

Monolithic Newton-Multigrid Solver for Fluid-Structure-Interaction Problems

Stefan Turek and Jaroslav Hron

Institut für Angewandte Mathematik und Numerik, TU Dortmund
Vogelpothsweg 87, 44227 Dortmund, Germany
e-mail: ture@featflow.de

ABSTRACT

We present a monolithic FEM multigrid approach to solve the problem of time dependent interaction between an incompressible viscous fluid and an elastic solid. The continuous formulation of the problem and its discretization is done in a monolithic way, treating the problem as one continuum. The Q2/P1 finite elements are used for the discretization and an approximate Newton method with coupled multigrid linear solver of local Schur Complement, resp., Vanka type is developed for solving the equations. We discuss possible efficient strategies of setting up the resulting system and its solution. We consider the flow to be incompressible and in the laminar regime, but including also nonlinear effects coming from non-newtonian or viscoelastic or non-isothermal behaviour. The structure can be compressible or incompressible and the deformations of the structure are allowed to be significant in terms of displacement. Several configurations of benchmarking type are used to analyze the presented numerical methods and code implementations for the fluid-structure interaction problem qualitatively and particularly quantitatively with respect to flexibility, robustness, efficiency and accuracy of the computation.

REFERENCES

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