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ACCURACY IMPROVEMENT OF COMPACT TYPE SHOCK CAPTURE SCHEME WITH MULTI-STEP STRATEGY FOR SUPERSONIC TURBULENT FLOW

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In this paper, we present a multi-step reconstruction strategy to improve accuracy of compact type weight essentially non-oscillation schemes. In supersonic turbulent flow, discontinuities and small scale motions present simultaneously. To capture discontinuity, various kinds of shock-capture methods were developed and showed excellent performance in compressible flow simulation with shock. To resolve small scale structures, compact schemes were designed and applied to incompressible turbulent flow yielding exciting results. However, both of shock-capture schemes and compact schemes are not suitable for supersonic turbulence simulation that shock-capture schemes have a high dissipation rate which may overwhelm small scale structures while compact schemes lead to non-physical oscillation near shock. Among all existing compact type shock capture schemes, a recent effort to combine WENO scheme and compact scheme is the compact-reconstructed WENO (CRWENO) scheme (Ghosh & Baeder *SIAM J. Sci. Comput.*, 34 (**3**) 2012). This scheme may resolve small scale motions in smooth region well and captures shock without numerical oscillation. It is claimed that the CRWENO scheme is 5th-order accuracy in smooth region. However, present accuracy analysis of CRWENO scheme shows that it is second order accuracy at points between discontinuities. This may decreases accuracy for complex flow with arbitrary distribution of shocks and small scale structures such as supersonic turbulent flow with shocklets. To improve accuracy of CRWENO scheme, a multi-step strategy is employed to construct numerical flux. Firstly, two four-order stencils are constructed based on existing three 3-order stencils. Then, the numerical flux is reconstructed by these two 4-order stencils according to their weights. In this way, accuracy at all points in such circumstance is improved from 2nd-order to 3rd-order, two points near discontinuity is improved to 4th order. Numerical results of one-dimensional problems show that present method improves accuracy at all points between discontinuities compared with CRWENO scheme and WENO scheme. To further evaluate present scheme, two dimensional supersonic circular cylinder flow at various Mach numbers is

simulated. Finer wake structure of circular cylinder is obtained in comparison with CR-WENO scheme and WENO scheme. Vortex/shock interaction, shear layer development and vortex shedding are well resolved. As it has been shown, accuracy of compact type scheme is not satisfactory at points between two discontinuities. Present muti-step strategy may serve as a guide for future improvement of compact type scheme for supersonic turbulent flow simulation.

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