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A FINITE ELEMENT METHOD FOR TWO-PHASE FLOWS BASED ON ADAPTIVE INTERFACE-FITTED MESHES

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A broad range of numerical methods have been devised in the last decades to simulate multi-phase flows. Many of them are based on interface-capturing strategies, where the interface is represented implicitly by a continuous function defined over the whole computational domain (for instance a level-set function). The discrete jump in fluid properties, as well as interfacial phenomena like the surface tension, are then approximately taken into account at the level of the elements/cells intersected by the interface (for instance through Volume-of-Fluid or Cut Finite Element Methods) or in a thicker band of elements/cells around the interface. Local mesh refinement, at least in the normal direction, is often required to accurately capture the behaviour of the interface.

In this work, we seek to combine the flexibility of the level-set representation of the interface with the efficiency of a Finite Element Method based on interface-fitted meshes. A local mesh adaptation procedure is carried out at each time step in order to accurately fit the mesh to the zero iso-value of the level-set function [1, 2]. The incompressible Navier-Stokes equations are then solved with a stabilized Finite Element formulation involving a different pressure field for each phase, and the interfacial forces can be taken into account through surface terms [3], instead of relying on a Continuum Surface Force (CSF) model. The level-set function is advected through a standard stabilized Finite Element method and periodically re-initialized in a geometric manner. The accuracy and efficiency of the method is assessed on academic test cases such as rising bubbles.

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