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Recent developments of isogeometric collocation: Neumann boundary conditions, contact and plasticity formulations

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Within the framework of NURBS-based isogeometric analysis, collocation methods have been recently proposed and their accuracy and efficiency demonstrated for elastostatics and explicit dynamics [1-3]. In this presentation, we illustrate some recent results on the extension of isogeometric collocation to the non-linear setting by modeling large deformation contact between deformable bodies and rate-independent plasticity. As a significant premise to the contact investigation, we also treat the imposition of Neumann boundary conditions (BCs).

In the first part of the presentation, we focus on Neumann BCs and large deformation contact between deformable bodies. Both Neumann BCs and contact constraints (which are interpreted as deformation-dependent Neumann BCs) are enforced using three different techniques: a) a “pure collocation” scheme, in which the contact conditions are collocated at the Greville or Demko abscissae along the contacting surfaces; b) an “hybrid collocation-Galerkin” scheme, in which collocation equations are written in the interior of the contacting bodies, whereas the contact constraints are enforced weakly; c) an “enhanced collocation” scheme, in which the collocated contact conditions are written considering a combination of surface and bulk terms. The advantages and drawbacks of the three approaches are illustrated through suitable examples.

In the second part of the presentation, we extend the development of isogeometric collocation to modeling of rate-independent J2-plasticity with isotropic and/or kinematic hardening. Numerical tests are illustrated and results are compared with those from Galerkin methods in terms of convergence rate and computational efficiency.

The significant potential of isogeometric collocation as a competitive alternative to Galerkin finite elements is confirmed for the treatment of contact and plasticity problems.

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