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High-accuracy Material Point Method based on the Moving Least Squares Method

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The Mesh-free methods which require no meshes have applied to many engineering issues such as large deformation problems and discontinuous problems and so on. Also, the Material Point Method (MPM) that is one of the Mesh-free methods and was developed by Sulsky *et al.* in 1994 has been applied to the contact problems of solids and the large deformation problems. The discretization of MPM concerns the Lagragian particles and Eulerian background mesh.

In the MPM the physical behavior of particles is calculated by using the mesh which is composed of the finite elements, and all particle information is extrapolated to the physical value of those elements. That is, the particles and meshes interact explicitly with one another through the finite elements, where these particles are able to move freely in analytical domain but there is no need to move for the meshes. Hence, it is said that the MPM has the best properties of particle methods and finite element method. However, it has been pointed out that there is a problem of a decrease of strain energy in the precision, which is might arise from the incremental algorithm or approximate method of the strain and stress. Moreover, the relationship between the background mesh-size and the number of particle has remained less well-defined.

In this study we tried to make clarification of the relationship between the mesh-size and the inter-particle distance. Additionally, we tried to improve accuracy of the MPM by introducing the Moving Least Squares Method (MLSM) to the stress calculation scheme of the MPM. As a result, we achieved the reduction of the error associated with dynamic displacement in elasticity problems. In this paper we show the formulation of proposed method and the some numerical examples with comparison analyses, and describe some advantages of the scheme.

Keywords: Mesh-free method, Material Point Method, Moving Least Squares Method, Lagragean-Eulerian method