Mixed isogeometric collocation methods for nearly-incompressible, finite strain elasticity

Frederik Fahrendorf*, Roland Kruse and Laura De Lorenzis

Institut für Angewandte Mechanik
Technische Universität Braunschweig
Pockelsstr. 3, 38106 Braunschweig, Germany
e-mail: {f.fahrendorf,r.kruse,l.delorenzis}@tu-braunschweig.de, web page: https://www.tu-bs.de/iam

ABSTRACT

Isogeometric collocation methods combine the advantages of isogeometric analysis with a high efficiency for high-order discretizations compared to standard Galerkin approaches (see e.g. [3, 7]). So far isogeometric collocation techniques have been successfully applied to various fields of research, especially solid mechanics problems (see e.g. [1, 2, 4, 5, 6]). In this work we apply the isogeometric collocation framework to simulate nearly-incompressible, finite strain elasticity problems. Nearly-incompressible elasticity problems can lead to an overly stiff behaviour called volumetric locking. To prevent this undesirable material behaviour, the application of a mixed method is a common approach due to its robustness and accuracy. Herein we consider two different forms of mixed methods. The first one is based on the additional introduction of a pressure field, whereas in the second one the complete stress tensor will be approximated. The aforementioned mixed approaches are applied to various numerical examples, including typical benchmark problems.

REFERENCES

[1] A. Patton and J.-E. Dufour and P. Antolin and A. Reali. *Fast and accurate elastic analysis of laminated composite plates via isogeometric collocation and an equilibrium-based stress recovery approach.* arXiv preprint arXiv:1901.08797, 2019.

[2] E. Marino and J. Kiendl and L. De Lorenzis. *Explicit isogeometric collocation for the dynamics of three-dimensional beams undergoing finite motions.* Computer Methods in Applied Mechanics and Engineering, 343:530-549, 2019.

[3] H. Gomez and L. De Lorenzis. *The variational collocation method.* Computer Methods in Applied Mechanics and Engineering, 309:152-181, 2016.

[4] R. Kruse, N. Nguyen-Thanh, L. De Lorenzis, T.J.R. Hughes. *Isogeometric collocation for large deformation elasticity and frictional contact problems.* Computer Methods in Applied Mechanics and Engineering, 296:73-112, 2015.

[5] L. De Lorenzis, J.A. Evans, T.J.R. Hughes, A. Reali. *Isogeometric collocation: Neumann boundary conditions and contact.* Computer Methods in Applied Mechanics and Engineering, 284:21-54, 2015.

[6] F. Auricchio, L. Beirão da Veiga, T.J.R. Hughes, A. Reali, G. Sangalli. *Isogeometric collocation for elastostatics and explicit dynamics.* Computer Methods in Applied Mechanics and Engineering, 14:249-252, 2014.

[7] D. Schillinger, J. Evans, A. Reali, M. Scott, and T.J.R. Hughes. *Isogeometric collocation: Cost comparison with Galerkin methods and extension to adaptive hierarchical NURBS discretizations.* Computer Methods in Applied Mechanics and Engineering, 267:170-232, 2013.