An efficient numerical method for interface problems using coupled isogeometric boundary elements and finite elements.

Michal P. Rajski*†, Maximilian Harmel† and Roger A. Sauer†

† Aachen Institute for Advanced Study in Computational Engineering Science (AICES)
RWTH Aachen University
Templergraben 55, D-52062 Aachen, Germany
e-mail: rajski@aices.rwth-aachen.de - Web page: https://www.aices.rwth-aachen.de

ABSTRACT

In certain branches of engineering applications, interface problems can be encountered involving physical phenomenons such as thermal expansion, thermo-mechanical contact or electromagnetic interaction. In this work a general isogeometric framework for the coupling of the boundary element method (BEM) and finite element method (FEM) is presented. In general, FEM is well suited for the analysis of problems involving non-linearities or inhomogeneities. On the other hand, BEM has significant advantages when it comes to stress concentrations or problems in unbounded domains. Additionally the formulation of the BEM allows to represent the solution inside of the domain based on the boundary, reducing the dimensionality of the problem by one order. Thus the complementary characteristics of both methods allow to create an efficient framework for solving multiphysical problems.

The interface between two adjacent media is modeled using Kirchhoff-Love thin shell theory. The rotational-free character of this approach allows to capture the non-linear behaviour of shells [1] or membranes [2] solely based on the surface discretization. The mechanical behaviour of such an interface is solved using an isogeometric finite elements formulation.

The boundary element method is used to model the external potential field and hence a common curvilinear parametrization is sufficient to solve coupled volumetric problems. Both methods are using isogeometric analysis [3] in their formulation, admitting better accuracy and smoothness based on non-uniform rational B-Splines (NURBS) compared to classical approaches.

The presented coupled approach creates an interesting alternative in the wide range of numerical methods. The effort of meshing is significantly decreased due to both usage of IGA as well as the coupled BE/FE formulation in comparison to for example pure FEM approaches. The considered approach is illustrated by several numerical examples.

REFERENCES

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