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Abstracts of Papers to Appear

An Adaptive Mesh Algorithm for Evolving Surfaces: Simulations of Drop Breakup and Coalescence. Vittorio Cristini, Jerzy Bławzdziewicz, and Michael Loewenberg. Department of Chemical Engineering, Yale University, New Haven, Connecticut 06520-8286.

An algorithm is presented for the adaptive restructuring of meshes on evolving surfaces. The resolution of the relevant local length scale is everywhere maintained with prescribed accuracy through the minimization of an appropriate mesh energy function by a sequence of local restructuring operations. The resulting discretization depends on the instantaneous configuration of the surface but is insensitive to the deformation history. Application of the adaptive discretization algorithm is illustrated with three-dimensional boundary-integral simulations of deformable drops in Stokes flow. The results show that the algorithm can accurately resolve detailed features of deformed fluid interfaces, including slender filaments associated with drop breakup and dimpled regions associated with drop coalescence. Our algorithm should be useful in a variety of fields, including computational fluid dynamics, image processing, geographical information systems, and biomedical engineering problems.

An Accurate Eno Driven Multigrid Method Applied to 3-D Turbulent Transonic Flows. B. Epstein,* A. Averbuch,† and I. Yavneh.‡ *The Academic College of Tel-Aviv-Yaffo, Computer Science Department 4 Antokolsky Street, Tel Aviv 64044, Israel; †School of Mathematical Sciences, Tel Aviv University, Tel Aviv 69978; and ‡Faculty of Computer Science, Technion, Haifa 32000, Israel.

A multigrid method for computing steady solutions of the compressible Navier-Stokes equations is described. The convection part of the equations is approximated by a simple low order upwind-biased scheme employed for multigrid relaxation in combination with a higher order Essentially Non-Oscillatory (ENO) scheme used to supply a defect correction to the right-hand-side of the discrete equations on the locally finest multigrid levels in a way ensuring the overall high accuracy of the solution. A damping technique is employed to stabilize and accelerate the defect-correction process.

A Moving Mesh Finite Element Method for the Solution of Two-Dimensional Stefan Problems. G. Beckett, J. A. Mackenzie, and M. L. Robertson. Department of Mathematics, University of Strathclyde, Livingstone Tower, 26 Richmond Street, Glasgow, Scotland G1 1XH.

An r-adaptive moving mesh method is developed for the numerical solution of an enthalpy formulation of two-dimensional heat conduction problems with a phase change. The grid is obtained from a global mapping of the physical to the computational domain which is designed to cluster mesh points around the interface between the two phases of the material. The enthalpy equation is discretised using a semi-implicit Galerkin finite element method using linear basis functions. The moving finite element method is applied to problems where the phase front is cusp shaped and where the interface changes topology.

Convergent Cartesian Grid Methods for Maxwell's Equations in Complex Geometries. A. Ditkowski,* K. Dridi,† and J. S. Hesthaven.* *Division of Applied Mathematics, Brown University, Box F, Providence, Rhode Island 02912; and †Optics and Fluid Dynamics Department, Risø National Laboratory, DK-4000 Roskilde, Denmark.

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A convergent second order Cartesian grid finite difference scheme for the solution of Maxwell's equations is presented. The scheme employs a staggered grid in space and represents the physical location of the material and metallic boundaries correctly, hence eliminating problems caused by staircasing, and, contrary to the popular Yee scheme, enforces the correct jump-conditions on the field components across material interfaces. A detailed analysis of the accuracy of the new embedding scheme is presented, confirming its second order global accuracy. Furthermore, the scheme is proven to be a bounded error scheme and thus convergent. Conditions for fully discrete stability is furthermore established. This enables the derivation of bounds for fully discrete stability with CFL-restrictions being almost identical to those of the much simpler Yee scheme. The analysis exposes that the effects of staircasing as well as a lack of properly enforced jump-conditions on the field components has significant consequences for the global accuracy. It is, among other things, shown that for cases where a field component is discontinuous along a grid line, as happens at general two- and three-dimensional material interfaces, the Yee scheme exhibits local divergence and loss of global convergence. To validate the analysis several one- and two-dimensional test-cases are presented, showing an improvement of typically 1-2 orders of accuracy at little or no additional computational cost over the Yee scheme, which in most cases exhibits first order accuracy.

A Problem-Independent Limiter for High-Order Runge-Kutta Discontinuous Galerkin Methods. A. Burbeau,* P. Sagaut,* and Ch.-H. Bruneau.† *ONERA, BP 72-29, av. de la Division Leclerc, 92322 Chôtillon Cedex, France; and †Université Bordeaux I, 351, Cours de la Libération, 33405 Talence Cedex, France.

This paper is devoted to the use of discontinuous Galerkin methods to solve hyperbolic conservation laws. The emphasis is laid on the elaboration of slope limiters to enforce nonlinear stability for shock-capturing. The objectives are to derive problem-independent methods that maintain high-order accuracy in regions where the solution is smooth, and in the neighbourhood of shock waves. The aim is also to define a way of taking into account high-order space discretization in a limiting process, to make use of all the expansion terms of the approximate solution. A new slope limiter is first presented for one-dimensional problems and any order of approximation. Next, it is extended to bidimensional problems, for unstructured triangular meshes. The new method is totally free of problem-dependence. Numerical experiments show its capacity to preserve the accuracy of discontinuous Galerkin methods in smooth regions, and to capture strong shocks.