A new boundary treatment scheme to simulate two-dimensional free surface flows in SPH

Hyung-Jun Park, Hyun-Duk Seo and Phill-Seung Lee*

[*] Department of Mechanical Engineering, Korea Advanced Institute of Science and Technology

291 Daehak-ro, Yuseong-gu, Daejeon 34141, Republic of Korea

e-mail: hjpark89@kaist.ac.kr; dukdukseo@gmail.com; phillseung@kaist.edu,
web page: http://cmss.kaist.ac.kr

ABSTRACT

A new formulation considering a support domain that is truncated by boundary regions is proposed to simulate two-dimensional free surface problems in smoothed particle hydrodynamics (SPH). For particles approaching the boundary regions, the proposed formulation directly imposes boundary conditions without the use of boundary particles. The formulation is simply defined by adding the boundary truncation terms to mass and momentum conservation equations in the conventional SPH formulation. Since there is no need to use boundary particles, the modeling of boundary regions becomes easier and computationally more efficient. The performance of the proposed model is verified through several numerical examples: inclined bed problem, dam-break problem, sloshing problem, hydrostatic problem, pulsating box problem. The numerical results are compared with those of existing experiments and the SPH models using boundary particles.

REFERENCES

[1] Monaghan, J. J. (1992). Smoothed particle hydrodynamics. Annual review of astronomy and astrophysics, 30(1), 543-574.
[2] Liu, G. R., & Liu, M. B. (2003). Smoothed particle hydrodynamics: a meshfree particle method. World Scientific.
[3] Kulasegaram, S., Bonet, J., Lewis, R. W., & Profit, M. (2004). A variational formulation based contact algorithm for rigid boundaries in two-dimensional SPH applications. Computational Mechanics, 33(4), 316-325.
[4] Monaghan, J. J., & Kajtar, J. B. (2009). SPH particle boundary forces for arbitrary boundaries. Computer Physics Communications, 180(10), 1811-1820.
[5] Adami, S., Hu, X. Y., & Adams, N. A. (2012). A generalized wall boundary condition for smoothed particle hydrodynamics. Journal of Computational Physics, 231(21), 7057-7075.
[6] Ferrand, M., Laurence, D. R., Rogers, B. D., Violeau, D., & Kassiotis, C. (2013). Unified semi-analytical wall boundary conditions for inviscid, laminar or turbulent flows in the meshless SPH method. International Journal for Numerical Methods in Fluids, 71(4), 446-472.
[7] Park HJ, Seo HD, Lee PS. (2019). A new wall boundary treatment method for simulating 2D free surface flows in SPH. Manuscript in preparation.