11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

IMPLEMENTATION OF AN ISOGEOMETRIC GALERKIN BOUNDARY ELEMENT METHOD IN 2D

A. Bantle[1] and S.A. Funken[2]

[1] University of Ulm, Helmholtzstraße 20, 89081 Ulm, andreas.bantle@uni-ulm.de,
http://www.uni-ulm.de/index.php?id=45680
[2] University of Ulm, Helmholtzstraße 20, 89081 Ulm, stefan.funken@uni-ulm.de,
http://www.uni-ulm.de/index.php?id=31315

Key words: *Isogeometric BEM, Galerkin BEM, NURBS-enhanced BEM.*

When using high order boundary element methods (BEM) for the solution of problems on domains with curved boundaries it is necessary to approximate the boundary accurately. A significant loss of accuracy is observed in p- and hp- BEM using a polygonal approximation of the boundary. There are several approaches that remedy this problem, for example isoparametric, NURBS-enhanced, and isogeometric methods.

NURBS-enhanced methods were first introduced by [1] in the finite element context and an implementation of a NURBS-enhanced boundary element method is presented in [2]. While the geometry is represented with a Non-Uniform Rational B-Splines (NURBS) basis a piecewise polynomial basis is used for the ansatz-space.
Isogeometric methods that were introduced in [3] use the same NURBS basis for both the boundary representation and the ansatz-space.

We present an implementation and analysis of an isogeometric and a NURBS-enhanced boundary element method for Laplace and Lamé equations. In both methods, the integral equations are solved with a Galerkin method. The arising singular and weakly singular integrals are evaluated using different regularization techniques and adapted quadrature rules. Furthermore, we derive rigorous upper bounds for the quadrature errors.
We present numerical results for the isogeometric and NURBS-enhanced Galerkin BEM. In addition to uniform h-, p-, and k- refinement strategies, we present combinations of the three refinements which yield a faster convergence for the energy error with respect to the degrees of freedom. Overall, we are able to perform calculations for polynomial degrees up to $p = 64$ and reduce the energy error to double machine precision. Finally, we give a comparison between the isogeometric methods and the high-order NURBS-enhanced methods.

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