Decoupling of Nonlinearities in Acoustic-Structure Interaction

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The wide field of fluid-structure interactions contains many applications for elasto-acoustic coupling problems, especially nonlinear ones. Linear elasticity is restricted to the case of small deformations. Nonlinear acoustic effects including dissipation and generation of higher harmonics play an important role in ultrasonics. The choice of a velocity potential or pressure based formulation of the acoustic part and quite often a displacement one of the elastic part results in Dirichlet-Neumann type interface conditions.
In this presentation, decoupling strategies and algorithms for the nonlinear elasto-acoustic system are discussed. The nonlinear aspect is investigated in both, the elastic and acoustic part, and compared with each other. A mortar finite element discretization in combination with a generalized Newmark scheme leads to a system on which a subspace iteration for solving the nonlinear equation and a second iteration for the elasto-acoustic connection is applied. The corresponding solvability results for this kind of coupling problems are analyzed. Two illustrative numerical schemes using different solvers for the subspace iteration, a Newton-like and a fixed point iteration method are given. In particular a better performance, i.e. smaller convergence rates, is obtained for a multiplivative Schwarz method. Computational calculations show the superior behavior to an additive Schwarz method. An additional improvement of the convergence rate is achieved with the introduction of a small region where both subdomains overlap.

References:

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