Weighted relative distance tracking method for particle methods

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ABSTRACT

Particles methods are versatile tools to analyze multiphase flows and free surface problems due to their versatility of tracking moving boundaries even with huge deformations. However, many boundary tracking methods used on particle methods are simple to implement but with low accuracy and other methods provide very good detection results at complicated implementation cost or high computational time. In the particle method called Moving Particle Semi-implicit (MPS) method [1], the accuracy of the boundary particles tracking methods affect the precision of the pressure calculated by the method and the interaction between fluid phases. There are many boundary particles tracking methods based on the geometry of the neighbouring particles distribution [2], [3], the properties of the particles [1], counting of neighbour particles [4], gradient vector of a property of the particles [5], relative distance between particles [6] and a combination of different methods [7]. In the present work, an alternative boundary particles detection method is proposed to improve the accuracy of the boundary particles detection and keeping the implementation easy. It is based on a combination of the method proposed by Koshizuka & Oka [1] based on the particle number density and the weighted relative distance between particles.

REFERENCES

[1] S. Koshizuka and Y. Oka, "Moving-particle semi-implicit method for fragmentation of incompressible fluid," Nucl. Sci. Eng., vol. 123, no. 3, pp. 421–434, 1996.

[2] T. Tamai, K. Shibata, and S. Koshizuka, "Development of the Higher-order MPS Method Using the Taylor Expansion," Trans. JSCES, no. 20130003, 2013.

[3] C. G. Koh, M. Gao, and C. Luo, "A new particle method for simulation of incompressible free surface flow problems," no. November 2011, pp. 1582–1604, 2012.

[4] M. Tanaka and T. Masunaga, "Stabilization and smoothing of pressure in MPS method by Quasi-Compressibility [in japanese]," J. Comput. Phys., vol. 229, no. 11, pp. 4279–4290, 2010.

[5] S. Itori, T. Iribe, and E. Nakaza, "AN IMPROVEMENT OF DIRICHLET BOUNDARY CONDITIONS IN NUMERICAL SIMULATIONS USING MPS METHOD [japanese]," J. Japan Soc. Civ. Eng. Ser. B2 (Coastal Eng., vol. 68, no. 1, pp. 17–28, 2012.

[6] H. Gotoh, A. Khayyer, and C. Hori, "New Assessment Criterion of Free Surface for Stabilizing Pressure Field in Particle Method [jap]," J. Japan Soc. Civ. Eng. Ser. B2 (Coastal Eng., vol. 65, no. 1, pp. 21–25, 2009.

[7] B.-H. Lee, J.-C. Park, M.-H. Kim, and S.-C. Hwang, "Step-by-step improvement of MPS method in simulating violent free-surface motions and impact-loads," Comput. Methods Appl. Mech. Eng., vol. 200, no. 9–12, pp. 1113–1125, Feb. 2011.