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NUMERICAL INTEGRATION IN SCAN-BASED IMMERSOGEOMETRIC ANALYSIS

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Immersogeometric analysis takes the advantages of both Isogeometric analysis (IGA), proposed by Hughes *et al.* [1] and the Finite Cell Method (FCM) introduced by Rank and co-workers [2]. Immersogeometric analysis has been applied successfully in various problems in solid mechanics, fluid-structure interaction problems and in scan-based analysis [3].

In the context of scan-based analysis, the geometry is defined implicitly through a level set function based on the image intensity. In order to preform immersogeometric analysis, we construct an explicit approximation of this geometry by complementing a bi-sectioning procedure with a triangulation procedure. An advantage of this technique is that a reconstruction of the trimmed boundary is obtained [4]. A disadvantage is the computational expenses related to the integration schemes that follow from this bi-sectioning procedure.

In this contribution, we will investigate in detail the accuracy and computational complexity of the current integration scheme and alternative schemes presented in [5] in the context of scan-based analysis. We study the contributions of the various approximation errors, viz., the geometry error, the integration error and the discretization errors. Based on this study we propose an optimized quadrature scheme for scan-based immersogeometric analysis.

REFERENCES

[1] Hughes, T.J.R., Cottrell, J.A., Bazilevs, Y. Isogeometric analysis: CAD, finite elements, NURBS, exact geometry and mesh refinement. *Computer methods in applied mechanics and engineering* 194.39 (2005): 4135–4195.

[2] Parvizian, J., Düster, A., Rank, E. Finite cell method. *Computational Mechanics* 41.1 (2007): 121–133.

[3] Verhoosel, C. V., Van Zwieten, G. J., Van Rietbergen, B., De Borst, R. Image-based goal-oriented adaptive isogeometric analysis with application to the micro-mechanical modeling of trabecular bone. *Computer Methods in Applied Mechanics and Engineering* 284 (2015): 138–164.

[4] Hoang, T., Verhoosel, C. V., Auricchio, F., van Brummelen, E. H., Reali, A. Skeleton-stabilized IsoGeometric Analysis: High-regularity Interior-Penalty methods for incompressible viscous flow problems. *arXiv preprint arXiv:1711.04910* (2017).

[5] Hubrich, S., Di Stolfo, P., Kudela, L., Kollmannsberger, S., Rank, E., Schrder, A., Düster, A. Numerical integration of discontinuous functions: moment fitting and smart octree. *Computational Mechanics* 60.5 (2017) 863–881.