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DIFFERENT TIME INTEGRATION SCHEMES FOR MORTAR CONTACT METHODS

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ABSTRACT

In the present talk large deformation contact problems of flexible bodies are addressed within a nonlinear finite element framework. Based on the most general description of the contact constraint as proposed in Laursen & Heinstein [4], both the well known NTS method as well as the mortar method can be derived easily. We introduce a mortar based formulation for frictionless contact situations, although an extention to friction is straightforward, as shown in Yang et al. [5]. Since no internal dissipation occurs, several conservation properties have to be satisfied in the continuous form: conservation of linear and angular momentum as well as conservation of energy. Satisfaction of these properties can be ensured for either contact formulations.

Concerning the discrete form of the contact constraints, the development of energy and momentum conserving 'mechanical' integrators for differential algebraic equations (DAEs) has achieved major improvements over the past years. The contact constraints are in general enforced using Lagrange multipliers, which gives rise to the aforementioned DAE formulation. Energy consistent mechanical integrators have been recently developed for DAE-formulations of constrained mechanical systems (Gonzalez [3], Betsch and Steinmann [2] and Betsch & Hesch [1]).

In a first step, the contact constraints are reparametrised by using quadratic invariants in accordance with Cauchy's Representation Theorem. These quadratic invariants have to be invariant against general Lie-group actions, especially against translational and rotational groups to enforce algorithmic conservation of linear and angular momentum. The gradient of the constraint has to be split using the chain rule into the gradient of the constraint with respect to the invariants followed by the gradient of the invariants with respect to the configuration. Evaluating the second gradient at the mid-point configuration ensures conservation of linear and angular momentum, independent of the evaluation of the first gradient. Applying a so called 'discrete gradient' in the sense of Gonzalez [3] to the first gradient ensures additionally algorithmic conservation of energy.

Turning special attention to a comparison of widely used integrators like Newmark or explicit time integration schemes, the proposed energy momentum scheme exhibits superior behavior and stability.

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