Incompressible Smoothed Particle Hydrodynamics with Generalised Particle Distribution

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Abstract

Smoothed Particle Hydrodynamics (SPH) is a novel numerical discretisation scheme applicable to fluid dynamics problems with highly-nonlinear deformation and fragmentation.

The SPH scheme is a meshless technique that uses the Lagrangian description of motion to model such fluid behaviours. However, the non-regularity of particle distribution affects the accuracy of the method and the convergence characteristics due to the Lagrangian nature of the moving computational nodes or particles.

To overcome the above mention shortfall, the Eulerian SPH scheme was developed ensuring second or higher order of accuracy for Cartesian particle distributions. However, it is only applicable to isotropic distributions.

For anisotropic particle distributions within the Eulerian description of motion, the explicit iterative shifting method based on the Fickian diffusion equation, herein called generalised particle distribution (GPD), is developed in order to achieve close to theoretical convergence rates.

The characteristics of the iterative shifting method with respect to different smoothing kernels and particle distributions are investigated. Further, we perform an analysis on the shifting coefficient A, which controls the shifting distance, and apply an under-relaxation factor with significant improvements in computational cost.

The improvements of the proposed method are demonstrated in highly anisotropic particle distributions on a 2-D domain. Future work includes the extension to 3-D domains an implicit formulation.

Keywords: *CFD, SPH, Particle Distribution, Fickian Diffusion Equation, Iterative Shifting, Under Relaxation Factor.*

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Biography

Dae-young Park received his Bachelor of Science in Mechanical Engineering in 2018 from Incheon National University (INU). During his studies, he worked at the research laboratory, Cross-interactive Fluid Engineering, Department of Engineering, INU. He is currently involved in the programme of MSc. Thermal Power and Fluid Engineering at the University of Manchester. His research focus is on Computational Fluid Dynamics, especially on discretisation schemes for multi-scale engineering problems