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A parallel sparse algorithm targeting arterial fluid mechanics computations. (English)

Zbl 1398.76115
Comput. Mech. 48, No. 3, 377-384 (2011).

Summary: Iterative solution of large sparse nonsymmetric linear equation systems is one of the numerical challenges in arterial fluid-structure interaction computations. This is because the fluid mechanics parts of the fluid + structure block of the equation system that needs to be solved at every nonlinear iteration of each time step corresponds to incompressible flow, the computational domains include slender parts, and accurate wall shear stress calculations require boundary layer mesh refinement near the arterial walls. We propose a hybrid parallel sparse algorithm, domain-decomposing parallel solver (DDPS), to address this challenge. As the test case, we use a fluid mechanics equation system generated by starting with an arterial shape and flow field coming from an FSI computation and performing two time steps of fluid mechanics computation with a prescribed arterial shape change, also coming from the FSI computation. We show how the DDPS algorithm performs in solving the equation system and demonstrate the scalability of the algorithm.

MSC:

76M10 Finite element methods applied to problems in fluid mechanics
76D05 Navier-Stokes equations for incompressible viscous fluids
76Z05 Physiological flows
92C35 Physiological flow
74F10 Fluid-solid interactions (including aero- and hydro-elasticity, porosity, etc.)

Keywords:

arterial fluid mechanics; incompressible flow; boundary layer mesh refinement; preconditioning techniques; nested iterative methods; parallel sparse algorithms

Software:

SPIKE

Full Text: DOI

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