Adaptive Refinement for Compressible Flow Analysis using an Isogeometric Discontinuous Galerkin Method

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ABSTRACT

This work aims at developping an efficient isogeometric approach to simulate compressible flows including shocks. The use of the classical isogeometric analysis method based on a finite-element formulation [1] is tedious in this context, due to the necessity to introduce suitable terms for stabilization and shock capturing. Therefore, an alternate formulation is explored, based on a Discontinuous Galerkin formulation, better suited to hyperbolic conservation laws [2]. This approach relies on the *Bézier extraction* technique to transform NURBS patches into a set of discontinous rational elements without altering the geometry. It has been shown [3] that the resulting method exhibits optimal convergence rates for regular solutions, allows a sharp capture of discontinuities and preserves CAD-based geometries.

On this basis, the present work focuses on the use of adaptive refinement techniques to improve the computational efficiency. An error indicator based on the measure of the solution jump at element interfaces is introduced, in conjunction with a dynamic refinement and coarsening technique for rational Bézier elements based on multiple knot insertion. We show that this approach allows a significant reduction of the computational time and preserves the convergence rates. In particular, a local refinement is achieved in regions where rapid variations of the solution are observed, while a coarse discretization is maintained in other regions without altering the geometry. Illustrations are provided for unsteady Euler equations, with and without shocks, and compressible Navier-Stokes equations.

REFERENCES

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