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A monolithic projection framework for constrained FSI problems with the immersed boundary method[1] LUOHAO WANG, CHUNMEI XIE, WEIXI HUANG, Tsinghua University — Constrained fluid-structure interaction (CFSI) problems involving complex substructures and their shapes are commonly seen in daily life, e.g. a flying kite and a drifting parachute. Such a system may contain several substructures inter-linked by ropes or hinges, and may have high stiffness materials in certain parts. By treating all high stiffness constraints ideally, a monolithic projection framework for CFSI problems is proposed to solve multi-structure and multi-constraint problems. Immersed boundary method (IBM) in the continuous forcing form is used to evaluate the constraint force on the fluid-structure interface due to the no-slip condition. Besides, constraints from material properties and inter-structure dynamics are uniformly formulated, with both bilateral and unilateral types. All subsystems are assembled into a monolithic system and solved efficiently by decoupling with nested approximate LU decomposition. Error analysis based on general semi-discrete operators shows that the current framework has a second-order temporal accuracy for decomposition. Cases such as flags and parachutes are simulated and results show a nearly second-order overall temporal accuracy, along with significant efficiency improvement.

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