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An unfitted formulation for fluid structure interaction

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We present a numerical procedure that combines an extended finite element formulation (XFEM) and a Discontinuous Galerkin (DG) technique for the simulation of three-dimensional (3D) fluid-structure interaction problems in the case of a structure immersed in a fluid.

The target final application application is the study of the mechanics of the heart valves. The use of a 3D model also in the thin structure describing the valve allows to have information also on the internal stresses, and to better describe the valve dynamics compared to models where the structure is reduced to an immersed surface.

The structural mesh is however kept independent from that of the fluid domain and the structure is thus completely embedded. Coupling conditions are imposed by enriching locally the degrees of freedom in the fluid elements that intersect the structure and by employing a consistent penalization approach. The chosen unfitted formulation combines the XFEM technique with a DG discretization applied locally.

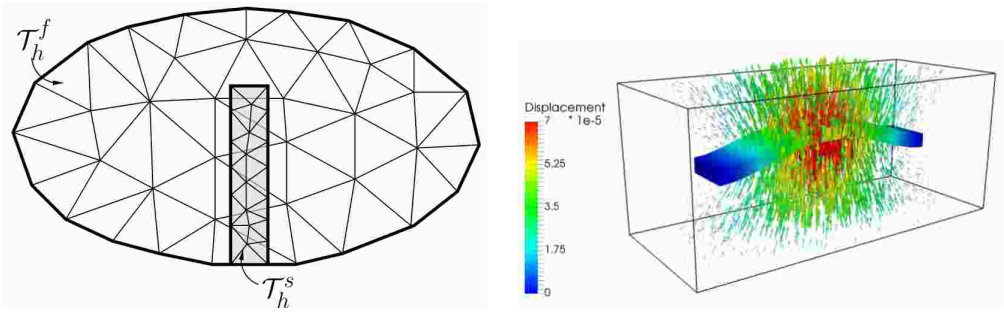

Figure 1: On the left a sketch of the structure mesh overlapping the fluid one, on the right a result of the fluid interaction problem on a simple configuration (from [1]).

In [1] we have first tested the method with a static structure, showing its effectiveness in imposing the coupling conditions efficiently, and then implemented a full fluid structure interaction problem with a linear elastic model. The 3D code has been entirely implemented within the finite element library Lifev [2].

In this work we plan to present some novel results on more realistic configuration and more complex non-linear models for the structure dynamics.

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