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Numerical Simulation and Optimization of Fluid-Structure Interaction Problems

Abstract:
In many applications in industry and science one is faced with interactions of fluid flows and structural deformations. The numerical simulation and optimization of such problems can help for a better understanding and/or design of corresponding processes. In the lecture an integrated approach for numerical optimization of fluid-structure interaction (FSI) problems is presented. The key components of the method are (i) an implicit partitioned FSI solver involving the finite-volume flow code FASTEST with ALE formulation, the finite-element structural code FEAP, and the coupling interface MpCCI, (ii) a surface representation tool based on NURBS, (iii) a grid deformation approach involving algebraic and elliptic methods for moving the fluid grid, as well as (iv) derivative-free and sensitivity-based mathematical optimization techniques. A key feature of the integrated method is the unified treatment of structural deformation due to FSI and shape variation for fulfilling the optimization objectives. One crucial aspect for the performance of the approach is the efficiency and accuracy of the FSI solver which has to be run repeatedly during the optimization procedure. Several techniques improving the solver to this respect are discussed, e.g., advanced grid moving, multigrid methods, and parallelization. Results for several representative test cases involving FSI with laminar and turbulent flows illustrate the corresponding capabilities.