An Accurate and Stable Multiphase MPS Method with Corrective Matrix

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ABSTRACT

The moving particle semi-implicit (MPS) method is a fully-Lagrangian particle solver, which has been applied to simulating various free surface and multi-phase flows. However, the random distribution of particles results in the lack of strict convergence in MPS. The corrective matrix can correct and modify the particle irregularity, thereby enhancing accuracy. Khayyer and Gotoh [1] firstly derived corrective matrix for MPS but only applied it to the gradient model. In this study, corrective matrix will be applied to all the MPS models (including gradient, divergence and Laplacian) to enhance accuracy comprehensively. Corrective matrix can be applied to the divergence model in a way similar to gradient. The first-order error term is removed based the accurate corrected gradient model to enhance accuracy of Laplacian [2]. The new models are then coupled into our previously-developed multiphase MPS (MMPS) method [3]. The particle shifting technology is applied to improve stability further. A simulated bubble rising problem with high density ratio (1000:1) demonstrates accuracy is enhanced (see Fig. 1). In conclusion, the accuracy and reliability of MPS are enhanced comprehensively with the adoption of corrective matrix, and both the coding and computational overheads are small.

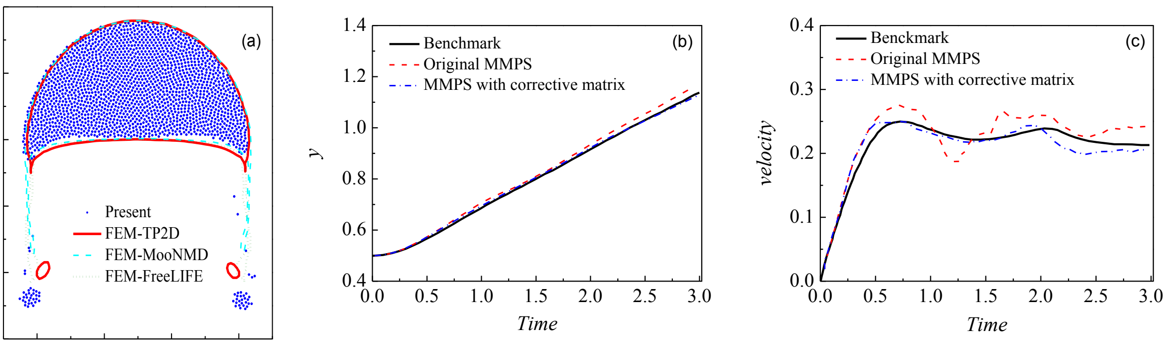

Fig. 1 Bubble rising simulation: (a) bubble shape (b) bubble position and (c) rising velocity

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