Solving the wave generation in numerical SPH-based wave tanks

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ABSTRACT

The increasing exposure of coastal zone population and assets to hazards related to climate change (i.e. sea level rise, and increased storminess) urges to analyse the performance of coastal defences under future scenarios by employing sophisticated but effective and accurate predictive tools. As a meshless and Lagrangian technique, Smoothed Particle Hydrodynamics (SPH) is ideally suited to fluid and solid mechanics with highly nonlinear deformation and is currently widely employed for engineering applications to study fluid-structure interaction and multi-phase flows [1]. Based on SPH methods, DualSPHysics is a set of C++, CUDA and Java codes designed to deal with real-life engineering problems [2]. The use of GPUs along with coupling with other open-source codes and libraries allows managing huge amount of data while reducing the computational cost. For coastal engineering applications, DualSPHysics is perhaps the most advanced open-source SPH-based solver nowadays. The code has been successfully applied to a number of free-surface problems that involve wave propagation, run-up (Figure 1), breaking, wave impact, wave energy applications [3].

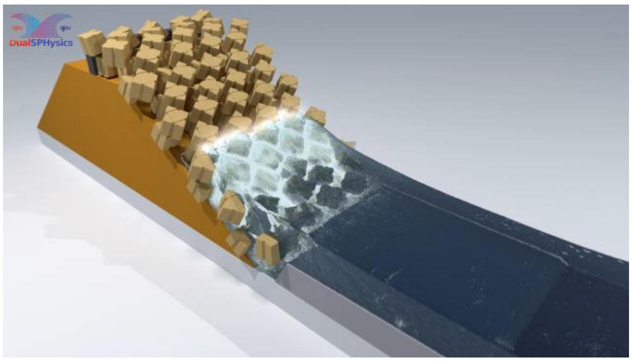

Figure 1. Realistic wave run-up on armor breakwater with DualSPHysics model.

With a proper embedded wave generation and absorption algorithm (for monochromatic, irregular and solitary waves), DualSPHysics implements now three different numerical schemes for coupling with less demanding wave propagation models, where multi-layered moving boundaries, relaxation zone technique and open boundaries are employed to solve the model-model information transfer. These schemes act both as stand-alone generation techniques and as coupling frameworks. The latter option allows facing large domains and multi-scaled problems where SPH is used for very detailed modelling of fluid-structure interaction while the wave propagation and transformation over large domain areas are left to non-linear shallow water equation or potential flow solvers. Scope of the present work is to provide a brief but detailed overview of all the aforementioned implementations in DualSPHysics together with their latest most relevant applications to real coastal engineering problems.

REFERENCES

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