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EFFICIENT AND ACCURATE MULTI-DIMENSIONAL LIMITING STRATEGY FOR HIGHER-ORDER DG AND CPR METHODS

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Multi-dimensional limiting process (MLP) has been developed quite successfully in FVM. Compared with traditional limiting strategies, such as TVD or ENO-type schemes, MLP effectively controls unwanted oscillations particularly in multiple dimensions. The oscillation-control (or shock-capturing) mechanism has been established by combining the local maximum principle and the multi-dimensional limiting (MLP) condition, which leads to the formulation of the efficient and accurate MLP-u slope limiters [1].

Recently, this limiting philosophy has been hierarchically extended into higher-order methods, such as discontinuous Galerkin (DG) method and correction procedure via reconstruction (CPR) method. The resulting algorithm, called the hierarchical MLP, facilitates the accurate capturing of detailed flow structures in both smooth and discontinuous regions [2]. Troubled-cells are detected within the MLP concept, and the projection procedure and MLP slope limiter hierarchically determines sub-cell distributions. As a result, the proposed method can provide multi-dimensional monotonic solutions without compromising the formal order of accuracy of DG and CPR methods in smooth region. Based on the previous progresses, a robust and accurate but simple form of higher-order MLP limiting is provided so that it can handle complex vortical structures on unstructured grids accurately, even if such flow features interact with strong shocks.

At the present stage, some two and three dimensional numerical experiments are performed to validate its performance. Figure 1 compares the computed results for the double Mach reflection problem, one of the well-established benchmark tests for high-resolution methods. MLP limiting with $P3$ DG and CPR methods successfully controls oscillations around strong shocks and provides enhanced resolution around the Mach stem. As a viscous computation, three-dimensional oblique shock-mixing layer problem is computed

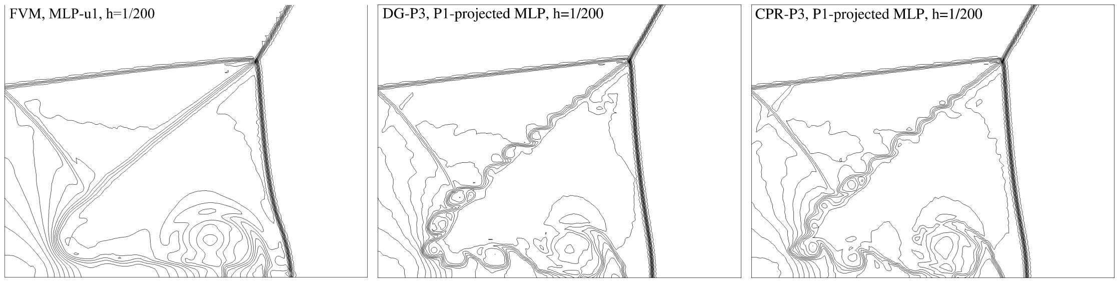

Figure 1: Comparison of density contours around the double Mach stem.

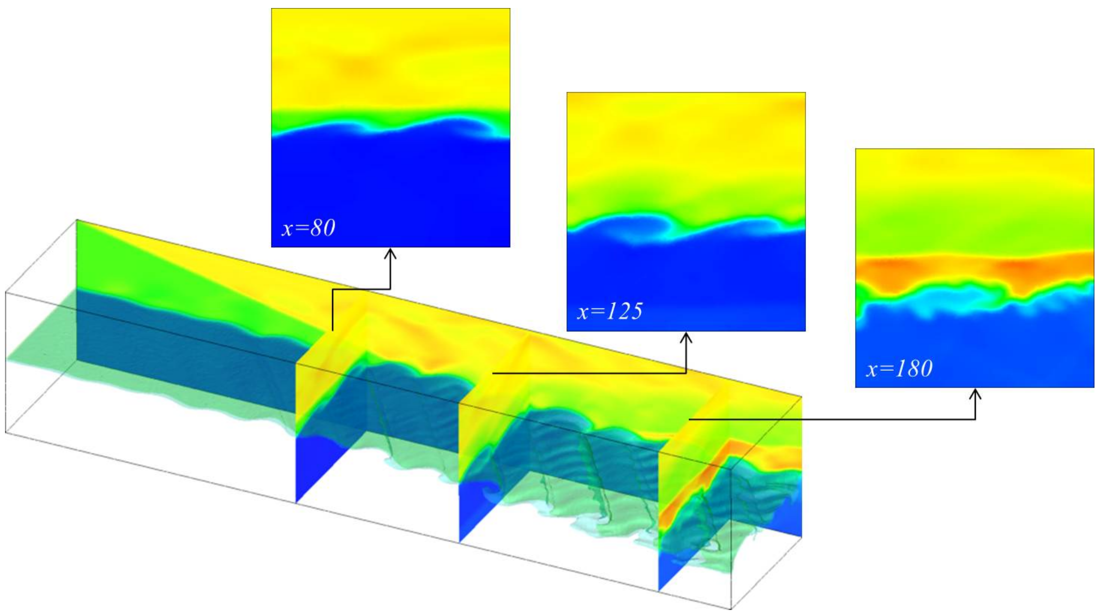

Figure 2: Spanwise density distribution of three-dimensional oblique shock-mixing layer interaction at $t = 120$.

by DG-$P2$ with MLP, as shown in Fig. 2. It is seen that the proposed method can resolve detailed flow structure, especially for the downstream shock-vortex interaction.

In the final paper, we are going to carry out extensive numerical experiments on triangular and tetrahedral meshes, explore and compare numerical features of the proposed limiting for higher-order DG and CPR methods.

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