Insight into the Accuracy of Adaptive Grid Methods for Captured Shocks

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Abstract

The accuracy of two grid adaptation strategies: 1) grid redistribution and 2) local grid refinement, is examined by solving the 2–D Euler equations for the supersonic steady flow around a cylinder. Second- and fourth-order linear finite difference shock-capturing schemes, based on the Lax-Friedrichs flux splitting, are used to discretize the governing equations. As the grid is locally refined or clustered near the shock, the first-order error component resulting from the shock-capturing procedure decreases, while the high-order error component drastically increases because of the grid nonuniformity. The comparison of uniform and both adaptive grids results shows that the numerical solution obtained on a uniform grid with the same number of grid points is more accurate in the L_2 norm sense in regions away form the shock. Furthermore, it is found that both the local grid refinement and grid redistribution methods do not practically improve accuracy of the pressure integral across the shock compared to that calculated on the corresponding uniform grid. These results are in contrast to the general belief that multidimensional grid adaptation methods improve the accuracy of captured discontinuities. We present a simple analysis that reveals the main problems associated with both grid adaptation techniques, ultimately producing a reduction in the numerical solution accuracy.