Journal of Computational Physics **175,** 793–794 (2002)
doi:10.1006/jcph.2001.6988, available online at http://www.idealibrary.com on IDEAL®

Abstracts of Papers to Appear

A Nonlinear Flux Split Method for Hyperbolic Conservation Laws. Youssef Stiriba. CERFACS/CFD Team, 42 Avenue Gaspard Coriolis, 31057 Toulouse Cedex 1, France.

We present and analyze the performance of a nonlinear, upwind flux split method for approximating solutions of hyperbolic conservation laws. The method is based on a new version of the single-state-approximate Riemann solver devised by Harten, Lax, and van Leer (HLL) and implemented by Einfeldt. It makes use of two-sided local characteristic variables to reduce the dissipation of HLL by introducing the flavor of HLL into the Steger–Warming flux vector splitting scheme. We use the characteristic decomposition and the method-of-lines approach to construct high-order versions of the first-order scheme and demonstrate their efficiency and robustness in several numerical tests.

Grid Adaptation for Functional Outputs: Application to Two-Dimensional Inviscid Flows. David A. Venditti and David L. Darmofal. Massachusetts Institute of Technology, Department of Aeronautics and Astronautics, 77 Massachusetts Avenue, Room 37-442, Cambridge, Massachusetts 02139.

This paper presents an error estimation and grid adaptive strategy for estimating and reducing simulation errors in integral outputs (functionals) of partial differential equations. Adaptive criteria are derived using an adjoint-based error correction technique that relates the local residual errors of both the primal and adjoint solutions to the global error in the prescribed functional. This relationship allows local error contributions to be used as indicators in a grid adaptive strategy designed to produce specially tuned grids for accurately estimating the chosen functional. In this paper, attention is limited to two-dimensional inviscid flows using a standard finite volume discretization, although the procedure may be readily applied to other types of multidimensional problems and discretizations. Numerical examples demonstrate that the proposed adaptive procedure compares favorably in terms of accuracy, efficiency, and robustness relative to a commonly used gradient-based adaptive method.

2D Simulation of a Silicon MESFET with a Nonparabolic Hydrodynamical Model Based on the Maximum Entropy Principle. Vittorio Romano. Dipartimento di Matematica e Informatica, Universitá di Catania, viale A. Doria 6, 95125 Catania, Italy.

A hydrodynamical model for electron transport in silicon semiconductors, which is free of any fitting parameters, has been formulated on the basis of the maximum entropy principle. The model considers the energy band to be described by the Kane dispersion relation and includes electron–nonpolar optical phonon and electron–acoustic phonon scattering. The set of balance equations of the model forms a quasilinear hyperbolic system and for its numerical integration a recent high-order shock-capturing central differencing scheme has been employed. Simulations of an n^+–n–n^+ silicon diode have been presented and comparison with Monte Carlo data shows the good accuracy of the model and performance of the numerical scheme. Here the results of simulations of a silicon MESFET in the two-dimensional case are presented. Both the model and the numerical scheme demonstrate their accuracy and efficiency as CAD tools for modeling realistic submicron electron devices.

Reference Jacobian Optimization-Based Rezone Strategies for Arbitrary Lagrangian Eulerian Methods. Patrick Knupp,* Len Margolin,† and Mikhail Shashkov.‡ *Parallel Computing Sciences Department, Sandia National Laboratories, MS-0847, P.O. Box 5800, Albuquerque, New Mexico 87185-0847; †Center for Nonlinear

0021-9991/02 $35.00

Studies, Los Alamos National Laboratory, MS-B258, Los Alamos, New Mexico 87545; and ‡Theoretical Division, T-7, Los Alamos National Laboratory, MS-B284, Los Alamos, New Mexico 87545.

The philosophy of the arbitrary Lagrangian–Eulerian (ALE) methodology for solving multidimensional fluid flow problems is to move the computational grid, using the flow as a guide, to improve the accuracy and efficiency of the simulation. A principal element of ALE is the rezone phase in which a “rezoned” grid is created that is adapted to the fluid motion. We will describe a general rezone strategy that ensures the continuing geometric quality of the computational grid, while keeping the “rezoned” grid as close as possible to the Lagrangian grid at each time step. Although the methodology can be applied to more general grid types, here we restrict ourselves to logically rectangular grids in two dimensions. Our rezoning phase consists of two components: a sequence of local optimizations followed by a single global optimization. The local optimization defines a set of “reference” Jacobians which incorporates our definition of mesh quality at each point of the grid. The set of reference Jacobians then is used in the global optimization. At each node we form a local patch from the adjacent cells of the Lagrangian grid and construct a local realization of the Winslow smoothness functional on this patch. Minimization of this functional with respect to the position of the central node defines its “virtual” location (the node is not actually moved at this stage). By connecting this virtually moved node to its (stationary) neighbors, we define a reference Jacobian that represents the best locally achievable geometric grid quality. The “rezoned” grid results from a minimization (where the points are actually moved) of a global objective function that measures the distance (in a least-squares sense) between the Jacobian of the rezoned grid and the reference Jacobian. This objective function includes a “barrier” that penalizes grids whose cells are close to being inverted. The global objective function is minimized by direct optimization leading to the rezoned grid. We provide numerical examples to demonstrate the robustness and effectiveness of our methodology on model examples as well as for ALE calculations of Rayleigh–Taylor unstable flow.

A Cartesian Grid Method for Solving the Two-Dimensional Streamfunction-Vorticity Equations in Irregular Regions. Donna Calhoun. Courant Institute of Mathematical Sciences, 251 Mercer Street, New York, New York 10012-1185.

We describe a method for solving the two-dimensional Navier–Stokes equations in irregular physical domains. Our method is based on an underlying uniform Cartesian grid and second-order finite-difference/finite-volume discretizations of the streamfunction-vorticity equations. Geometry representing stationary solid obstacles in the flow domain is embedded in the Cartesian grid and special discretizations near the embedded boundary ensure the accuracy of the solution in the cut cells. Along the embedded boundary, we determine a distribution of vorticity sources needed to impose the no-slip flow conditions. This distribution appears as a right-hand-side term in the discretized fluid equations, and so we can use fast solvers to solve the linear systems that arise. To handle the advective terms, we use the high-resolution algorithms in CLAWPACK. We show that our Stokes solver is second-order accurate for steady state solutions and that our full Navier–Stokes solver is between first- and second-order accurate and reproduces results from well-studied benchmark problems in viscous fluid flow. Finally, we demonstrate the robustness of our code on flow in a complex domain.