Partitioned solver for strongly coupled fluid–structure interaction

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Résumé en anglais	In this work a fluid–structure interaction solver is developed in a partitioned approach using block Gauss–Seidel implicit scheme. Finite volume method is used to discretize the fluid flow problem on a moving mesh in an arbitrary Lagrangian–Eulerian formulation and by using an adaptive time step. The pressure–velocity coupling is performed by using the PIMPLE algorithm, a combination of both SIMPLE and PISO algorithms, which permits the use of larger time steps in a moving mesh. The structural elastic deformation is analyzed in a Lagrangian formulation using the St. Venant–Kirchhoff constitutive law, for non-linear large deformations. The solid structure is discretized by the finite volume method in an iterative segregated approach. The automatic mesh motion solver is based on Laplace smoothing equation with variable mesh diffusion. The strong coupling between the different solvers and the equilibrium on the fluid–structure interface are achieved by using an iterative implicit fixed-point algorithm with dynamic Aitken's relaxation method. The solver, which is called vorflexFoam, is developed using the open source C++ library OpenFOAM. The solver is validated on two different benchmarks largely used in the open literature. In the first one the structural deformation is induced by incompressibility. The second benchmark consists on a vortex excited elastic flap in a Von Karman vortex street. Finally, a more complex case is studied including two elastic flaps immersed in a pulsatile flow. The present solver detects accurately the interaction between the complex flow structures generated by the flaps and the effect of the flaps oscillations between each other.
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