An embedded isogeometric Kirchhoff-Love shell formulation for the shape optimization of non-conforming multi-patch and stiffened structures

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ABSTRACT

Isogeometric shape optimization uses a unique model for the geometric description and for the analysis [1]. The benefits are multiple: in particular, it avoids tedious procedures related to mesh updates. However, isogeometric shape optimization has so far been mainly applied to simple structures modelled by single patch geometries. It is known that for real-world structures, multipatch models are required. Furthermore, non-conforming junctions and trimmed configurations are often inevitable. This issue is not only challenging for the analysis, but it also raises geometric difficulties during the shape updates. Thus, we develop a new approach by employing the Free-Form Deformation principle [2]. Surfaces are embedded into volumes in order to tackle the geometric constraint of connecting interfaces between given patches during the shape modifications. For the analysis, we introduce the embedded Kirchhoff-Love shell formulation where the mid-surface is represented by a NURBS composition while the displacement field is approximated using the same spline functions as for the embedded surface [3]. Finally, a new mortar method is formulated to couple the non-conforming Kirchhoff-Love shells. It provides the possibility to use domain decomposition methods which allows to distribute the patches amongst several processors running in parallel, at a very competitive cost. We apply the developed method to optimize stiffened structures widely used in aeronautics.

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