Patch-wise Integration of Trimmed Surfaces

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Key Words: *Isogeometric Analysis (IGA), patch-wise integration, trimming.*

In the Isogeometric Analysis (IGA), the numerical integration can simplistically be performed using a standard "p+1" Gauss rule (p being the degree of the approximation). However, IGA uses non-uniform rational B-splines (NURBS) as shape functions which inherit a high smoothness. Therefore, it is possible to apply a numerically more efficient integration with fewer quadrature points. This is considered in patch-wise integration rules [1]. These rules are based on the tensor product construction of NURBS surfaces, and, thus, do not apply to trimmed geometries.

Complex NURBS geometries in CAD are mostly modelled employing trimming techniques. Therefore, IGA should be capable of dealing with trimmed geometries to fulfil its promise to carry out structural analysis directly on CAD geometries. Multiple methods for the Isogeometric Analysis of trimmed structures were presented over the last years (an overview is provided in [2]).

We herein propose a method which enables the application of patch-wise integration rules for trimmed surfaces. Thus, our approach is computationally more efficient by reducing the overall number of quadrature points. Our results are in good agreement with the results obtained by a well-established local trimming approach which follows the procedure mentioned in [3] for the distinction of trimming cases and applies the blending function method described in [4] for determining quadrature points of trimmed elements. In order to assess our new patch-wise integration method, we perform geometrically linear and non-linear structural analysis with isogeometric Kirchhoff-Love shell elements and validate our results with respect to reference solutions obtained from single patch, multi-patch and classical trimming models.

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