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COMPARISON OF HYBRID AND STANDARD DISCONTINUOUS GALERKIN METHODS IN A MESH-OPTIMIZATION SETTING

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Computational fluid dynamics has advanced at a rapid pace over the last several decades, driven by improvements in both hardware and algorithms. These advancements have made possible large-scale fluid dynamics simulations, with detailed physics and over intricate geometries. However, as simulations become more complex, so does the task of ensuring accuracy of the results, a task that cannot be robustly performed by expert practitioners due to the size and complexity demands of current problems.

High-order methods improve the resolution of simulations, but at a price of increased computational costs and memory requirements. Furthermore, flow features such as discontinuities or singularities in derivative quantities do not lend themselves to efficient resolution via high order. To address these shortcomings, we study the performance of high-order methods in a mesh-adaptive setting guided by output error estimates. The adaptive setting is based on a discretization-specific optimization approach and yields meshes tailored to both the problem (output) of interest and the spatial/temporal discretization used. This setting allows for an efficient distribution of mesh resolution in cases with flow singularities, and for a fair comparison between various discretizations and orders of approximation.

In the present work, we compare the performance of high-order schemes derived from the discontinuous Galerkin (DG) finite element method. These schemes include traditional DG and hybridized/embedded versions (HDG [1], EDG [2]). The target set of equations is compressible Navier-Stokes, and for cases of engineering interest we assess convergence of outputs with degrees of freedom and computational time, memory demands and solver complexity, and the requirements on mesh resolution at different approximation orders.

REFERENCES

[1] K.J. Fidkowski. A hybridized discontinuous Galerkin method on mapped deforming domains. *Computers and Fluids.* (2016) **139**(5), pp. 80–91.

[2] N.C. Nguyen and J. Peraire and B. Cockburn. A class of embedded discontinuous Galerkin methods for computational fluid dynamics. *Journal of Computational Physics.* (2015) **302**, pp. 674–692.