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Application of the virtual element method to non-conforming contact interfaces

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ABSTRACT

In the literature numerous formulations for classical contact and different discretization methods for the contact zone are available. Widely used are the penalty and Lagrange multiplier method to enforce contact constraints in the finite element environment (see for example [1]). But especially non-conforming contact interfaces require a high effort in discretizing the contact surface in order to properly link the degrees of freedom. In this work we adapt the standard contact approaches penalty and Lagrange multiplier method to be used with virtual elements in the contact zone. This allows for an easy and robust contact algorithm for non-conforming meshes with a nodal enforcement of the contact constraint.

The main idea of the recently developed virtual element method (see [2]) is to find a single

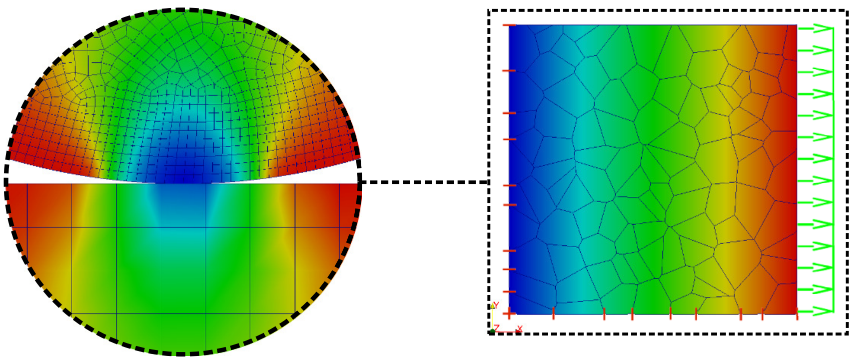

Figure 1: The contact of non-conforming meshes is combined with a VEM discretization.

function that can project the nodal values on the element area while being compatible with the interpolated values on the boundary. The integration is then executed on the element boundary without the need of an isoparametric mapping. This gives the advantage over classical finite elements that it is easily possible to discretize a geometry using convex or non-convex polygons with an arbitrary number of vertices. Additionally it offers a simple formulation and the possibility to achieve higher continuity.

For this work the virtual elements are implemented for the case of linear elasticity. Therefore a suitable polynomial decomposition was chosen (see [3]). Furthermore, because the pure virtual ansatz function only represents an interpolation (here: linear) of the nodal values, the method has to be stabilized with an additional term to reduce the interpolation error.

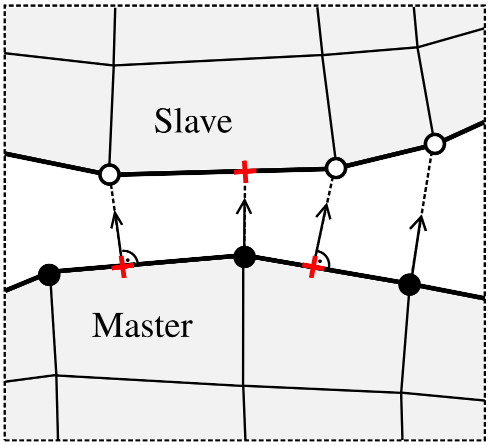

Figure 2: Node projection- and insertion-algorithm on contact surface.

The actual contact procedure consists mainly of a nodal projection algorithm. Here the feature of the virtual elements is used that arbitrary nodes can be inserted along the element boundary. Since this can be done without the need to recompute or change the element ansatz, an easy and robust algorithm is created that can actually transform a non-conforming mesh in a conforming mesh during the computation by projecting and inserting nodes on the opposing surface where needed. After matching the meshes the well known node-to-node contact procedures can easily be applied. In this work the used methods are described and the method is then tested in a contact patchtest, applied to the hertzian contact problem for small deformations and compared to standard contact methods.

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