Hybrid Galerkin-collocation methods for surface-oriented modeling of nonlinear problems in solid mechanics

The geometric model employed for the design process in standard Computer Aided Design (CAD) software differs completely from the geometric description used in the well-established Finite Element Method (FEM) for structural analysis. A common method to define solids in CAD is the boundary representation modeling technique (B-rep) that defines the solid in terms of bounded NURBS surfaces (Non-Uniform Rational B-Splines). The final model data contains thus solely the surface topology of the solid but the analysis process requires a description of the interior domain. Hence, the geometry needs to be remodeled by finite element meshing or by deriving a tri-variate NURBS parametrization for Isogeometric Analysis (IGA).

Meshing with standard FEM results in an approximation error and can be a daunting task. In the framework of IGA [1], a tri-variate parametrization with NURBS requires a special form of segmentation and does not necessarily simplify the meshing process. The scaled boundary finite element method (SB-FEM) [2] parametrizes the structure by a radial scaling parameter that emanates from a scaling center and a parameter in circumferential direction along the boundary.

The main objective of this research project is to develop a computational method that combines the features of isogeometric analysis and of the scaled boundary approach in order to make direct use of the surface modeling technique that dominates in CAD today. Moreover, we seek for methods that apply to a wide class of nonlinear continuum mechanics problems [3], including an interface to complex three-dimensional constitutive laws. This project is funded by the German Research Foundation (DFG) and is a collaborative work with the Differential-Algebraic Systems Group at the Technical University of Kaiserslautern.

