Nitsche-type Unfitted Fluid Structure Interaction Model Coupled with Material Point Method

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Abstract

We propose a novel hybrid method that incorporates the Arbitrary Lagrangian-Eulerian (ALE) approach into material point method(MPM) for fluid-structure interaction(FSI) problems. In this formulation, fluid motion is described by Navier- Stokes equations formulated in ALE form. Variational formulation concerning the fluid is supported by the stabilizing residual-based variational multiscale(RBVM) method. Variational structural equations concerning the solid are assembled using MPM. We let fluid-solid interface cut the elements arbitrarily. To ensure well system conditioning and stability of the resulting system irrespective of how the interface intersects the cut elements, face-oriented ghost penalty stabilization is applied on the cut element faces. Continuity of velocities and normal stresses on the boundary is weakly enforced by the Nitsche's method. The advantage of our hybrid approach is that it provides a dynamic framework which eliminates certain shortcomings of ALE based finite element methods for fluid structure interaction problems involving large structural deformation. This study is supported by supported by NSF DMS Grant: *Hybrid Fluid-Structure Interaction Material Point Method with applications to Large Deformation Problems in Hemodynamics* [1]

Keywords— fluid-structure interaction, material point method, arbitrary lagrangian-eulerian, Nitsche's method

[1]https://www.nsf.gov/awardsearch/showAward?AWD_ID=1912705