Numerical integration on trimmed volumes

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ABSTRACT

The flexibility of NURBS surface representations in computer-aided design is greatly enhanced by the use of trimming. More precisely, only a part of the parameter domain is active, while a region defined by a trimming curve or surface is discarded. For example, a trimming curve can be the result of a surface-surface intersection.

There still exist several big challenges for the treatment of trimmed patches in isogeometric analysis, one of them being the numerical integration. For isogeometric Galerkin methods it is necessary to perform quadrature on the trimmed parametric domains of the employed models in order to assemble the system matrices and right-hand sides.

In this talk, we present a novel quadrature rule for trimmed trivariate domains whose trimming surface is given implicitly by a real-valued function on the whole domain. Thereby, we extend our method for the two-dimensional case, which will appear shortly in [1], to the three-dimensional case. Our approach combines a linear approximation of the trimming surface with a correction term consisting only of a lower-dimensional integral. The latter increases the convergence rate of the quadrature error by one, achieving a cubic rate of convergence for the overall quadrature with respect to h-refinement. It should be noted that the implementation of the method is extremely simple, since it requires neither intersection computations nor high-order approximations of the trimming surface.

We present numerical experiments that show that our method performs robustly on a selection of trimmed patches and that the error correction leads to higher orders of convergence without compromising the computational complexity. Furthermore, our examples demonstrate the method's potential for applications in isogeometric analysis.

REFERENCES

[1] F. Scholz, A. Mantzaflaris and B. Jüttler. First order error correction for trimmed quadrature in isogeometric analysis. *Advanced Finite Element Methods with Applications, LNCSE, Springer* (2019)