure Poisson equation, is time-consuming and consumes massive computing resources as a fluid solver, a lattice Boltzmann method (LBM) and S-PIM coupled method has been developed by employing LBM as fluid solver. And In order to simulate violent FSI problems associated with overturning and breaking of free surface flow efficiently, a smoothed particle hydrodynamics (SPH) and S-PIM coupled method has also been proposed by using SPH as fluid solver.

Keywords: immersed method; smoothed point interpolation method; fluid-structure interaction; gradient smoothing technique; large deformation