A new 3D parallel SPH scheme for free surface flows

Angela Ferrari *

Abstract

We propose a new robust and accurate SPH scheme, able to track correctly complex three-dimensional non-hydrostatic free surface flows and, even more important, also able to compute an accurate and little oscillatory pressure field. It uses the explicit third order TVD RungeKutta scheme in time, together with the new key idea of introducing a monotone upwind flux for the density equation, thus removing any artificial viscosity term. For the discretization of the velocity equation, the non-diffusive central flux has been used. To asses the accuracy of the new SPH scheme, a 3D mesh-convergence study is performed for the strongly deforming free surface in a 3D dam-break and impact-wave test problem providing very good results. Moreover, the parallelization of the new 3D SPH scheme has been carried out using the message passing interface (MPI) standard, together with a dynamic load balancing strategy to improve the computational efficiency of the scheme. Thus, simulations involving millions of particles can be run on modern massively parallel supercomputers, obtaining a very good performance, as confirmed by a speed-up analysis. The 3D applications consist of environmental flow problems, such as dam-break flows and impact flows against a wall.

Key words: smooth particle hydrodynamics (SPH), free surface flows, dambreak problems

References

[1] A. Ferrari, M. Dumbser, E.F. Toro and A. Armanini. A New 3D Parallel SPH scheme for Free Surface Flows. *Computers and Fluids*, 38:1203–1217, 2009.

[2] A. Ferrari. SPH simulation of free surface flow over a sharp-crested weir. *Advances in Water Resources*, 33:270–276, 2010.

[3] A. Ferrari, L. Fraccarollo, M. Dumbser, E.F. Toro and A. Armanini. Three–Dimensional Flow Evolution after a Dambreak. *Journal of Fluid Mechanics*, 663:456–477, 2010.

*Laboratory of Applied Mathematics, University of Trento, Via Mesiano 77, I-38100 Trento, Italy.
e-mail: michael.dumbser@ing.unitn.it