On efficient and robust numerical solution algorithms for nonstationary, nonlinear, coupled problems

Thomas Wick
AG Wissenschaftliches Rechnen
Institut für Angewandte Mathematik
Leibniz Universität Hannover

In this presentation, we give an overview of our last 5-year developments for solving nonstationary, nonlinear, coupled problems. Our focus will be on two specific applications: phase-field fracture propagation resulting in a quasi-stationary variational inequality; and secondly, nonlinear fluid-structure interaction will be addressed. From a numerical point of view, the efficient and robust solution of the entire PDE is of interest, but as well the efficient and robust evaluation of so-called quantities of interest (goal functionals). The latter represent only parts of the solution that is of interest in a specific application. Considering coupled PDEs, we will discuss the classification and realization of coupling conditions in detail. Our implementations employ mesh adaptivity in conjunction with parallel computing. In this regard, a lot of effort has been spent in designing sustainable software frameworks based on deal.II and DOpElib. Selected numerical examples demonstrate our developments. Here, we also highlight open questions, ongoing work and future challenges.

References

1. T. Wick; Zielorientierte Numerik für Multiphysiksimulationen, GAMM-Rundbrief, Nr. 2, 2018 (in german)

2. T. Heister, T. Wick; Parallel solution, adaptivity, computational convergence, and open-source code of 2d and 3d pressurized phase-field fracture problems, PAMM, 2018, arXiv arXiv:1806.09924

3. D. Jodlbauer, U. Langer, T. Wick; Parallel Block-Preconditioned Monolithic Solvers for Fluid-Structure-Interaction Problems, International Journal for Numerical Methods in Engineering, Vol. 117 (6), 2019, pp. 623-643

4. L. Failer, T. Wick; Adaptive Time-Step Control for Nonlinear Fluid-Structure Interaction, Journal of Computational Physics (JCP), Vol. 366, 2018, pp. 448 - 477

5. B. Endtmayer, U. Langer, T. Wick; Multigoal-Oriented Error Estimates for Non-linear Problems, Journal of Numerical Mathematics (JNUM), accepted in July 2018