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Stability Analysis and Numerical Study of Stefan Problems for Embedded Computation of Moving Internal Boundaries

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ABSTRACT

Classical finite element methods used to model problems with internal boundaries rely on body fitted computational grids. However, those methods encounter computational challenges when the boundaries are deformed or moved substantially. Embedded methods avoid boundary fitted grids in favor of immersing the boundary in a pre-existing fixed grid. In this category of methods we are interested in the shifted boundary method, where the physical boundary is replaced by a surrogate boundary, which is updated after each displacement of the physical boundary [1, 2]. Here, we examine the application of this technique to a Stefan problem. In the formulation, the moving boundary progresses at a speed determined by the normal flux jump and is a source of instabilities which can impact the solution on the whole domain. To understand this, a linear stability analysis of the numerical technique is performed [3]. The stability analysis gives an understanding of the terms necessary to add in the weak formulation for its stabilization. A comparison is made with and without these terms to highlight the improvement in accuracy of the method.

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