A General Moving Mesh Framework for Simulating Multi-Phase Flows

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Abstract: In this talk, we present an adaptive moving mesh algorithm for meshes of unstructured tetrahedra in three space dimensions. The algorithm automatically adjusts the size of the elements with time and position in the physical domain to resolve the relevant scales in multiscale physical systems while minimizing computational costs. Since the mesh redistribution procedure normally requires to solve large size matrix equations (arising from discretizing the Euler-Lagrange equations or a minimization problem), we will describe a procedure to decouple the matrix equation to a much simpler block-tridiagonal type which can be solved by multi-grid methods efficiently. To demonstrate the performance of the proposed 3D moving mesh strategy, the algorithm is implemented in finite element simulations of fluid-fluid interface interactions in multiphase flows. In this talk, we will propose a general framework on how to design an adaptive grid method useful for this kind of simulations. To demonstrate the main ideas, we consider the formation of drops by using an energetic variational phase field model which describes the motion of mixtures of two incompressible fluids. The phase field model consists of a Navier-Stokes system coupled with volume preserving Allen-Cahn type phase equations. Numerical results on two- and three-dimensional simulations will be presented.

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