High-performance Large Eddy Simulation using High-order Discontinuous Galerkin Method

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ABSTRACT

The direct reconstruction method (DRM) is applied to the high-order discontinuous Galerkin (DG) method for solving multi-dimensional compressible Navier-Stokes (NS) equations [1-3]. In the DRM-DG method, flux functions in spatial integrals of DG weak formulation are represented via generalized reconstruction that is a generalized concept of interpolation in which the number of reconstruction nodes is larger than the number of interpolants. As a result, each spatio-temporal flux is decomposed into spatial and temporal terms separately. The integral of the spatial term is then precomputed in a pre-processing step. This approach significantly reduces computational costs compared with the conventional quadrature-based DG method when high-order mixed-curved meshes are employed. To validate the DRM-DG method, transitional flows (Figs. 1 and 2) are solved by the large eddy simulation (LES). For time-marching, both explicit and implicit Runge-Kutta (RK) multi-stage methods are considered, and the generalized minimal residual (GMRES) method with the incomplete lower-upper factorization (ILU) preconditioner is considered as a linear system solver for the implicit RK method. Computed results confirm that the DRM-DG method successfully resolves the physical characteristics of transitional flows and significantly improves the computational performance of LES compared to the quadrature-based DG method.

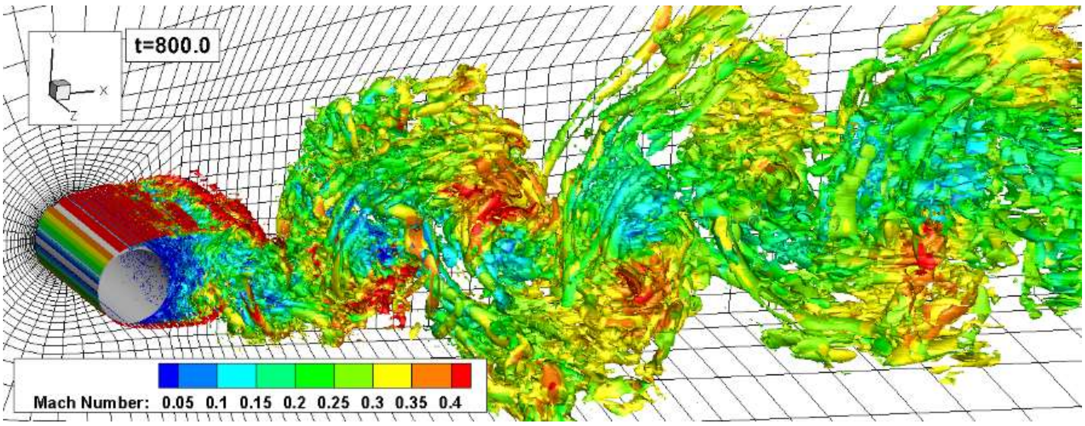

Figure 1. LES analysis of a transitional flow over a circular cylinder.

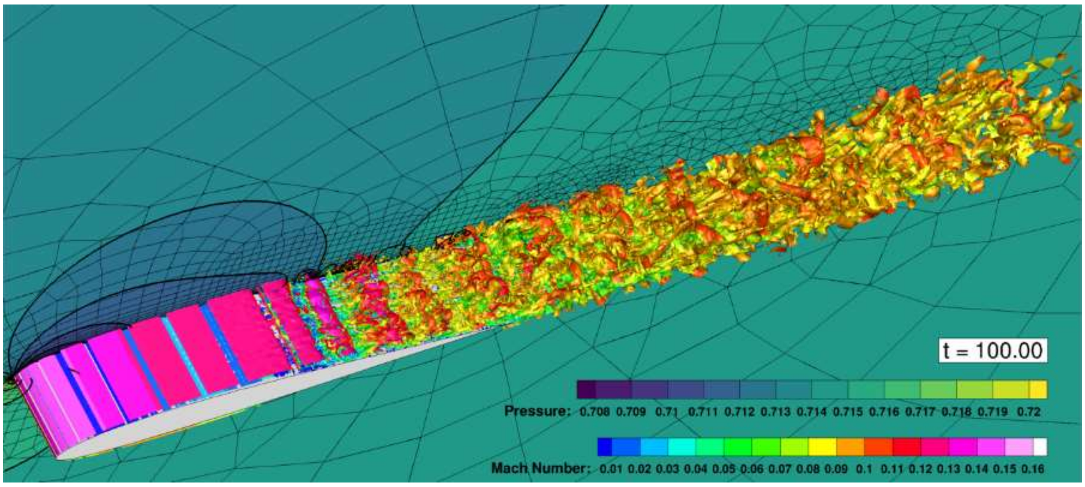

Figure 2. LES analysis of a transitional flow over the SD7003 airfoil.

REFERENCES

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