Constitutive Relation Error Method (CRE) for linear problems solved using Isogeometric Analysis

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ABSTRACT

The paper focuses on the application of the Constitutive Relation Error method (CRE) for a posteriori error estimation in Isogeometric Analysis (IGA). IGA enables to represent exactly the geometry of mechanical problems based on basis functions generated from Non-uniform Rational B-Splines (NURBS). The exact geometry in IGA can be maintained at the coarsest level of discretization. This helps to directly eliminate the error sources due to the violation of geometry, approximation of applied loads and boundary conditions without additional assumption.

In the present work, the CRE concept is used to assess the discretization error, and potentially other error sources, from the approximate IGA solutions not satisfying the equilibrium conditions. Essentially, the principles for the construction of so-called admissible (equilibrated) fields construction in the framework of IGA are identical to these in FEM. However, since B-splines or NURBS shape functions of IGA are established for control points instead of physical nodes, a relevant nomination for components of force densities was proposed to facilitate their determination. The construction is furthermore performed at the knot span level. Two first numerical examples are presented: a linear elasticity problem of L-shape console beam with a singularity point, and a heat transfer problem in an annulus. They are typical test cases where IGA was proven to be superior to FEM. The obtained results show the potential power of CRE in estimating errors of IGA solutions for linear problems. In addition, an extension of the CRE tool for controlling the error when coupling IGA and PGD model reduction is proposed.

REFERENCES

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