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ACCELERATION OF STRONGLY COUPLED FLUID-STRUCTURE INTERACTION WITH MANIFOLD MAPPING

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Strongly coupled partitioned fluid-structure interaction problems require multiple coupling iterations per time step. In other words, the fluid domain and the structure domain are solved multiple times in each time step such that the kinematic and dynamic interface conditions on the fluid-structure interface are satisfied. Quasi-Newton methods have been successfully applied in case the fluid and structure solvers are considered as black boxes.

In this contribution manifold mapping is applied on the fluid-structure interaction problem in order to minimize the interface residual [1, 2]. Manifold mapping originates from multi-fidelity optimization, and the algorithm is applied for the first time in a simulation context, instead of an optimization context. A computationally inexpensive low-fidelity model is combined with a high-fidelity model in order to accelerate the convergence of the high-fidelity model. Manifold mapping is preferred over space mapping, since a proof of convergence for the manifold mapping iteration is available, whereas this has not been shown for space mapping [1]. In this contribution, following the multi-level acceleration approach in [4], a coarse mesh is combined with a highly refined mesh.

The manifold mapping algorithm is applied to the standard cylinder with an attached flap FSI3 benchmark proposed in [3]. As shown in [4], by combining a coarse mesh with refined mesh, computational gains of 50% can be achieved. A similar gain in efficiency is expected with the applied of manifold mapping on a strongly coupled fluid-structure interaction problem. Manifold mapping considers the flow and structure solvers as black boxes, and is therefore preferred over the multi-level approach which does require modifications of the flow solver for a computationally efficient implementation.

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