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AUTOMATIC HP ADAPTATION FOR DISCONTINOUS GALERKIN BY MEANS OF τ-ESTIMATION

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A nodal explicit high order DG code has been developed. The Euler equations have been discretized using a Discontinuous Galerkin Spectral Element Method (DGSEM) coupled with a low storage Runge-Kutta time integration scheme of order three [1].

To increase the flexibility of the solver a mortar element method [2] was implemented to couple the element faces when hanging nodes or elements with varying polynomial orders are used in the computational mesh.

The novelty of the method, is the possibility to perform automatic local spatial adaption (using either h or p refinement) based on τ-estimation. A mesh adaptation algorithm, based on the truncation error estimation by means of τ-estimation, was developed by Fraysse *et al.* in Finite Volumes, resulting in a very efficient and cheap adaptation sensor [4]. The τ-estimation method was successfully extended from low to high order methods by Rubio *et al.* [3].

The adaptation algorithm developed selects the optimum size (h) and polynomial order (p) in each element based on the value and the rate of convergence of the truncation error. Furthermore the truncation error estimation permits the decoupling of the polynomial order in each spacial dimension which optimizes the computational cost. The adaption algorithm developed is compared to other adaptation algorithms found in the literature.

The adaption techniques were tested on a Transsonic airfoil with M=0.8 and angle of attack α=1.25 with Euler Equations. Furthermore a source flow problem was choosen as a test case.

REFERENCES

[1] D. A. Kopriva. Implementing Spectral Methods for Partial Differential Equations: Algorithms for Scientists and Engineers. Springer Publishing Company, 1st edition, 2009.

[2] Kopriva, David A and Woodruff, Stephen L and Hussaini, M Yousuff. Computation of electromagnetic scattering with a non-conforming discontinuous spectral element method. International journal for numerical methods in engineering, 2002

[3] G. Rubio, E. Valero, F. Fraysse, and J. de Vicente. The Estimation of Truncation Error by tau-Estimation for Chebyshev Spectral Collocation Method. Journal of Scientific Computing, 1-28, 2013.

[4] François Fraysse, Eusebio Valero, Jorge Ponsin. Comparison of Mesh Adaptation Using the Adjoint Methodology and Truncation Error Estimates. AIAA Journal, Vol 50. Number 9. 2012.