AUTOMATIC ISOGEOMETRIC ANALYSIS SUITABLE TRIVARIATE MODELS GENERATION FROM STANDARD B-REP CAD

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ABSTRACT

We present an effective method to automatically construct trivariate B-spline models of complicated geometry and arbitrary topology. Our method takes as input a B-rep solid model defined by its triangulated boundary, that can be obtained from the segmentation and STL generation of a 3D imaging output or the triangle surface meshing of CAD part. Using cuboid decomposition [1,2,3], an initial polycube approximating the input boundary mesh is built. The polycube can be used to approximate very roughly the geometry of a model while faithfully replicating its topology. Due to its highly regular and trivariate structure, the polycube is suitable for serving as the canonical domain of the volume parameterization required for trivariate NURBS construction. The polycube's nodes and arcs decompose the input model locally into quadrangular patches, and globally into hexahedral domains. Using cross fields [4] (Cross fields are different from vector fields in the way that their topology is closely related to the topology of the surface on which they are defined) and aligned global parameterization [5,6,7], the position of the polycube nodes and arcs are optimized across the surface in a way to achieve low overall patch distortion, and alignment to principal curvature directions and sharp features (i.e. the aligned global parameterization should be locally oriented according to the computed cross field). Based on the optimized polycube and parameterization, compatible B-spline boundary surfaces are reconstructed. Finally, the interior volumetric parameterization is computed using Coon's interpolation and the B-spline surfaces as boundary conditions. The efficiency and the robustness of the proposed approach are illustrated by some examples.

REFERENCES

[1] H. Al-Akhras, T. Elguedj, A. Gravouil, and M. Rochette, “3D Isogeometric Analysis Suitable Trivariate NURBS Models from Standard B-Rep CAD”, *Computer Methods in Applied Mechanics and Engineering*, doi:10.1016/j.cma.2016.04.028, 2016.

[2] Bo Li, Xin Li, Kexiang Wang, and Hong Qin. “Surface mesh to volumetric spline conversion with generalized poly-cubes”. *IEEE Transactions on Visualization and Computer Graphics*, 99(PrePrints):1, 2013.

[3] Hassan Al-Akhras. “Automatic Isogeometric Analysis Suitable Trivariate Models Generation – Application to Reduced Order Modeling”. PhD thesis, INSA de LYON, *École Doctorale MEGA ED 162*, 2016.

[4] N. Ray, B. Vallet, L. Alonso, and B. Lévy. “Geometry Aware Direction Field Processing”. In: *ACM Transactions on Graphics* 29.1 (2009), 1:1–1:11.

[5] D. Bommes, H. Zimmer, L. Kobbelt, “Mixed-integer quadrangulation”, *ACM Tranactions on Graphics*, Vol. 28, pp. 77:1-77:10, 2009.

[6] Marcel Campen and Leif Kobbelt. “Quad layout embedding via aligned parameterization”. In *Computer Graphics Forum*, volume 33, pages 69-81. Wiley Online Library, 2014.

[7] Ashish Myles and Denis Zorin. “Global parametrization by incremental flattening”. *ACM Transactions on Graphics* (TOG), 31(4):109, 2012.