A first approach of contact problems resolution with The eXtreme Mesh deformation approach (X-MESH)

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Contact mechanics is the study of solids that touch each other, something which happens quite often in everyday life. However, even if the dissipative phenomenon like friction or adhesion are put aside, modeling this problem is not trivial. Indeed, a fundamental principle in contact mechanics is that two solids can not interpenetrate each other. This is modeled by inequality constraints, which have been at the core of many research during the past decades [1, 2]. Most of these methods are quite efficient in modeling the inside of the contact zone, however only a few of them are able to sharply model the contact front, that is the boundary between the contacting and non-contacting zone. Yet, a sharp representation of the contact front is necessary to get optimal convergence rate, as it was shown by [3] for instance.

In this work, the X-MESH approach, originally introduced in [4] to model phase-change fronts, is applied to contact problems. The method could be applied to any contact problems, but here as a first approach we chose to illustrate its capabilities on several 1D and 2D quasi-static membrane problems in small perturbation. An equilibrium criteria is introduced to determine how to move the nodes of the finite element mesh in an X-MESH fashion in order to have a time continuous, sharp representation of the contact front. These nodes movements allow to model topological change of the contact front, including coalescence and splitting, without remeshing or changing the mesh topology.

We show that the X-MESH method allows to recover optimal mesh convergence rates, and how it allows to model complex topological changes of the contact zone.

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