

Large Scale Parallel MPS-FE Fluid Structure Interaction Simulation System Using Adventure_Solid and LexADV_EMPS

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ABSTRACT

For fluid structure interaction (FSI) problems involving violent free surface flows, we have developed a robust FSI coupling method named MPS-FE method [1], and its improved one [2]. These methods utilize the Finite Element (FE) method for structure computation and the Moving Particle Simulation/Semi-implicit (MPS) method [3] for fluid computation with free surfaces, respectively. Our two coupling methods are based on a partitioned coupling approach and achieve efficiency, robustness, and modularity of software libraries.

However, to apply our MPS-FE methods to actual problems and analyze in detail, parallelization with high computational efficiency is required because degrees of freedom in our problems is quite large. Therefore, in this study, we have developed a large-scale parallel MPS-FE FSI simulation system coupling two existing codes, named Adventure_Solid [4, 5] and LexADV_EMPS [6, 7]. The Adventure_Solid is a parallel FE solver which is based on the hierarchical domain decomposition method and employs the balancing domain decomposition method as a preconditioner for the iterative solution procedure of large linear equations. The LexADV_EMPS is a parallel Explicit-MPS solver where dynamic and spatial domain decomposition is employed to ensure the load balance for efficient parallel computation in terms of the number of moving particles in each domain. To exchange physical values on FSI interface, a coupler code has been implemented and used in our simulation system. The coupler code manages a data communication table between statically and dynamically decomposed domains. Using our developed FSI simulation system, we demonstrate some large-scale FSI simulations.

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