Consistent and inconsistent Lagrange multiplier methods for the finite element solution of unilateral contact problems using non-matching meshes

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In this note we propose and compare two stabilized Lagrange multiplier methods for the finite element solution of unilateral contact problems with non-matching meshes.
One basic question when dealing with non-matching meshes is how to handle the quadrature problem on the contact interface, i.e integrating products of functions on one side of the interface with functions on the other. The essence of our methods lies in the discretization of the multiplier space, in the form of an interjacent global polynomial layer, which greatly simplifies the implementation.
The inconsistent method takes the form of a perturbed Lagrange multiplier method with an added penalty term to stabilize the resulting scheme. The consistency error will not dominate the discretization error in energy like norms if we make the penalty term mesh dependent and, in order not to destroy the condition number of the discrete problem, we would like to make the penalty term proportional to $O(h^{-1})$ with the drawback that it will only give optimal convergence in case of piecewise linear elements. The consistent method is related to the domain decomposition method with non-matching meshes of [1], which preserves optimal convergence for higher order schemes.

References

[1] R. Becker, P. Hansbo, and R. Stenberg, "A finite element method for domain decomposition with non-matching grids," *Chalmers Finite element center*, Preprint 2001-15.