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EFFICIENCY ISSUES OF PARTITIONED SOLUTION IN FLUID-STRUCTURE INTERACTION

***Malte von Scheven, Ekkehard Ramm and Manfred Bischoff**

Institut für Baustatik und Baudynamik, Universität Stuttgart
Pfaffenwaldring 7, 70550 Stuttgart, Germany
{mvs,ramm,bischoff}@ibb.uni-stuttgart.de
http://www.ibb.uni-stuttgart.de/

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ABSTRACT

Numerical simulation of large scale computational fluid dynamics (CFD) and fluid-structure interaction (FSI) problems is still today a very challenging task. The correct modeling of the fluid flow, governed by the instationary incompressible Navier-Stokes equations, and the nonlinear structural behavior of light-weight structures is a challenge of its own. In addition the coupling of both physical fields introduces further requirements on stability and efficiency of the involved algorithms.

Already the single fields, especially the fluid, demand high efficiency of the solution algorithm. Here, assembly of the element matrices and in particular the iterative solver for the global system of linear equations are the most time consuming parts of the solution process. We will present an approaches to significantly increase efficiency for the calculation of the element matrices exploiting the special features of vector supercomputers [1] and compare the efficiency of different iterative solvers and pre-conditioners for the fluid investigating different Reynolds numbers.

The partitioned solution of FSI problems is particularly advantageous in terms of flexibility and code reuse. As staggered algorithms proved to be unstable in a wide range of applications, iterative schemes need to be employed. Their convergence rate is decisive for the overall efficiency of the algorithm. We will introduce iterations schemes making use of different dynamically adapted relaxation methods that accelerate the convergence. The additional use of a fully converged coarse grid solution of the coupled problem as a predictor to the iteration scheme can significantly accelerate its convergence and increases the efficiency of the whole coupling scheme.

A selection of two- and three-dimensional numerical examples demonstrate the capabilities of the formulation.

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