Numerical Analysis and Simulations of Fully Eulerian Fluid-Structure Interactions using Cut Finite Elements

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In this presentation, we discuss monolithic fluid-structure interactions in fully Eulerian coordinates using cut finite elements. The attractiveness of using Eulerian coordinates for the solid equations as opposed to arbitrary Lagrangian Eulerian approaches lies in the ability of the derived method to handle large deformations, topology changes and contact problems more easily. In such a setting the mesh is not fitted to the interface between the two physical subdomains as the interface is allowed to move freely through elements. For the treatment of cut elements we employ a CutFEM approach in the discretization, where the interface conditions are imposed weakly via Nitsche terms. It is well-known that the cuts impact the condition number of the resulting discrete systems such that additional stabilization is required. To this end, ghost penalty terms around the interface zone between the fluid and the solid are employed. In extension to the published literature, such a ghost penality approach for the entire fully Eulerian fluid-structure interaction problem is new. We establish theoretical results on quadrilateral elements for coercivity and inf-sub stability. The analysis is supplemented by some numerical examples with fixed interfaces.

References:

[1] https://arxiv.org/abs/2402.00209

[2] https://arxiv.org/abs/1605.09681

[3] https://doi.org/10.1016/j.apnum.2011.01.008

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