Klaudius Scheufele

# Multi-Secant quasi-Newton Variants for Parallel Fluid-Structure Simulations – and Other Multi-Physics Applications

Institute for Parallel and Distributed Systems
University of Stuttgart
Universittsstrae 38
D-70569 Stuttgart
klaudius.scheufele@ipvs.uni-stuttgart.de
Miriam Mehl

Multi-secant quasi-Newton methods based on secant information produced with no overhead throughout subsequent solver iterations have been shown to be particularly suited to solve non-linear fixed-point equations that arise from partitioned multi-physics simulations where the exact Jacobian is inaccessible. In all these methods, the multi-secant equation for the approximate (inverse) Jacobian is enhanced by a norm minimization condition. It is well-known, that fluid-structure simulations, e. g., typically require the use of secant-information from previous time steps. The number of these time-steps highly depends on the application, its parameters, the used solvers, and the mesh resolution. Using to few leads to a relatively high number of iterations, using too many not only to a computational overhead but also to an increase of the number of iterations, as well. Determining the optimal number requires a costly try-and-error process, which can be avoided using a modified method that considers the difference of the current (inverse) Jacobian and the one of the previous time step in the norm-minimization. Thus, previous time step information is taken into account in an implicit and automatized way without magic parameters. We show numerical results for fluid-structure interactions for both methods proving the robustness and numerical efficiency of the second variant. In addition, we propose a new algorithm eliminating the drawback of having to store full interface Jacobian approximations for the Jacobian difference norm minimization. This results in a highly efficient, parallelizable, and robust iterative solver applicable for surface coupling in many types of multi-physics simulations.