A Smoothed-Particle-Hydrodynamics simulation approach combining consistent kernel gradients with variable resolution schemes

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Focus of this work is set in the field of Computational Fluid Dynamics and starting point are the kernel based approximations, on which the Smoothed Particle Hydrodynamics (SPH) method is based. The study adresses two frequently reported issues of SPH, i.e. errors related to truncated kernels or irregular particle distributions as well as the aim to reduce the computational cost associated to homogeneous particle resolution. Attention is devoted to the synergy of an explicit correction strategy to approximately achieve first-order consistent kernels [1] and a variable resolution approach [2]. The suggested novel combination is simple and effective. It stands out for a straightforward implementation inside a WCSPH, GPU-based SPH-framework [3]. A number of validation studies featuring fully wetted and free surface flow configurations will be employed to assess the predictive benefits. Results obtained from the kernel-corrected variable resolution method are compared against homogeneous resolution approaches with and without modified kernel gradients. As indicated by Fig. 1, a benefit is displayed by the results of the combination, in both hydrostatic and dynamic test cases. Exemplary snapshots from simulations, with and without the combined approach, are reported in Fig. 2.

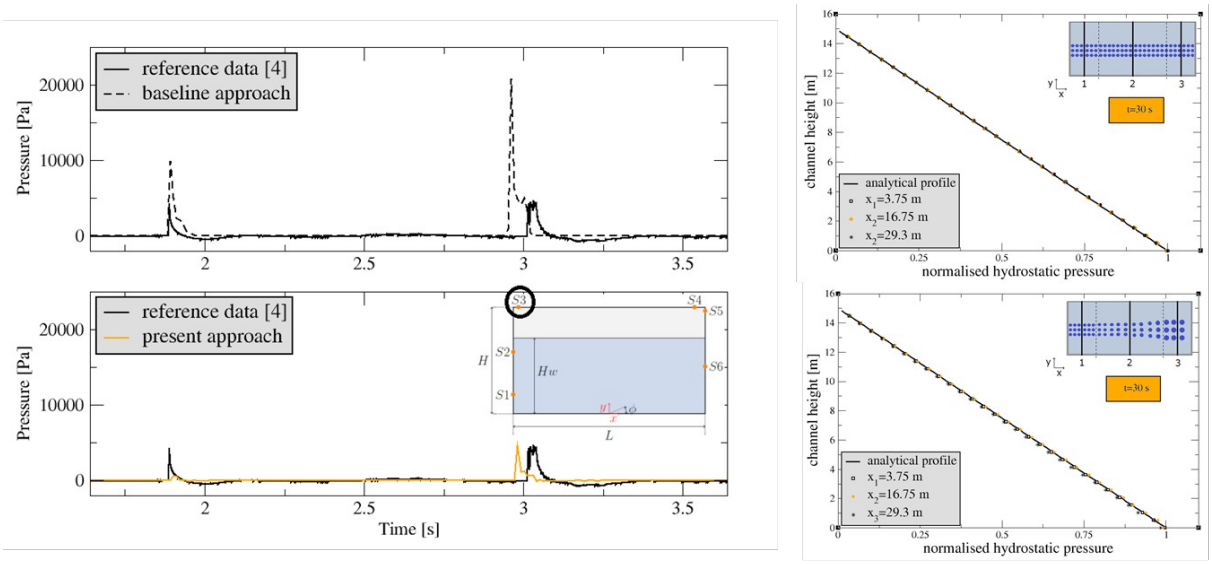

Fig. 1: Comparison of predicted and measured pressure signal for a sloshing case (left) and pressure profile for a hydrostatic case (right) using the baseline and the present SPH approach.

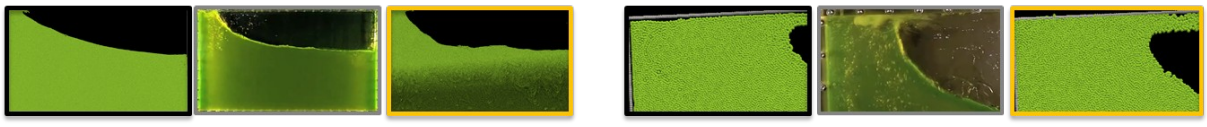

Fig. 2: 2D sloshing case - snapshots from simulations featuring the baseline SPH approach (left, black), experimental observations (middle, grey) and the present approach -consistent kernel gradient, with and without variable resolution- (right, orange).

References
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