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Abstracts of Papers to Appear

Preconditioning Techniques for Large Linear Systems: A Survey. Michele Benzi. Mathematics and Computer Science Department, Emory University, Atlanta, Georgia 30322.

This article surveys preconditioning techniques for the iterative solution of large linear systems, with a focus on algebraic methods suitable for general sparse matrices. Covered topics include progress in incomplete factorization methods, sparse approximate inverses, reorderings, parallelization issues, and block and multilevel extensions. Some of the challenges ahead are also discussed. An extensive bibliography completes the paper.

Computational Solution of Two-Dimensional Unsteady PDEs Using Moving Mesh Methods. G. Beckett, J. A. Mackenzie, A. Ramage, and D. M. Sloan. Department of Mathematics, University of Strathclyde, Livingstone Tower, 26 Richmond Street, Glasgow G1 1XH, Scotland.

Numerical experiments are described which illustrate some important features of the performance of moving mesh methods for solving two-dimensional partial differential equations (PDEs). Here we are concerned with algorithms based on moving mesh methods proposed by W. Huang and R. D. Russell [*SIAM J. Sci. Comput.* **20**, 998 (1999)]. We show that the accuracy of the computations is strongly influenced by the choice of monitor function, and we present a monitor function which yields a higher rate of convergence than those that are commonly used. In an earlier paper [G. Beckett, J. A. Mackenzie, A. Ramage, and D. M. Sloan, *J. Comput. Phys.* **167**, 372 (2001)], we demonstrated a robust and efficient algorithm for problems in one space dimension in which the mesh equation is decoupled from the physical PDE and the time step is controlled automatically. The present work extends this algorithm to deal with problems in two space dimensions.

Toward an Oscillation-Free, Mass Conservative, Eulerian–Lagrangian Transport Model. Anabela Oliveira and André B. Fortunato. Departamento de Hidráulica, Núcleo de Estuários, Laboratório Nacional de Engenharia Civil, Av. do Brasil 101, 1700-066 Lisboa, Portugal.

Ten numerical schemes to reduce spurious oscillations in transport simulations were implemented and tested in a Eulerian–Lagrangian control-volume finite element model. The schemes included both new and existing flux-corrected transport (FCT) algorithms and nonlinear filters. The ability of the methods to eliminate numerical oscillations while preserving mass and minimizing the introduction of numerical diffusion was compared in 2D tests of varying complexity. The application of local mass correction algorithms was shown to be vital to avoid the introduction of mass errors by FCT. While none of the methods emerged as optimal for all cases, a new FCT method with a local mass correction scheme and a nonlinear filter can be recommended as the best approaches in general. The method of choice depends on the problem being solved, in particular on the concentration gradients and on the grid resolution.

Estimation of Modeling Error in Computational Mechanics. J. Tinsley Oden and Serge Prudhomme. Texas Institute for Computational and Applied Mathematics, The University of Texas at Austin, 201 E. 24th St., Austin, Texas 78712.

We review and extend the theory and methodology of *a posteriori* error estimation and adaptivity for modeling error for certain classes of problems in linear and nonlinear mechanics. The basic idea is that for a given collection

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of physical phenomena a rich class of mathematical models can be identified, including models that are sufficiently refined and validated that they satisfactorily capture the events of interest. These fine models may be intractable, too complex to solve by existing means. Coarser models are therefore used. Moreover, as is frequently the case in applications, there are specific quantities of interest that are sought which are functionals of the solution of the fine model. In this paper, techniques for estimating modeling errors in such quantities of interest are developed. Applications to solid and fluid mechanics are presented.

Eigensolution Analysis of the Discontinuous Galerkin Method with Nonuniform Grids. I. One Space Dimension. Fang Q. Hu* and Harold L. Atkins.† *Department of Mathematics and Statistics, Old Dominion University, Norfolk, Virginia 23529; and †NASA Langley Research Center, Hamptom, Virginia 23681.

We present a detailed study of spatially propagating waves in a discontinuous Galerkin scheme applied to a system of linear hyperbolic equations. We start with an eigensolution analysis of the semidiscrete system in one space dimension with uniform grids. It is found that for any given order of the basis functions, there are at most two spatially propagating numerical wave modes for each physical wave of the partial differential equations (PDE). One of the modes can accurately represent the physical wave of the PDE and the other is spurious. The directions of propagation of these two numerical modes are opposite, and, in most practical cases, the spurious mode has a large damping rate. Furthermore, when an exact characteristics split flux formula is used, the spurious mode becomes nonexistent. For the physically accurate mode, it is shown analytically that the numerical dispersion relation is accurate to order $2p+2$, where p is the highest order of the basis polynomials. The results of eigensolution analysis are then utilized to study the effects of a grid discontinuity, caused by an abrupt change in grid size, on the numerical solutions at either side of the interface. It is shown that due to "mode decoupling," numerical reflections at grid discontinuity, when they occur, are always in the form of the spurious nonphysical mode. Closed-form numerical reflection and transmission coefficients are given and analyzed. Numerical examples that illustrate the analytical findings of the paper are also presented.