Frictional contact formulation with geometric and materials nonlinearities

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Abstract

Finite element simulations of contact problems often involve modeling the interaction of multiple bodies across a non-confirming interface. Non-Confirming Meshes (NCM) are typically associated with large sliding or adaptive refinement on one side of the interface to capture localized nonlinear behavior due to large deformations, damage and inelasticity. The use of NCMs, however, presents a number of numerical issues; the main challenge with such discretizations is the presence of the non-conforming interface where it is critical to ensure compatibility of the kinematic and traction fields. The Enriched Discontinuous Galerkin Approach (EDGA) (Haikal and Hjelmstad, 2010) addresses this challenge by implementing a local enrichment along with an interface stabilization procedure to enable a two-pass approach in enforcing contact conditions that preserve the weak continuity of surface tractions without introducing dual interface fields.

In this study, the EDGA is extended to model contact in the presence of material and geometrical nonlinearities, as well as friction. The enrichment used in the EDGA introduces a higher-order interpolation on the contact interface, which requires an increase in the integration rule. To avoid changing the integration points' locations to accommodate the higher-order interpolation, a progressive integration rule (Gauss-Kronrod quadrature) is employed to preserve material history at existing integration points. A new approach for handling frictional conditions under large deformations is introduced. The proposed approach is designed to increase algorithmic efficiency and circumvent numerical issues encountered when modeling stick/slip conditions in Coulomb frictional contact models.

Keywords: Frictional Contact, Interface Formulation, Non-conforming meshes, EDGA.