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Trimming, Mapping, and Optimization in Isogeometric Analysis of Shell Structures

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Zusammenfassung

The design and the analysis of thin-walled structures rely on the quality of the geometric models. Isogeometric Analysis provides a natural framework in considering both models as one. Consequently, geometrical errors are excluded by construction. In order to extend the applicability of Isogeometric Analysis, a combination of reconstruction and coupling methods is proposed to perform analysis on trimmed NURBS surfaces. This approach comprises trimmed single and multi-patch surfaces. The performance of this new methodology is highlighted in various examples. Moreover, a new concept, denoted as Isogeometric Load Design, is derived. This method enables to define areas of arbitrary shape to be subjected to a given loading. In particular, these loading areas do not have to conform with the underlying parameterization. Thus, a new feature is added to the framework of integrated design and analysis.

Another aspect in the design and analysis of thin-walled structures deals with shape optimization. It can be shown that Isogeometric Analysis and Shape Optimization merge naturally. Moreover, the equality of the involved models provides several advantages compared to the classical approaches. Additionally, it is demonstrated that only the coefficients of a gradient field and not the discrete gradient vectors should be applied to update the design. Otherwise, the influence of the individual design variables and its basis functions is not correctly reflected. In a next step, Isogeometric Shape Optimization is extended from single patch problems to multi-patches. The need for a continuity constraint on the optimization model is delineated and a variational formulation of this constraint is introduced. This formulation provides the possibility to handle design models consisting of conforming and nonconforming multi-patches. At several examples, it is highlighted that this constraint can be used to perpetuate continuity across patch boundaries. Moreover, it is shown that initial non-smoothly joined patches can be transformed during the optimization procedure into a smooth multi-patch shape.