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AN ADAPTIVE TIME STEPPING PROCEDURE FOR MONOLITHIC FLUID-STRUCTURE INTERACTION SOLVERS

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The numerical analysis of fluid-structure interaction problems has been a field of intensive research for years and plays an important role in engineering applications of all kind. Especially, the coupling of incompressible fluid flow and deformable structures undergoing large deformations is of particular interest. When it comes to real world applications, it is crucial to make predictions about the physical problem at hand very accurately, but still efficiently and with reasonable costs. With respect to temporal discretization using constant time step sizes $\Delta t_n = const.$ in all time steps, a high level of temporal accuracy can only be achieved by choosing overall small time step sizes. However, this leads to a tremendous increase in computational time, especially when such small time step sizes are not necessary throughout the entire simulation in order to maintain the desired level of accuracy. By choosing the time step sizes Δt_n adaptively and individually for each time step n, the local discretization error of the applied time integration scheme can be limited to a user-given bound and, thus, one can achieve the desired level of accuracy by simultaneously limiting the computational costs.

For single-field problems, such adaptive time stepping schemes are well understood and readily available in literature. Well known adaptive time stepping schemes for pure structural dynamics based on *a posteriori* error estimation have been proposed by e.g. [1]. Alternative approaches are based on *a priori* error estimations [2] or on the 'apparent highest frequency' [3, 4]. Adaptive time stepping schemes for pure fluid dynamics based on *a posteriori* error estimation can be found in [5, 6], among others.

In this contribution, we combine error estimation in the structure and fluid field to build an adaptive time stepping algorithm for fluid-structure interaction problems. This algorithm is integrated into the monolithic solver framework [7]. By controlling the local temporal

discretization error in the structure and fluid field, an optimal time step size can be selected that satisfies the accuracy demands in both fields. Due to the central and important role of the fluid-structure interface, the discretization error at the interface is monitored as well and is incorporated into the step size selection process.

In the presentation, the formulation of the proposed adaptive time stepping scheme for the monolithic fluid-structure interaction solver will be given and examples will be provided, that demonstrate the behaviour of the newly proposed method with respect to accuracy and computational costs.

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