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A Wall Boundary Computation Model by Polygons for Moving Particle Semi-Implicit Method

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ABSTRACT

Moving Particle Semi-implicit (MPS) method is one of the particle methods[1], that has been studied in many applications, such as analysis of shipping water[2] and micro fluidics[3]. In this paper, we present an improvement of wall boundary calculation model for MPS method. Although particle methods are well suited for computation of a free surface flow, they still have issues. Wall boundaries are usually descritized into particles and used as boundary conditions. To compute a fixed boundary, the particles are calculated as fixed particles. These wall particles cause several issues. First, the wall particles, which are a descretized expression of boundary, cannot represent a smooth boundary. When a boundary with a slope is considered, they are not calculated as a smooth slope but a bummpy surface. Second, the wall particles increase the computational burden and so this leads to increase of computation time because the number of wall particles are large. The method proposed in this paper does not use wall particles but uses polygons. To compute each term, the contribution of fluid particles and the boundary is separated. This paper shows how the equations are derived from usual equations and then shows some computational results with the present method. Lastly, the result using the present method is compared with one using the wall particles quantitatively.

The wall particles have effect in the particle density, pressure term and viscosity term. Therefore, these terms have to be modeled in order to develop a new wall boundary computation model. In these terms, the contribution from fluid particles and that from the wall is separated. The contribution from the wall for particle density $\sum_{j \in wall} W(\mathbf{r}_{ij})$ is called *wall weight function*. To compute the pressure term, the pressure of a wall have to be modeled. By considering the physical meaning of the pressure force, it is modeled as a force to push a fluid particle back to the rest distance when the distance between the particle and the wall is below the rest distance. This gives us the definition of the pressure of the wall P_{wall}. To construct the Poisson equation for the pressure of the fluid particles, the particle density of the fluid particle have to be modeled. It is modeled with the *wall weight function* and then the Poisson equation for the pressure is constructed. After solving the equation, the gradient of the pressure is calculated with P_{wall}. The viscosity term is also modeled by separating the contribution from the wall and with the *wall weight function*.

Figure 1 shows the simulation results with the *wall weight function* and wall particles. The color of the particle indicates the particle density. Figure 2 shows the quantitative comparisons between them.

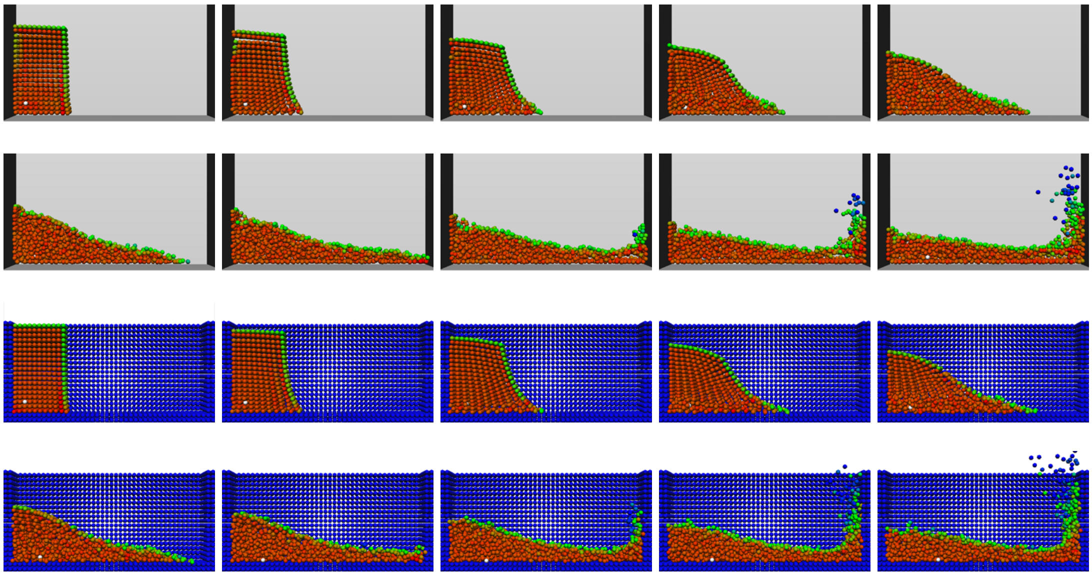

Figure 1: Simulation results using the *wall weight function* and the wall particles.

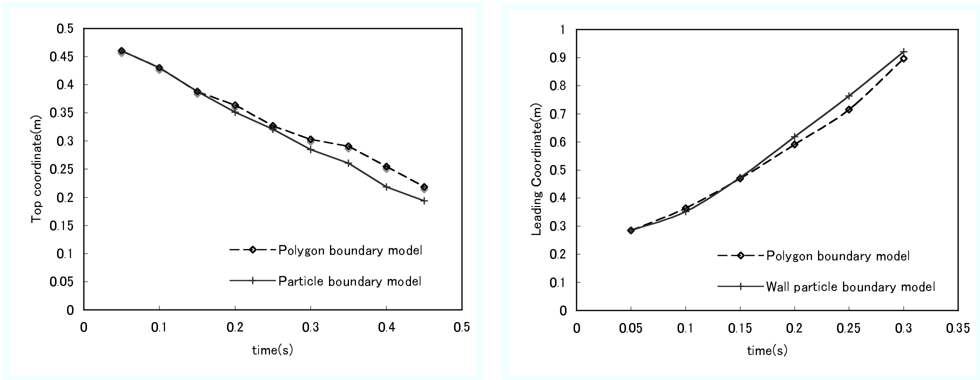

Figure 2: Comparison of the height and the leading coordinate of the water.

They show the comparison of the height of the water and the comparison of the leading coordinate of the water. We can see that the height of the water is higher in the result with *wall weight function* and the leading coordinate is slower in the result with *wall weight function*. However we can say that good agreement is obtained between them.

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