Adaptive finite cell methods for contact problems

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In this talk, we extend our work on the adaptive optimal control of contact problems [1] onto the discretization by means of the finite cell method (FCM), which is a particular combination of the fictitious domain concept and finite element method. We present only the results for the simulation of the contact problems, in order to focus on the FCM. A more complete work on this topic is given in [3], which also covers the optimal control of contact problems. The underlying contact problems lead to variational inequalities, which have non-regular solution operators, yet we want to apply Newton's method. Therefore, we regularize the non-smooth problems by penalization and afterwards discretize them using the FCM. The latter method allows for a different domain on the discrete and the continuous level. This is in particular useful, if the original domain has a difficult shape or changes during a time-dependent process. We briefly discuss the a-priori FCM-error for the resulting semi-linear problem.

As both modifications (penalization and FCM) introduce great challenges to the conditioning, an adaptive algorithm is required to manage these numerical difficulties as well as the discretization error. Applying the dual weighted residual method, an error identity for the error measured by a goal functional is derived. This identity respects the different error sources. Extending the ideas presented in [1] and [2], we finally deduce computable error estimators concerning the different sources. We present the actual estimators as well as numerical results substantiating the accuracy of the a-posteriori error estimators and the efficiency of the adaptive algorithm.

References:

[1] A. Rademacher, K. Rosin. Adaptive optimal control of Signorini's problem. *Comput. Optim. Appl.*, 70(2):531–569, June 2018.

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