

# LARGE-SCALE MPS-FE ANALYSIS OF FLUID-STRUCTURE INTERACTION WITH FREE SURFACE

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Water disasters such as tsunamis and floods involve Fluid-Structure Interaction (FSI) problems with free surface flows. Since failures of artifacts are caused due to inundation, water forces and impact forces by floating objects, simulation of such problems have great importance to design for safety and robustness.

To solve such problems, we have developed a new FSI method named MPS-FE method. The method adopts the Finite Element (FE) method for structure computation and the Moving Particle Simulation (MPS) method [1], one of mesh-free particle methods, for fluid computation involving free surfaces. These two methods are coupled with a partitioned coupling approach, i.e. the Conventional Serial Staggered (CSS) scheme [2]. The MPS-FE method takes advantage of both methods and has software modularity.

In our previous studies, we have verified and validated the accuracy of MPS-FE method. In this study, we aim to solve a large-scale problem for practical use. Some of the present authors have developed a large-scale parallel FEM program named ADVENTURE [3, 4] and a large-scale parallel Explicit-MPS (E-MPS) method program [5]. We develop a coupler program which couples these parallelized programs, and present some application examples to demonstrate the applicability and versatility of large-scale MPS-FE computation.

## REFERENCES

- [1] S. Koshizuka and Y. Oka, Moving-particle semi-implicit method for fragmentation of incompressible fluid, *Nucl. Sci. Eng.*, **123**, pp.423–433, 1996.
- [2] C. Farhat and M. Lesoinne, Two efficient staggered algorithms for the serial and parallel solution of three-dimensional nonlinear transient aeroelastic problems, *Comput. Meth. Appl. Mech. Eng.*, **182**, pp.499–515, 2000.
- [3] <http://adventure.sys.t.u-tokyo.ac.jp>
- [4] S. Yoshimura, R. Shioya, H. Noguchi and T. Miyamura, Advanced general-purpose computational mechanics system for large-scale analysis and design, *J. Comput. Appl. Math.*, **49**, pp.279–296, 2002.
- [5] K. Murotani, S. Koshizuka, T. Fujisawa, N. Mitsume, and S. Yoshimura, Hierarchical domain decomposition explicit MPS method for a large-scale tsunami analysis, *JSME-CMD ICMS2012, 9th-11th October*, 2012.