Smoothed material point method for simulating transient responses

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ABSTRACT

To simulate transient responses with semi-discretization methods in space, it is usually required to include the artificial viscosity in order to reduce numerical noise. The choice of the artificial viscosity is problem-dependent such that there are different forms of the artificial viscosity for different types of problems. As a result, the quality of transient solutions could be affected due to the use of an unsuitable artificial viscosity. The material point method (MPM) has been developed to simulate the multi-phase (solid-fluid-gas) interactions involving large deformation and failure evolution [1, 2]. In view of improving the performance of the MPM for transient problems without using the artificial viscosity, this work is focused on combining the advantages of both smoothed particle hydrodynamics (SPH) and MPM to develop a smoothed material point method (SMPM), which is more accurate and stable than MPM and SPH for transient problems. The proposed procedure is different from that coupling the MPM and SPH [3]. The SMPM is based on the introduction of the SPH approximation scheme into the MPM mapping and remapping process. Three numerical examples will be presented to demonstrate the potential of the proposed procedure. The first example is a one-dimensional wave propagation problem as shown in the previous MPM work [4]. One-dimensional impact problems including elastic and hardening plastic cases are then simulated with the SMPM and compared with the MPM and SPH in the second example. In the third example, two-dimensional disks impact problem in work [1] is simulated with the SMPM, and the result is compared with the simulation of MPM. There is no artificial viscosity used in all these three examples. Future tasks will be discussed based on the current work.

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