Strongly coupled fictitious domain-SPH and FEM for fluid-structure interactions

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ABSTRACT

This study proposes a novel strongly coupled fluid-structure interaction (FSI) framework by integrating the fictitious domain (FD) method [1][2] into Smoothed Particle Hydrodynamics (SPH). Furthermore, by applying a ghost cell boundary (GCB) model [3] to the proposed FD-SPH framework, we develop a coupling procedure with the finite element method (FEM) using arbitrary continuum elements.

The developed FD-SPH-FEM coupling, enhanced by the GCB model, enables robust and highly accurate simulations of complex interactions between violent free-surface flows and nonlinear structural responses. A key advantage of this approach is the capability to independently prescribe the fluid particle resolution and the structural mesh resolution.

In this presentation, we outline the conceptual framework, mathematical formulation, and numerical algorithm of the proposed method. Its validity is demonstrated through fundamental benchmark tests, including hydrostatic and dam-break problems involving a deformable body. Finally, a numerical example of a practical tsunami-structure interaction scenario is presented to highlight the effectiveness of the proposed method.

REFERENCES

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