Solving Compressible Flow Problems by Isogeometric Analysis

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Abstract

Isogeometric Analysis (IgA), introduced in (Hughes et al. 2005), aims at bridging the gap between Finite Element Analysis (FEA) and Computer-Aided Design (CAD) by extending classical FEA towards ansatz functions such as B-splines or NURBS (non-uniform rational B-splines), which enable the more precise or even exact representation of complex geometry objects. Since its introduction IgA gained popularity in many computational mechanics and fluid dynamics applications but its use in compressible flow calculations is very limited.

In this paper, we present our implementation of a positivity-preserving isogeometric high-resolution scheme for compressible flow problems in the open-source library G+Smo (Jüttler et al. 2014). It builds upon the generalisation of the algebraic flux correction paradigm (Kuzmin et al. 2012) to multi-patch IgA as universal building block for the design of positivity-preserving high-order discretizations. In particular, we analyze techniques for the positivity-preserving multi-patch coupling and boundary treatment.

Our implementation adopts Fletcher's group formulation (Fletcher 1983) together with an efficient edge-based formation of system matrices and vectors (Göddeke et al. 2014) from pre-computed coefficients to overcome the high computational costs that are typically observed in quadrature-based IgA-assembly algorithms. Finally, we extend our solution algorithm to a space-time formulation that makes it possible to combine high-order approximations in space and time. The suggested approach is applied to several test problems for compressible flows.

References

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