Development of a partitioned coupling analysis system for fluid-structure interactions using an ISPH code and the ADVENTURE system

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Abstract

To prevent and mitigate tsunami-related disasters on coastal area, a numerical simulation of tsunami-induced forces on structures is of great importance. For a 3-dimensional tsunami run-up and inundation simulation, mesh-free particle methods, such as the smoothed particle hydrodynamics (SPH) method and the moving particle semi-implicit (MPS) method, have been widely used. To improving numerical stability of particle methods, the stabilized incompressible SPH (ISPH) method has been proposed using a relaxing the density invariance condition [1]. Moreover, to improving a parallel efficiency, a combination of a hierarchical bucket-based domain decomposition and a dynamic load balancing for the explicit MPS (E-MPS) method, which adopts a pseudo-compressibility approach, has been proposed [2]. On the other hand, the finite element method (FEM) is a powerful tool for structures. The ADVENTURE system is well-known open source FEM software.

In this research, we consider to develop a partitioned coupling analysis system for fluid-structure interaction (FSI) problems such as tsunami-induced forces on structures. A coupling technique of SPH and FEM has been applied to FSI problems involving free surface flows [3]. Moreover, a coupling technique of E-MPS and FEM has been investigated for the interaction problem between an elastic structure and free surface flows [4]. Mitsume et al. developed a coupling analysis system with in-house coupling code [5], however, its approach is lack versatility. In here, Yoshimura et al. have developed a general-purpose coupling analysis platform, named REVOCAP_Coupler [6], which couples a FEM code and another one. Therefore, we attempt to use the REVOCAP_Coupler for coupling of an in-house SPH code and a FEM code. We adopt the ADVENTURE_Solid as a elasto-plastic FEM software. Using a developed system, we demonstrated some numerical examples of FSI problems.

Keywords: Fluid-structure interaction, finite element method, incompressible SPH method, ADVENTURE, REVOCAP

References

[1] Asai, M., Aly, A.M., Sonoda, Y. and Sakai, Y. (2012) A stabilized incompressible SPH method by relaxing the density invariant condition, *Journal of Applied Mathematics* **2012**, 139583.
[2] Murotani, K., Koshizuka, S., Tamai, T., Shibata, K., Mitsume, N., Yoshimura, S., Tanaka, S., Hasegawa K., Nagai, E., and Fujisawa, T. (2014) Development of Hierarchical Domain Decomposition Explicit MPS Method and Application to Large-scale Tsunami Analysis with Floating Objects, *Journal of Advanced Simulation in Science and Engineering* **1**, 16-35.
[3] Yang, Q., Jones, V. and McCue, L. (2012) Free-surface flow interactions with deformable structures using an SPH-FEM model, *Ocean Engineering* **55**, 136-147.
[4] Mitsume, N., Yoshimura, S., Murotani, K. and Yamada, T. (2014) MPS-FEM partitioned coupling approach for fluid-structure interaction with free surface flow, *International Journal of Computational Methods* **11**, 1350101.
[5] Mitsume, N., Yoshimura, S., Murotani, K. and Yamada, T. (2016) Parallel analysis system for fluid-structure interaction with free-surface using ADVENTURE_Solid and LexADV_EMPS, *Advances in Computational Fluid-Structure Interaction and Flow Simulation, Springer International Publishing*, 245-255.
[6] Yoshimura, S., Yonemura, N. and Yamada, T. (2007) Coupling Analysis Platform in Parallel Environments REVOCAP_Coupler, *Proceedings of APCOM2007*.