Comparison of interface models to account for surface tension in SPH method

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ABSTRACT

The Smoothed Particle Hydrodynamics method (SPH) is a meshfree Lagrangian simulation method widely applied for fluid simulations due to the advantages presented by this method for solving problems with free and deformable surfaces.

In many scientific and engineering applications, surface-tension effects play an important or even dominating role in the dynamics of the system. For instance, the breakage (instability) of a liquid film is strongly affected by the strength of the surface tension at the liquid-air interface. Simulating deforming phase interfaces with strong topological changes is still today a challenging task. As a promising numerical method, here we use SPH to predict the interface instability at a water-air interface.

The main challenge in modelling surface tension at free-surface with SPH is the accurate representation of the surface-tension force at the interface. When only the liquid phase is modelled (to decrease the computational cost), the standard SPH approximations to calculate the normal direction and curvature of the interface suffer from a lacking “full support”, i.e. the omitted and therefore missing air particles. Various models for such free-surface surface-tension corrections were presented, see e.g. amongst others Sirotkin et al. [1], Ordoubadi et al. [2], Ehigiamusoe et al. [3]. Many of these models follow the classical Continuum Surface Force (CSF) approach (Morris [4], Adami et al. [5]) and incorporate different corrections/treatments at the surface.

The objective of our ongoing study is to investigate the influence of the interface properties estimation in these models. We compare different free surface particle detection schemes, normal vector calculations and curvature estimations for the quality of the resulting surface-tension effect. In this work, we focus on two-dimensional problems and consider a static drop with Laplace law and oscillating drops as representative test cases.

KEYWORDS

Smoothed Particle Hydrodynamics, Free surface flow, Surface tension, Interface description

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