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Abstract Level set methods have recently gained much popularity to capture discontinuities, including their possible propagation. In this contribution we present a finite element approach for solving the governing equations of level set methods. After a review of the governing equations, the initialisation of the level sets, the discretisation on a finite domain and the stabilisation of the resulting finite element method will be discussed. Special attention will be given to the proper treatment of the internal boundary condition, which is achieved by exploiting the partition-of-unity property of finite element shape functions.

Keywords level sets · finite elements · partition of unity · evolving discontinuities

1 Introduction

In the late 1980s, Osher and Sethian [1] have suggested an elegant method to numerically model hypersurfaces. The starting point is the definition of a scalar level set function ϕ. The zero-isolevel contour of this function describes the hypersurface, while the signed distance provided by the level set function enables the simulation of the evolution of the hypersurface.

Initially, level set methods were applied to the computation of phase changes in flows as driven by a diffusion equation. Subsequent applications have also included weather predictions and image analysis [2]. More recently, they have also been used in conjunction with finite element methods that exploit the partition-of-unity property of finite element shape functions to capture crack propagation, especially in

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