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A Row and Column Scaling Preconditioner for Efficient Fluid-Structure Modeling in Cardiovascular System[1] CHI ZHU, University of California, Berkeley, VIJAY VEDULA, Columbia University, SHAWN SHADDEN, University of California, Berkeley — Blood flow and tissue mechanics are two fundamental elements in cardiovascular modeling. Biological tissue is mostly treated as incompressible, and its governing equations in a velocity-pressure formulation are very similar to the Navier Stokes equations. This similarity enables one to model blood flow and tissue mechanics using the same mixed finite-element numerical framework, which can be advantageous for fluid-structure-interaction simulations. Taylor-Hood elements is commonly used to solve velocity-pressure formulations as they satisfy the inf-sup condition. The challenge is that these elements can lead to extremely ill-conditioned matrix system. Existing open-source softwares usually overcome this by using direct solvers, which become less economic for large scale problems. In this study, we present a new preconditioning strategy, wherein a row and column scaling (RCS) preconditioner is first used to regulate the matrix before applying common preconditioner/iterative solver combinations. We demonstrate that the proposed RCS can drastically reduce the condition number of the matrix systems, and, in turn, the overall computational time with minimal computational overhead. Its capability will be demonstrated in practical patient-specific cardiac modeling applications.

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