The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Shock-capturing for high-order discontinuous Galerkin solvers

Yu Pan[1], Zhen-Guo Yan[1,2], Spencer J. Sherwin[1] and Joaquim Peiró[1]

[1] Department of Aeronautics, Imperial College London, South Kensington Campus, London SW7 2AZ, U.K. {yu.pan16; z.yan17; s.sherwin; j.peiro}@imperial.ac.uk
[2] State Key Laboratory of Aerodynamics, China Aerodynamics Research and Development Center, Mianyang, China. zgyan@skla.cardc.cn

Keywords: *Compressible flow, Shock-capturing, High-order hp/spectral methods, Discontinuous Galerkin methods, Artificial viscosity*

The purpose of this work is to identify a suitable shock-capturing strategy for improving the robustness and efficiency of high-order discontinuous Galerkin (DG) compressible Navier-Stokes solvers. The implementation of shock capturing requires a sensor able to identify discontinuities in the simulated flow, and a numerical device to prevent the appearance of oscillations near discontinuities.

We have adopted the highest modal decay sensor proposed in reference [1] to identify the elements where the presence of discontinuities triggers oscillations. To smooth these oscillations, we have assessed approaches based on the addition of artificial viscosity terms incorporating bulk stresses [2], shear stresses [3], and Laplacian operators. The Laplacian form is overly dissipative, whilst the addition of bulk stresses performs well but exhibits oscillations in density, and the shear stress form is the most dissipative for strong shear layers.

Following this assessment, we have devised an artificial viscosity term based on a combination of bulk stresses with additional terms in the density and energy components, and shear stresses.

The shock-capturing performance of the new formulation of the artificial viscosity terms will be illustrated using two-dimensional benchmark problems such as the Riemann problem and the shock vortex interaction.

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