Texas Tech University - Department of Mathematics and Statistics

Seminar in Applied Mathematics

Numerical solution of stationary incompressible FSI problems with multigrid solvers and domain decomposition smoothers

GIORGIO BORNIA

Texas Tech University

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ABSTRACT. We investigate the numerical performance of a monolithic Newton-multigrid solver with domain decomposition smoothers for the solution of a class of stationary incompressible FSI problems. The physics of the problem is described using a monolithic approach, where mass continuity and stress balance are automatically satisfied across the fluid-solid interface. The deformation of the fluid domain is taken into account within the nonlinear Newton iterations according to an Arbitrary Lagrangian Eulerian (ALE) scheme. Due to the complexity and variety of the operators, the implementation of the Jacobian matrix in the nonlinear iterations is not a trivial task. To this purpose, we make use of automatic differentiation tools for an exact computation of the Jacobian matrix. The numerical solution of steady-state problems is particularly challenging, due to the ill-conditioning of the induced stiffness matrix. Moreover, the enforcement of the incompressibility condition calls for the use of incompressible solvers either of mixed or segregated type. At each nonlinear outer iteration the resulting linearized system is solved with a geometric multigrid solver. We consider a GMRES smoother preconditioned by an Additive Schwarz Method (ASM). The domain decomposition of the preconditioner is driven by the natural splitting between fluid and solid domain. The numerical results of some benchmark tests for steady-state cases show agreement with the literature and an increased robustness with our choice of smoothers with respect to standard ones.