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Implicit Eulerian Fluid-Structure Interaction Method for the Modeling of Highly Deformable Elastic Membranes

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Abstract : This paper is concerned with the development of a fully implicit and purely Eulerian fluid-structure interaction method tailored for the modeling of the large deformations of elastic membranes in a surrounding Newtonian fluid. We consider a simplified model for the mechanical properties of the membrane, in which the surface strain energy depends on the membrane stretching. The fully Eulerian description is based on the advection of a modified surface tension tensor, and the deformations of the membrane are tracked using a level set strategy. The resulting nonlinear problem is solved by a Newton-Raphson method, featuring a quadratic convergence behavior. A monolithic solver is implemented, and we report several numerical experiments aimed at model validation and illustrating the accuracy of the presented method. We show that stability is maintained for significantly larger time steps.

Keywords : finite element method, implicit, level set, membrane, Newton method
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