Stabilized methods for fluid-structure interaction

Yue Yu, Brown University

In hemodynamic problems, the arterial wall density is relatively light and usually close to the blood density. However, this brings a special challenge for numerical simulations: the convergence of the partitioned FSI procedure is problematic because of the so-called added-mass effect. We developed two types of stabilized methods for FSI problems. The first type is the fictitious methods, where additional subiteration is required between the fluid and structure in each time step. The fictitious methods are obtained by changing the coefficients of the pressure or acceleration terms in the fluid or structure equations, respectively, and therefore can be easily extended and implemented in any existing FSI solver. We also provided theoretical analysis to obtain optimal values for the fictitious parameters as well as to reveal a similarity with the popular Robin-based approach. The second type of stabilized method is a new stabilized explicit coupling partitioned scheme. In this method the stability does not depend on the added-mass effect, and no subiteration is needed. To control the variations at the interface, we treated the coupling interface conditions in a weak sense, and applied proper penalty terms on the displacement, pressure and velocity solvers separately. We numerically validated both methods, and shown the improved stability on various geometries including 3D patient-specific flexible brain arteries with aneurysms for very large deformations.