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Efficient optimal control of contact problems using the finite cell method

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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).

First of all, 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. For instance, this is very useful, if the original domain has a difficult shape.

However, both modifications (penalization and FCM) introduce great challenges to the conditioning. Handling those numerical difficulties is one of the aspects an adaptive algorithm has to manage. In order to achieve an efficient one, we balance the errors resulting from the different error sources - the discretization and regularization errors as well as the quadrature error - in an adaptive refinement strategy.

Applying the dual weighted residual method, we achieve an error identity for the error measured in the goal functional of the optimal control problem. This identity respects the different error sources. Combining the ideas presented in [1] and [2], we finally deduce computable error estimators concerning the different sources. For this purpose, we use the d-quadratic patchwise reconstruction in the discretization error estimator. In the regularization error estimator, we apply a Taylor expansion in the penalty parameter. For the quadrature error, a refined quadrature mesh comes into play.

We present the actual estimators as well as numerical results substantiating the accuracy of the error estimators and the efficiency of the adaptive algorithm.

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