Explicit Isogeometric B-Rep Analysis in Commercial Solver for Crash Using the IBRA Exchange Format

Lukas F. Leidinger[*ac], Michael Breitenberger[a], Anna M. Bauer[a], Roland Wüchner[a], Stefan Hartmann[b], Kai-Uwe Bletzinger[a], Fabian Duddeck[a], and Lailong Song[c]

[a] TUM Department of Civil, Geo and Environmental Engineering
Technical University of Munich
Arcisstr. 21, 80333 Munich, Germany
[*] e-mail: lukas.leidinger@tum.de, Web page: http://www.bgu.tum.de

[b] DYNAmore GmbH
Industriestr. 2, 70565 Stuttgart, Germany

[c] BMW Group Research and Innovation Center
Knorrstr. 147, 80788 Munich, Germany

ABSTRACT

The possibility to achieve faster and closed design cycles with only one geometric model for both design and simulation makes Isogeometric Analysis (IGA) attractive for automotive industry. However, practical CAD models typically consist of a considerably high number of trimmed NURBS patches which turned out to be a challenge for IGA. Isogeometric B-Rep Analysis (IBRA) [1] is a promising approach to enable the direct analysis of such (shell) models through a weak enforcement of boundary and patch coupling conditions by B-Rep elements.
In this contribution, we present the extension of IBRA to dynamic problems with explicit time integration (Explicit IBRA) and its application to a Reissner-Mindlin shell formulation with rotational DOFs. To enable the future application of Explicit IBRA to vehicle crash simulations, the penalty-based B-Rep element formulation is implemented into the commercial IGA solver LS-DYNA via a user-defined interface and combined with the NURBS-based isogeometric shell elements already available in LS-DYNA. For the consistent data transfer from CAD to simulation and back to CAD, a plug-in for the CAD program Rhinoceros outputting the recently proposed IBRA exchange format [2] is used. In order to establish the link to the IGA solver, data on two different interface levels of the IBRA exchange format is retrieved, showing the format's flexibility. This is, for the definition of B-Rep elements data on an integration point level is used, while for isogeometric shell elements the existing IGA functionality of LS-DYNA is exploited, which only requires patch and trimming data. This, together with the contact capabilities and elasto-plastic material models in LS-DYNA, now allows the direct analysis of NURBS-based trimmed multi-patch shell models in crash load cases. Moreover, a closed design cycle comprising design, preprocessing, analysis and postprocessing is established. The validity and effectiveness of Explicit IBRA is shown through benchmark problems and dynamic analysis of industrial CAD models. However, this approach is only the starting point for future investigations on IBRA in explicit dynamic problems.

REFERENCES

[1] M. Breitenberger, A. Apostolatos, B. Philipp, R. Wüchner, K.-U. Bletzinger, Analysis in computer aided design: Nonlinear isogeometric B-Rep analysis of shell structures, *Comput. Methods Appl. Mech. Engrg.*, Vol. **284**, pp. 401-457 (2015).

[2] T. Teschemacher, A. M. Bauer, T. Oberbichler, M. Breitenberger, R. Rossi, R. Wüchner and K.-U. Bletzinger, Realization of CAD-integrated Shell Simulation based on Isogeometric B-Rep Analysis, submitted to *Advanced Modeling and Simulation in Engineering Sciences* (2018).