Adaptive Simulation of Plates and Shells with Hierarchical B-Splines.

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ABSTRACT

The novel paradigm of Isogeometric Analysis (IGA) [1] applied to the Finite Element Method (FEM) has been a thriving area of research in recent years, aiming at tightening the gap between design and analysis. In Computer Aided Design (CAD) the standard representation of shapes is obtained via the so-called Boundary Representation (B-rep), which greatly simplifies the integration between CAD and dimensionally-reduced models, such as plates and shells. Additionally, thanks to the higher inter-element regularity of B-Splines compared to standard finite elements, fourth-order Partial Differential Equations (PDEs) (i.e. the governing equations of plates and shells) can be discretized in a straight-forward manner, without the need of additional degrees of freedom.

However, due to the tensor product nature of IGA, local refinement is a pivotal area of research in the IGA community. Furthermore, how to properly capture sharp features in the solution and how to trigger an adaptive method to resolve those features are still wide open questions in mechanical problems.[2]

In this work, we propose a new a-posteriori error estimator for plates and shells, which is computationally efficient and does not require the evaluation of the residual in a strong form. This is a crucial advantage, since the evaluation of the residual requires the computation of derivatives of shape functions up to order four (on a surface in case of a shell). In particular, starting from the work of [3], we develop an adaptive algorithm for fourth-order PDEs which is simple and performs well in steering adaptive simulations. Through several numerical examples on both smooth and singular benchmarks we show the reliability and efficiency of the proposed method.

REFERENCES

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