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Strongly Coupled Fluid-Body Dynamics in the Immersed Boundary Projection Method[1] CHENGJIE WANG, JEFF D. ELDREDGE, University of California, Los Angeles — A computational algorithm is developed to simulate dynamically coupled interaction between fluid and rigid bodies. The basic computational framework is built upon a multi-domain immersed boundary method library, whirl, developed in previous work. In this library, the Navier-Stokes equations for incompressible flow are solved on a uniform Cartesian grid by the vorticity-based immersed boundary projection method of Colonius and Taira. A solver for the dynamics of rigid-body systems is also included. The fluid and rigid-body solvers are strongly coupled with an iterative approach based on the block Gauss-Seidel method. Interfacial force, with its intimate connection with the Lagrange multipliers used in the fluid solver, is used as the primary iteration variable. Relaxation, developed from a stability analysis of the iterative scheme, is used to achieve convergence in only 2-4 iterations per time step. Several two- and three-dimensional numerical tests are conducted to validate and demonstrate the method, including flapping of flexible wings, self-excited oscillations of a system of linked plates and three-dimensional propulsion of flexible fluked tail.

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