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ADAPTIVITY AND LOCAL IMPACT DETECTION FOR DYNAMIC CONTACT PROBLEMS

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One of the main challenges in the adaptive simulation of dynamic contact problems is to resolve -in space as well as in time- non-smooth effects at the contact interface. As is well known, due to the moment of impact, classical time discretization schemes fail, i.e. energy blow-ups, oscillations in velocity and contact stresses can occur, and alternative strategies have to be developed.

In this talk, we present an adaptive discretization method for dynamic contact problems. Adaptivity in space based on a recent a posteriori error estimator is combined with a time-discretization, which detects individual impact times for contacting nodes. The transfer of the solution between the different meshes is discussed.

Our scheme uses two main ingredients: first, we add impact detection to the stabilized Newmark scheme by adjusting the parameters node-wise to the actual contact boundary. Second, we exploit ideas from our recent a posteriori error estimator [3] for mesh adaptation. The resulting method can resolve non-smooth effects at the contact boundary in space and time.

1 Adaptivity in Space and Time

One particularity of the recently developed strategy [1] is the prediction of the individual impact times of each contact boundary node in the spatial discretization. This is done by choosing the parameters in the underlying Newmark method node-wise depending on the current solution and active set. Especially, no global reduction of the time-step size is used.

In order to construct the desired space-time adaptive method, we accompany this strategy

by spatial mesh refinement which is based on a modification of the a posteriori error estimator for contact problems presented in [3] for time-discretized problems. We note that, although linear finite elements are widely used for the discretization in space of contact problems, there are only few a posteriori error estimators for contact problems available, see e.g. [4, 3].

Since for subsequent time-steps we might end up with different spatial meshes, a special treatment of the numerically computed values of the foregoing time step is required. In fact, a simple interpolation would lead to non admissible solutions and to oscillations in the contact stresses. We present and analyse a way to overcome this difficulty.

Summarizing, we present a space-time connecting discretization method for dynamic contact problems which uses adaptive discretization in space and a special time-discretization, which provides an implicit sub-time stepping at the contact boundary. We furthermore present the resulting adaptively refined meshes and discuss the stability of contact stresses and velocities. The numerical results in 3D illustrate the performance of our method.

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