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ENRICHED ISOGEOMETRIC ANALYSIS ON STITCHED NURBS PATCHES

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ABSTRACT

We propose a new form of approximation to perform isogeometric analysis on multiple NURBS patches. The concept of the proposed methodology is to use lower-dimensional NURBS entities with appropriate enrichment to "stitch" trimmed NURBS domains of a higher dimension. Specifically, we extend the previously developed enriched isogeometric analysis (EIGA) formulation in which the behavioral field is constructed to form partition of unity by a weighted composition of base approximation and boundary (or interfacial) approximation [1]. The neighborhood of the boundary is appropriately enriched based on the a priori knowledge of the local behavior. The stitching interface can be as simple as the boundary curve joining NURBS patches of identical material, or to couple NURBS patches of dissimilar materials which has discontinuous gradient of fields across the stitching boundary. The stitching naturally leads to "watertight" boundaries. The technique allows a complex domain to be composed by multiple trimmed NURBS patches with different discretization and/or distinct materials using a bottom-up Boolean compositional strategy. The proposed method leads to tight CAD-CAE integration by using the trimmed NURBS geometries directly imported from commercial CAD systems. Convergence studies and patch tests were performed, and several numerical examples of elatostatics problems are demonstrated to show the advantages of the proposed methodology.

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HEXAHEDRAL MESH GENERATION BASED ON FOLIATIONS

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ABSTRACT

This work will introduce a hexahedral mesh generation algorithm based on surface foliations. The foliations are induced by Strebel differentials. The Strebel differentials on the surface form a finite dimensional linear space, the basis can be obtained by harmonic maps from the surface to graphs, the graphs are constructed from topological pants decompositions. The method has solid theoretic foundations, and is capable of producing high quality hexahedral meshes with minimal number of singularity lines.

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PROVABLY GOOD SPLINE PARAMETEIZATION OF VOLUMEMETRIC MODLES

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ABSTRACT

Spline parameterization of volumetric models is a fundamental problem in iso-geometric analysis. In this talk, I will present a new solution to the difficult problem by applying various optimization technique. The method consists of three steps. First, a harmonic map is computed from a cube to a 3D geometric model whose boundaries are expressed in B-spline forms. Second, a bijective parameterization is computed by constraining the determinant of the Jacobian of the map is positive. Finally, the parameterization is optimized using MIPS energy such that the parameterization has a low distortion in addition to the bijectivity. Some examples are provided to demonstrate the effectiveness of proposed method.

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Explicit Basis Construction of Optimal Trial-Test Spaces using Discontinuous Petrov Galerkin for IGA

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ABSTRACT

Discontinuous Petrov Galerkin (DPG) methods continue to be widely used in the solution of Partial Differential Equations (PDE) for various model problems [1-4]. The *inf-sup* Babuska stability of the weak and ultra-weak formulation solutions of DPG has also been analyzed in the context of using the tightest test function spaces for a given solution trial space, through the concept of "broken" test spaces over a given domain discretization, and error analysis using discretized primal/dual operator norms [2,3]. Traditionally the test space is chosen to be a *sufficient* enlargement of the trial space. In the context of polynomial spline trial basis functions, the sufficient test basis used in practice are of a suitably higher degree than the trial space basis [4]. In the spirit of isogeometric analysis (IGA), we provide an explicit basis construction of the optimal test space for any given trial space basis, which is *necessary and sufficient* for *inf-sup* solution stability. We additionally examine tradeoffs of the use of *optimal* test basis for DPG vs traditional Galerkin solution of PDE's over smooth manifolds [5,6].

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