Geometry-Independent Field approximaTion (GIFT) for spline based FEM for Linear Elasticity: a Diffpack implementation

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In isogeometric analysis (IGA) [1], the same spline representation is employed for both the geometry and the unknown fields. This is considered as an advantage for the integration of Computer Aided Geometric Design (CAGD) and subsequent analysis in Computer Aided Engineering (CAE). On the other hand, using the same spline spaces for both geometry and field approximation creates a constraint which may be unwanted, when the geometry spline space is not well-suited to approximate the solution of the Partial Differential Equation (PDE), in particular when local mesh refinement is required to capture the solution with a tractable computational complexity. A discretization method, called Geometry Independent Field approximaTion (GIFT) introduced in [2], according to which the spline spaces used for the geometry and the field variables can be chosen and adapted independently, allows more flexibility in the field approximation preserving geometric exactness and tight CAD integration.

In this presentation, we investigate the implementation of such an approach within a commercial environment known as Diffpack [3]. Diffpack is an object oriented development framework for solving PDEs. It is based on the latest developments of Object-Oriented Numerics to a large extent and is coded in the C++ programming language. Diffpack is also a set of libraries containing building blocks in numerical methods for PDEs, for example arrays, linear systems, linear and nonlinear solvers, grids, finite elements and visualization support.

We describe the Diffpack implementation of IGA and GIFT and with it, investigate different choices of splines for geometry and field approximation in GIFT FEM for 2D linear elasticity problems based on B-splines, NURBS and RPHT-splines. We create geometries using Rhino3D and the geometric informations are exported to Diffpack isogeometric finite element toolbox [4] for numerical analysis. Thus converting the NURBS data into RPHT-splines [5] data structures, we apply hierarchical local refinement in RPHT-splines with simple adaptive GIFT method. We verify the standard patch tests [6] while approximating the solution field using different choices of splines. Choosing different refinement operations on the solution space independent of the geometric space, we study the convergency using the flexibility of GIFT method.

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