A Level Set Approach to Interface Problems on Cartesian Adaptive Grids

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Abstract

Several phenomena in the physical and the life sciences can be modeled as a time dependent interface problem and nonlinear partial differential equations. Examples include the study of materials, free surface flows and multiphase flows. One of the main difficulties in solving these classes of problems stems from the fact that the solution process must take into account the motion of a front that may undergo complex changes in topology, such as the interface between a material and its ambient melt, or between a liquid and a gas. Another difficulty is that such problems involve dissimilar length scales with smaller scales influencing larger ones so that nontrivial pattern formation dynamics can be expected to occur on all intermediate scales (multiscale phenomena). Numerical simulations represent a promising avenue, but face the limitations imposed by current computer technology: Uniform grids are limited in their ability to resolve small scales and are in such situations extremely inefficient in terms of memory storage and CPU requirements. Since their inception, adaptive mesh refinement (AMR) techniques have provided a tool to systematically concentrate the computational effort where it is most needed, allowing for efficient resolutions. In this talk, I will present recent advances in the numerical treatment of interface problem using the level set method in the context of adaptive mesh refinement.

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