Mesh Deformation Techniques in the Context of Isogeometric Analysis

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ABSTRACT

Mesh deformation techniques play an important role in various computational methods for solving PDEs. Most of applications require that the deforming mesh stays valid, or free of self-intersections, which translates into a requirement that the corresponding deformation mapping is bijective. In this work, we propose a mesh deformation algorithm based on the equations of nonlinear elasticity which relies on the logarithmic neo-Hookean material law to guarantee that the mesh stays valid even under large deformations. In order to solve the equations efficiently, we employ a variation of the incremental loading approach which numerically preserves bijectivity and can operate with an adaptive stepsize.

We illustrate the performance of the proposed algorithm by applying it to a common problem in Isogeometric Analysis: generating a volumetric parametrization for a computational domain when only a description of its boundary is available. The target domain is modeled as a deformed configuration of an initial simple domain. In order to construct the initial domain, we simplify the boundary of the target domain by projecting it in L^2-sense onto a coarse basis and then apply the Coons patch approach. A range of two-dimensional and three-dimensional examples is presented. Additionally, we demonstrate possible applications to fluid-structure interaction problems in the Arbitrary Lagrangian-Eulerian formulation.

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