Goal-oriented Error Estimation of Stationary Fluid-Structure Interaction with Partitioned Methods

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Abstract: Very efficient methods for solving fluid and elastic structure problems have been developed in the last decades. This enables to solve highly complex multi-physics problems such as fluid-structure interaction (FSI), in a fast way, if we apply partitioned algorithms that utilize these methods.

In most applications for FSI we are only interested in computing a certain physical quantity (e.g. drag values) as accurate as possible. If the FSI system is discretized in space and solved by an iterative partitioned scheme, an inaccuracy is induced. Consequently, the question arises, if it is possible to estimate the error coming from these sources. Thereby, we can decide whether the partitioned algorithm has to be solved more accurately or if we have to refine the mesh in order to improve the accuracy of the quantity in the upcoming simulation.

For this purpose, we use the dual-weighted residual method (DWR). With this method one can express the error in the quantity of interest in terms of residual information which makes it possible to localize the spatial discretization error. Moreover, based on [1] it is possible to seperate the errors coming from spatial discretization and the partitioned method, which can then be estimated. Since for DWR sensitivity information is required, the presented adaptive algorithm is especially useful for optimal control problems where sensitivity information is already available and the FSI system has to solved several times during the optimization process.

To validate the reliability of the estimators we compute a numerical benchmark problem in which the primal and dual solutions are both computed by partitioned fix-point schemes.

References

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