Embedding Techniques within Isogeometric B-Rep Analysis (IBRA) for the Modeling of Inhomogeneities in a Generalized CAD-integrated Workflow

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ABSTRACT

Using CAD models is advantageous for many engineering tasks and provides new possibilities, but requires special approaches in the simulation workflow. Isogeometric B-Rep Analysis (IBRA) introduced by Breitenberger et al. [1] is a generic concept to directly process and simulate full CAD models including multi-patches with continuity coupling and trimming. The geometry description is based on the Boundary-Representation (B-Rep) technique, which is commonly used in CAD systems. With this parametric representation, the basis for a coherent embedding is provided. Embedded entities can, analogously to trimming curves and boundary loops, be used to model local inhomogeneities. This technique uses the original CAD geometry descriptions, Non-Uniform Rational B-Splines (NURBS).

With the proposed approach, a manifold of applications arise. Linear embedded curves can e.g. be used as ribs on a shell by adding beam elements on the line as proposed in [2] or spatial surface element formulations can be reduced or extended which provides new modeling techniques for inhomogeneous materials in structures.

The embedded entities are described by the control points of the underlying NURBS patch, implying the use of the respective degrees of freedom. For different applications the control points may be enriched with additional degrees of freedom for supporting different types of finite element formulations. Moreover, this technique is not restricted to structural element formulations. It also allows other modifications and impacts, e.g. loads and supports.

To enhance classical FE solvers, a workflow is developed that allows the possibility of the use of IBRA with embedded properties. Exchange formats can be derived consistently, which are able to not only represent classical B-Rep models containing trimmed multi-patches but also allow embedded features. The exchange formats are standardized to provide the exchangeability and use of different tools. The entire workflow for IBRA is fully integrated into CAD environments for Pre- and Postprocessing simulation capabilities.

Several examples, also including industrial problems, are presented in order to demonstrate completeness of the workflow and reveal the advantageous aspects of using embedding in isogeometric analysis.

REFERENCES

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