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ANALYSIS OF COMPONENT-WISE FINITE DIFFERENCE WENO SCHEMES FOR CONSERVATION LAWS

Content :

High Resolution Shock Capturing (HRSC) schemes are nowadays one of the most used schemes for the computation of accurate numerical approximations to the solution of hyperbolic systems of conservation laws. Most of these schemes emerge form a clever combination of an upwinding framework, in which the iscretization of the equations on a mesh is performed according to the direction of propagation of information on that mesh, and a high order interpolation method as a mechanism to prevent the creation and evolution of spurious numerical oscillations.

We center our work on the use of component-wise schemes as an alternative to the use of characteristic wise schemes, based on the use of the spectral decomposition of the Jacobian matrix of the fluxes for upwinding, because in many cases this information is not available or is quite difficult to obtain. We explore some flux-splitting schemes, such as the Global Lax Friedrichs flux-splitting (GLF) and one based on using a biased flux-splitting that uses the estimated values of the minimum and maximum eigenvalues of the Jacobian matrix of the fluxes, instead of the spectral radius of it, as GLF schemes do. This new scheme reduces the spurious oscillations that may appear when using GLF scheme.

To reduce this oscillatory behavior we also work on redesigning the weights used in the WENO reconstructions proposed in [G.-S. Jiang and C.-W. Shu, Efficient implementation of weighted ENO schemes, J. Comput. Phys., 126(1), 1996] in our HRSC schemes. We compare the results obtained using a global definition of the smoothness indicators developed in [D. Levy, G.Puppo and G.Russo, A fourth-order central weno scheme for multidimensional hyperbolic systems of conservation laws, SIAM J. Sci. Comput. 24, 2002], using the weights defined by Yamaleev and Carpenter in [N.K. Yamaleev and M.H. Carpenter, A systematic methodology for constructing high-order energy stable WENO schemes, J. Comput. Phys., 228, 2009] and finally the new

weights, proposed in [F. Arandiga, M.C. Marti and P. Mulet, Weights design for maximal order WENO schemes, to appear], to prove that when using our proposed weights we reduce the oscillatory behavior while maintaining the high resolution of the scheme.

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