A Coupling Environment for Fluid-Structure Interactions on Cartesian Grids

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1 Abstract

This contribution describes a partitioned approach for fluid-structure interactions (FSI). We use the coupling environment FSI❄ce (see [2]) in order to make the flow solver and the structure solver independent from each other. This supports an easy exchange of different solvers on each side (flow and structure). The data independency is realised by introducing a central surface mesh in FSI❄ce that hides the internal computational grids of the two solvers from each other. The algorithmic independency is assured by encapsulating the complete control of the FSI simulation in the coupling environment. Thus, FSI❄ce decides in particular which coupling strategy (explicit/implicit) is to be used. Technically, this control is realised by the implementation of FSI*ce as a client with the solvers acting as servers. The client sends requests to the solvers which compute the requested simulation results and send them back to the client.

In our flow solver, we use adaptive Cartesian grids since they facilitate an efficient implementation due to their inherent structure and recursivity. This permits e.g. the use of efficient data structures and data access via space-filling curves. At the same time, these grids allow for arbitrarily local grid refinements (for the representation of complicated geometries or for solution dependent dynamical adaptivity, e.g.). As the coupling surface typically is represented by a triangulated mesh, a stable, flexible and performant component is needed that maps data from the solver's Cartesian grid to this mesh and vice versa.

A recent student project (*PeGSI* – Peano Geometry Sophisticated Interface [1]) covers these features by using an embedded spacetree model. We are currently working on an integration of this hierarchical volume-oriented model into FSI❄ce. This will allow for a very fast and efficient detection of triangles in the neighbourhood of a given vertex in the internal grid of a solver. Together with an encapsulated interpolation operator, this enables us to choose the type of interpolation (consistent/conservative) for the flow and structure solver in the central coupling environment.

References

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2. M. Brenk, H.-J. Bungartz, M. Mehl, and T. Neckel. Fluid-structure interaction on cartesian grids: Flow simulation and coupling environment. In H.-J. Bungartz and M. Schäfer, editors, *Fluid-Structure Interaction*, volume 53 of *LNCSE*. Springer, 2006.