The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Feature-independent mesh generation for high-order NEFEM

Xi Zou*, Ruben Sevilla, Oubay Hassan and Kenneth Morgan

Zienkiewicz Centre for Computational Engineering, Faculty of Science & Engineering
Swansea University, Swansea SA1 8EN, Wales, United Kingdom
{xi.zou, r.sevilla, o.hassan, k.morgan}@swansea.ac.uk

Keywords: *Exact Geometry, NURBS-enhanced FEM, De–featuring, Mesh Generation*

In the modern computer-aided engineering industry, generating appropriate meshes for computer-aided design (CAD) models, with complex multiscale geometric features, is known to be a major bottleneck, due to the excessive human intervention that is required. Researchers have put large efforts into methods of de–featuring complex CAD models, without yet achieving the fully automatised framework. Firstly, it is difficult to predict the effect of the de–featuring, before practically running a simulation. Secondly, some multiscale features might have no effect in the solution of a certain physical problem, but can be very influential when solving a different problem. Finally, the level of de–featuring is also closely related to the desired approximation accuracy. Ensuring that the same mesh can be used for different physical problems without compromising the quality of the mesh and the efficiency of the simulation, requires an update of the traditional mesh generator as well as the solver.

The NURBS–enhanced finite element method (NEFEM) has reduced the de–featuring problem, by separating the geometric representation from the solution approximation. These processes have been tightly coupled in the large majority of finite element solvers based on the isoparametric concept. Within NEFEM, the geometry is described by the boundary representation (B-rep) data directly from the CAD model in the parameter spaces, whereas the solution is approximated by polynomial functions in the physical space. This new paradigm allows the geometry to be exactly represented, with a mesh size respecting the user specification, and it is not restricted by the presence of multiscale geometric features.

This work will present a mesh generation approach, in which element faces may span across multiple surfaces and retain the exact B–rep geometry. The mesh generation process will be detailed, including a discussion on new quality metrics that have been specifically devised for the NEFEM elements. A number of examples will be employed to demonstrate the potential of the proposed technique.

REFERENCES

[1] Sevilla R, Fernández-Méndez S, Huerta A. NURBS-enhanced finite element method (NEFEM). *Int. J. Num. Meth. Engng.*, Vol. **76** (1), pp. 56–83, (2008).

[2] Sevilla R., Rees, L. and Hassan, O. The generation of triangular meshes for NURBS–enhanced FEM. *Int. J. Num. Meth. Engng.*, Vol. **108**, pp. 941–968, (2016).