Initial particle placement based on the centroidal Voronoi tessellation for two-dimensional flow simulation by the particle method

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Abstract

The particle methods such as the SPH method and the MPS method have been widely used for the analysis of free-surface flows. This paper focuses on the initial placement of particles for the particle method. The initial particle placement on the regular Cartesian grid is generally adopted. However, it is difficult to represent arbitrary boundaries such as slopes, curved walls, and fluid surfaces and then has negative effects on the precision of the numerical calculation. Moreover, a particle placement on vertices of a triangular or tetrahedral mesh has a capability to capture the curvature of the boundary but difficulty in evenly spaced particles.

To solve this issue, we propose an initial particle placement determined by the centroidal Voronoi tessellation (CVT) [1], which is a special type of Voronoi tessellation. By the famous Gersho's conjecture [2], Voronoi cells of the CVT asymptotically agree to regular hexagon grid in the two dimensional case. Therefore, our proposed method is expected to space out particles evenly. In this paper, we develop a system of a CVT-based particle placement and then demonstrates some numerical examples of fluid flow analysis with arbitrary boundaries by the particle method.

Keywords: Initial particle placement, centroidal Voronoi tessellation, particle method, fluid flow analysis

References

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