Hierarchical Refined Stable B-splines for Trimmed Geometries

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ABSTRACT

Trimming is a fundamental technique in geometric design which allows representing arbitrary shapes by tensor product patches. The distinguishing feature of the resulting trimmed patches is that only a certain part of them is *visualized*. Their mathematical description, however, is *not* changed and is *never* updated to reflect the visualized shape. Trimming procedures are simple from a conceptional point of view, but they lead to profound consequences and complications when trimmed models are applied to downstream applications [4].

General issues regarding a direct analysis of trimmed models are the detection of the visualized area, proper integration over this domain of interest, treatment of multipatch objects, and stabilization of trimmed parameter spaces. In this work, the latter aspect is addressed. Due to the trimming procedure, the tensor product basis is truncated which yields to degenerate basis functions with arbitrary small supports. Thus, the condition number of corresponding system matrices may become very large. This affects the performance of iterative solvers and may lead to unstable solutions.

In order to obtain a stable trimmed basis for isogeometric analysis, it is proposed to use a combination of extended B-splines [3, 5] and hierarchical refinement [1, 2]. The stabilization is accomplished by substituting degenerate basis functions by linear combinations of non-degenerate ones. The resulting stable piecewise polynomial functions are referred to as extended B-splines. Furthermore, local hierarchical refinement is employed to increase the flexibility of the procedure. A collocation based isogeometric boundary element formulation is used for the analysis. The properties of proposed approach are examined and verified with a number of test examples.

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