Volumetric Spline Parameterization for Isogeometric Analysis with Industry Applications

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ABSTRACT

As a new advancement of traditional finite element method, isogeometric analysis (IGA) adopts the same set of basis functions to represent both the geometry and the solution space, integrating design with analysis seamlessly. In this talk, I will present our latest research on volumetric spline parameterization for IGA applications. For arbitrary objects, a new centroidal Voronoi tessellation (CVT) based surface segmentation method is developed to build polycubes whose topology is equivalent to the input geometry. First, eigenfunctions of the secondary Laplace operator (SLO) are coupled with the harmonic boundary-enhanced CVT (HBECVT) model to classify vertices of the surface into several components based on concave creases and convex ridges of an object. For each segmented component, we then apply the skeleton information to define local coordinates and include them into the HBECVT model to further segment it into several patches, with predefined geometric constraints applied for valid polycube construction. Based on the constructed polycube, we obtain volumetric control meshes via parametric mapping. After that, truncated hierarchical spline basis functions are derived to enable analysis-suitability, including partition of unity and linear independence. Furthermore, a blended B-spline-Bézier approach is recently developed to construct basis functions around extraordinary nodes, achieving an optimal convergence rate of IGA. The developed pipelines have been incorporated into commercial software such as Abaqus and LS-DYNA for industry applications.