A two-dimensional ghost cell boundary model for the explicit MPS method

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Abstract

The purpose of this work is to present a two-dimensional ghost cell boundary model for the explicit moving particle simulation (MPS) method to treat the wall boundary problem accurately and robustly for complicated geometry. Arranging evenly spaced particles along the wall boundary are difficult for complicated geometry, while it is much easier to use cell/mesh with different sizes or shapes (e.g. triangles or quadrilaterals) to represent a wall boundary. The aim of this method is to develop a natural treatment method for wall boundary of complicated shapes. Ghost cells to represent walls are constructed in the pre-processing. A new integral particle-cell interaction model is proposed for the coupling of fluid particles and wall cells when enforcing wall boundary. Specifically, the particle-particle interaction near wall boundary is still modeled by the original version of MPS models via assuming that each particle takes the same area. The particle-cell interaction is modeled by the integral version of MPS models that requires the specific area of each cell. In this manner, the particle-cell interaction is modeled naturally. We also find that the new model is very suitable for the interaction modelling between MPS particles and finite elements, because one can easily construct ghost cells based on the finite element meshes. Finally, several numerical examples are performed to validate the effectiveness of the proposed model and investigate the effects of the distribution of ghost cells.

Keywords: Ghost cell boundary model, explicit MPS, fluid structure interaction