A Quadric Stabilization Approach on Partitioned Fluid-Structure Interaction Algorithm

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Abstract

Arbitrary Lagrangian-Eulerian (ALE) algorithms are extensively studied for fluid-structure interaction (FSI) problems due to their high accuracy and efficiency. In this paper, a quadric stabilization scheme has been introduced for partitioned FSI problems. Considering its deforming boundary, the viscous incompressible fluid domain is discretized with finite volume method in ALE description. The PISO algorithm is applied and the position of grids are updated using a Laplacian equation solver. An elastic finite deformation model is used in the solid domain. Green strain and Cauchy stress are employed to describe the mechanical behaviors of structure. The finite element method and Newmark approach are used for spatial and temporal discretization, respectively. On the FSI interface, Dirichlet-Neumann iterations are carried out. To meet the kinetic and dynamic conditions on the interface, an area weighed method is used for pressure and viscous forces interpolation. Displacement interpolation is applied using an interfacial energy conservation approach. Aitken relaxation method is applied to obtain a relative high efficiency in sub-iteration. Finally, the high accuracy and efficiency of this algorithm are indicated by a series of validation cases presented and comparisons with both analytical and numerical results. Numerical results also show enhanced robustness and efficiency by using the quadric stabilization scheme.

Keywords: FSI； ALE； FVM； FEM； Partitioned approach