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EMBEDDED INTERFACE METHODS FOR FLUID-STRUCTURE INTERACTION: ALGORITHMS AND APPLICATIONS

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Fluid-structure interaction (FSI) represents a complex multiphysics problem, characterised by strong coupling between the fluid and solid domain(s) along moving and highly deformable interface(s). Often, FSI problems experience topological changes, typically associated with evolving contact conditions between solid components. In such circumstances, a careful assessment of the discretisation strategy is required in order to accurately and efficiently accommodate evolving topology of computational domain.

This work discusses different options available to the developers focusing on embedded interface methods and finite element formulations. The strategy relies on Cartesian b-spline grid discretization allowing for straightforward h- and p-refinement and employs Nitsche's method to impose interface and boundary conditions. In order to ensure stability for a wide range of flow conditions a stabilized finite element formulation is employed. Nitsche's method has proven to be effective for the weak imposition of boundary conditions for the Navier-Stokes equations [1], however its use is here extended to the complex interface/boundary conditions arising in FSI problems experiencing solid-solid contacts [2]. Important ingredients of the developed strategy are: (i) the so-called ghost penalty term [3] that ensures stability of the cut cells for adopted spatial discretization, and (ii) efficient hierarchical subdivision and sub-cell merging procedure for integration of the cut cells.

Numerical examples are presented throughout the talk in order to illustrate the scope and effectiveness of the proposed approach. The examples are characterized by complex interaction between both external and internal flows with rigid bodies and flexible structures relevant for different areas of engineering.

REFERENCES

[1] W. G. Dettmer, C. Kadapa and D. Peric. A stabilised immersed boundary method on hierarchical b-spline grids. *Computer Methods in Applied Mechanics and Engineering*, Vol. **311**, pp. 415–437, 2016.
[2] C. Kadapa, W. G. Dettmer and D. Peric. A stabilised immersed boundary method on hierarchical b-spline grids for fluid-rigid body interaction with solid-solid contact. *Computer Methods in Applied Mechanics and Engineering*, Vol. **318**, pp. 242–269, 2017.
[3] E. Burman, S. Claus, P. Hansbo, M. G. Larson and A. Massing. CutFEM: Discretizing geometry and partial differential equations. *International Journal for Numerical Methods in Engineering*, Vol. **104**, pp. 472-501, 2015.