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Discontinuous-continuous Galerkin fluid-structure interaction algorithm for elastic structures with large deformations

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This contribution introduces a fluid-structure interaction (FSI) methodology, where the structure is considered elastic. High-order methods are employed to solve dynamics of both the fluid flow and the solid structure. One of the main requirements for the FSI methodology is a high level of modularity, meaning that the fluid and structure solvers are independent of each other. For this reason, a partitioned approach was adopted with the option of either weak or strong coupling.

An implicit discontinuous Galerkin scheme was implemented for the solutions of compressible Navier-Stokes equations in the arbitrary Lagrangian-Eulerian formulation. The interior penalty method is used to approximate viscous fluxes. Both laminar and turbulent viscous flows and inviscid flows are considered. The one-equation Spalart-Allmaras turbulence model is applied for turbulence modelling.

The elastic structure is described by nonlinear equations of elastodynamics, which are solved by an implicit finite-element scheme with Newton's iterative procedure. Since the fluid and structure meshes are mutually nonconforming on the fluid-solid interface, the aerodynamic stress is interpolated using radial basis functions. The mesh-deformations algorithm is also based on radial basis functions, the advantage of which is that it takes care of the interpolation of the structure's displacement on the fluid-solid interface. The fluid and structure solvers are validated independently on a couple of benchmarks and the coupled FSI solver is tested on the Turek-Hron benchmark proposed in [1] and again published in [2].

REFERENCES

[1] S. Turek and J. Hron, Proposal for numerical benchmarking of fluid-structure interaction between an elastic object and laminar encompressible flow. In: *Fluid-Structure Interaction* (edit.: H.J. Bungartz, M. Schäfer), Vol. **53**, Springer, Berlin, Heidelberg, pp. 371–385, 2006.

[2] S. Turek, J. Hron, M. Mádlík, M. Razzaq, H. Wobker, and J.F. Acker, Numerical simulation and benchmarking of a monolithic multigrid solver for fluid-structure interaction problems with application to hemodynamics. *Lecture Notes in Computational Science and Engineering*, Vol. **73**, pp. 193-220, 2010.