A COMPUTATIONAL METHOD FOR INTERFACE PROBLEMS IN MULTIPHYSICS APPLICATIONS

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ABSTRACT

Processes at interfaces dominate many multiphysics problems. Hence, it is essential to be able to adequately model and simulate sophisticated interface behavior, for instance, for analyzing and improving technical systems in which multiphysics phenomena occur. Interfaces appear as either non-moving interfaces or, even more challenging, moving interfaces. For instance, moving interfaces appear in the context of fluid-structure interaction and contact problems. We will present a general numerical method for accurate, robust and efficient simulation of these and other multiphysics problems with interfaces.

Recently, mortar methods have been developed as discretization schemes for improved handling of problems with interfaces. Originally introduced as a technique for domain decomposition, mortar methods can nowadays also be successfully used for a variety of multiphysics applications. The mortar approach is characterized by an imposition of interface constraints in a weak sense and by the possibility to prove its mathematical optimality. Particularly when being used in combination with so-called dual Lagrange multipliers, highly efficient computational methods can be designed in this way.

In this presentation, we will demonstrate the quality of dual mortar approaches for contact problems; see, e.g., [1]. The coupling of several subdomains with non-matching meshes in computational fluid dynamics can also be efficiently carried out with such methods, as described in [2]. This allows for coupling very fine boundary layer meshes to rather coarsely discretized bulk regions without any mesh-transition zone. Furthermore, we developed dual mortar methods for fluid-structure interaction (see, e.g., [3]), which provide excellent results for challenging problems in this context. We will also show that even the combination of fluid-structure interaction and contact as observed in phenomena such as wet contact and elastohydrodynamic lubrication might be successfully simulated when using dual mortar methods.

REFERENCES

[1] A. Popp, M. W. Gee, and W. A. Wall, A finite deformation mortar contact formulation using a primal-dual active set strategy, International Journal for Numerical Methods in Engineering 79 (2009) 1354–1391.

[2] A. Ehrl, A. Popp, V. Gravemeier, and W. A. Wall, A mortar approach with dual Lagrange multipliers for mesh tying within a variational multiscale method for incompressible flow, International Journal for Numerical Methods in Fluids, 2014, in press.

[3] T. Klöppel, A. Popp, U. Küttler, and W. A. Wall, Fluid-structure interaction for nonconforming interfaces based on a dual mortar formulation, Computer Methods in Applied Mechanics and Engineering 200 (2011) 3111–3126.