A smoothed MPM algorithm for elastodynamics

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Abstract

To accurately capture the dynamics in elastic materials by the computational methods, the artificial viscosity is necessary to damp out the numerical oscillation. The choice of the artificial viscosity is always problem-dependent, which is different equations for different types of problems [1]. The material point method (MPM) has been developed to model the multi-phase (solid-fluid-gas) interactions including large deformation and failure evolution [2, 3]. The SPH method has been also widely applied to simulate the fluid and solid mechanics [1]. However, the performance of both MPM and SPH methods in elastodynamics will be influenced by an unsuitable artificial viscosity. This work will focus on improving the capability of MPM in elastodynamics without using artificial viscosity, by combining the advantages of the SPH method and the MPM to develop a new smoothed MPM algorithm. The proposed method is more accurate and stable than both MPM and SPH for elastodynamics. It is different from the coupling of the MPM and SPH method in work [4]. The smoothed MPM is based on introducing the SPH reconstruction scheme into the MPM mapping and remapping procedure. This algorithm will include the advantages of both two methods, such as the high efficiency and convenient boundary conditions in the MPM method, the capability of modelling the free surface in the SPH method. Three elastodyamical examples will be presented to demonstrate the capability of the proposed algorithm. The first example is a one-dimensional wave propagation problem, which was simulated by classical MPM in previous work [5]. The compression problem on a two-dimensional elastic plane with circular hole is modeled by the SMPM and then compared with the FEM and SPH simulation in work [6] in the second example. In the third example, the impact problem between two-dimensional elastic bars is simulated by the SMPM. There is no artificial viscosity in all these three examples. Future work will be discussed based on the current work.

Keywords: MPM, SPH, large deformation, elastodynamics, Numerical simulations

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