Adaptivity, Contact and Fictitious Domain Methods

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ABSTRACT

Fictitious domain methods circumvent the necessity for a boundary conforming mesh by embedding the domain of computation in a larger, often Cartesian grid. Some variants like the finite cell method (FCM) [1] recover the original computational domain by specific integration rules that can handle the discontinuous integrands of elements cut by the boundary. Following this basic concept, special attention has to be paid for problems where the solution at or near the boundary of the domain itself plays a decisive role for the precision of the approximation. Examples are delamination [2] and contact problems, which are in the focus of this contribution. In both cases, non-linear boundary conditions have to be formulated at immersed boundaries. In general, they have to be imposed in a weak sense, since a strong form can only be applied at edges or faces of the elements. Furthermore, high accuracy and efficiency can often only be achieved by adapting the approximation by local refinement or increase of the order of shape functions. We apply the recently introduced multi-level hp-method [3] to locally refine the discretization in the vicinity of these singularities. A common challenge in the aforementioned contexts of delamination and contact problems is the changing position of the respective singularities over runtime. In this work, we demonstrate that the suggested method allows the refinement to stay local to propagating singularities by continuously refining and coarsening the mesh throughout the numerical simulation. By means of different two- and three-dimensional p-FEM and FCM applications, we show that this dynamic approach effectively decouples the size of the considered crack or contact zone from the actual part size, which yields a significant improvement in terms of the number of unknowns necessary for the discretization of the respective problem.

REFERENCES

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