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A Cartesian Mesh Method for Fluid-Structure Interaction HONG ZHAO, Dept. of Theoretical and Applied Mechanics, UIUC, JONATHAN FREUND, Dept. of Mechanical Science and Engineering, UIUC, ROBERT MOSER, Dept. of Mechanical Engineering, Univ. of Texas at Austin — Flow-structure interaction with finite solid deformation, of the kind common in biological systems, is well known to be challenging to simulate. There are fundamental differences in the material properties that make coupling difficult at the interface, whose position is not generally known a priori. The characteristics of solids and fluids are such that fluids are more naturally represented by an Eulerian formulation, and solids, because the referential state is important, are more naturally represented by a Lagrangian formulation. We have developed a Cartesian mesh method to simulate the combined system that preserves the attractive aspects of each formulation. The solid motion is tracked as in any Lagrangian formulation, while the momentum equations for both the solid and fluid are solved on a uniform Cartesian mesh. The solid stresses are computed on an unstructured mesh by using a finite element discretization and are distributed to the Cartesian mesh with conservative interpolation. Both fluids and solids are incompressible, as appropriate for biological systems. This condition is enforced via constraints. No artificial bulk modulus is employed. Convergence results are presented, as well as example simulation results for an advected deformable body, a very flexible leaflet, and a swimming jellyfish. Research supported by DOE.

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