6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

# Immersed B-spline finite elements for parametric solids

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**Keywords**: *immersed finite elements, b-splines, parametric solids, NURBS, STL*

We present a higher-order immersed b-spline finite element technique suitable for parametrically described solid geometries. Prevalent parametric representations in industry include the trimmed NURBS from CAD and the STL meshes from polygonal modelling. For discretisation we use non-boundary-conforming tensor-product b-splines and enforce the Dirichlet boundary conditions with the Nitsche technique. The cells intersected by the parametric bounding surface are first tesselated using a marching tetrahedra algorithm, and the linear tetrahedra are subsequently degree elevated and fitted to the curved bounding surface. This process relies on repeated and efficient interrogation of the parametric surface, i.e. ray-surface intersection computations. To this end, we consider two complementary robust interrogation approaches. In the first, for STL meshes a ray-triangle intersection algorithm and for NURBS novel non-iterative interrogation techniques from CAD are employed for computing the intersection in one shot. In the second approach, the finely tesselated parametric solid is first implicitised on an auxiliary tensor-product grid with a similar resolution (up to $2000^3$ cells). The subsequent interrogation of the implicit geometry on the auxiliary grid becomes straightforward. In this second approach the boundary approximation errors are controlled by the ratio of the cell sizes of the auxiliary and computational simulation grids. The robustness and accuracy of the developed approach are demonstrated with a number of benchmark examples and industrial geometries.

## REFERENCES

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