Bézier extraction-based implementation and adaptive refinement/coarsening of truncated hierarchical NURBS

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ABSTRACT

This contribution presents Bézier extraction of truncated hierarchical B-splines and the application of the approach to Adaptive Isogeometric Analysis. The developed procedures allow for the implementation of hierarchical B-splines and NURBS without the need for an explicit truncation of the basis. Moreover, standard procedures of adaptive finite element analysis for error estimation and marking of elements are directly applicable due to the strict use of an element viewpoint.

Starting from a multi-level nested mesh that results from uniform *h*-refinement, standard Bézier extraction is applied to active elements that contribute to the hierarchical approximation. This results in a multi-level system of equations without communication between individual hierarchy levels.

A hierarchical subdivision operator is developed to recover this communication by transforming the multi-level system of equations into a hierarchical system of equations. It is demonstrated that this approach implicitly defines the truncated hierarchical basis in terms of a simple matrix multiplication. In this way, the implementation effort is reduced to a minimum as shape function routines and Bézier extraction procedures remain unchanged compared to standard isogeometric analysis.

The convergence and the computational efficiency of the approach are examined various demonstration problems of heat conduction, linear elasticity, and phase-field modelling.

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