Multi-step Weighted Essentially Non-oscillatory Scheme

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A fifth-order accurate multi-step weighted essentially non-oscillatory (WENO) scheme is constructed in this paper. Different from the traditional WENO schemes, which are designed to have ($2r-1$)th order accuracy in the smooth regions directly from r candidate stencils, the new scheme is constructed through ($r-1$) weighting steps. In each step, only two neighboring stencils are used to construct the intermediate fluxes (or the final flux), which are only one order higher than the fluxes obtained from the previous step. Henrick's mapping function is used in each step to satisfy the sufficient condition of fifth-order convergence for a fifth-order WENO scheme, hence the new scheme is fifth-order accurate in smooth regions. The distinctive advantage of the new scheme is that it can improve the accuracy by one order higher than the traditional WENO schemes at transition points (connecting a smooth region and a discontinuity point), and hence it improves the accuracy in the regions near discontinuities. Numerical examples show that the new scheme is efficient and robust, and is less dissipative than the traditional fifth-order WENO schemes.

Keywords: Numerical method; weighted essentially non-oscillatory scheme; shock wave; complex flowfield simulation.