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The eXtreme Mesh deformation approach (X-MESH) for sharp contact fronts modeling

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Contact problems are governed 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 (contact zone boundary). 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, an efficient way to model sharp contact front is proposed, based on the X-MESH approach which was originally introduced in [4] to model phase-change fronts. The key idea is to move the nodes of a finite element mesh 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. Some finite elements may eventually reach zero measure, but we show in this work that this can be properly tackled.

The method could be applied to any contact problems, but we chose to illustrate its capabilities on several 1D and 2D quasi-static membrane problems in small perturbation. In particular 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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