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Simulations of Free Surface Flows Interacting with Solid Objects by Lattice Boltzmann Method Using Multiple GPUs

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We have developed a code of free surface flow simulations by using the lattice Boltzmann method and multiple GPUs. The lattice Boltzmann method is suitable for GPU computing and large-scale simulations because it is an explicit scheme to solve weakly compressible flows. However, the lattice Boltzmann method is difficult to solve the gas-liquid two-phase flows under high Reynolds number such as a dam-breaking problem. In this study, we solve the liquid phase region with free surface boundaries when the gas pressure does not have an important role for the flow phenomena. In order to improve the accuracy and the stability, the cumulant model[1] has been employed. The lattice Boltzmann method is coupled with the conservative Allen-Cahn equation as an interface capturing method. A moving boundary approach based on the interpolated bounce-back scheme is utilized at liquid-solid interfaces. The discrete element method is employed to describe motions of solid objects and collision between objects. A model constructed by multiple small spheres represents complex shapes of solid objects. The simulation method has been validated for several benchmarks. As an example, we demonstrate a dam-breaking onto a wet floor under high Reynolds number with $1153 \times 193 \times 577$ lattice nodes and 8 GPUs Tesla P100 as shown in Fig. 1. The characteristic phenomena of breaking wave can be successfully reproduced. Figure 2 shows the result of a dam-breaking water interacting with complex floating objects.

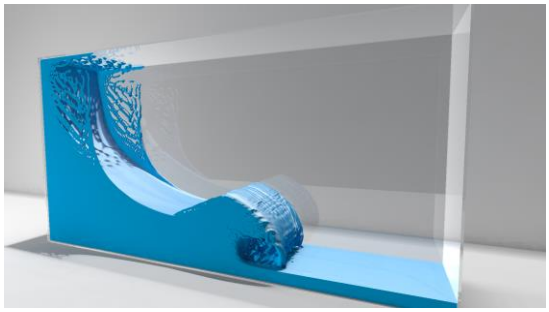

Fig. 1 A simulation result of a dam-breaking problem using $1153 \times 193 \times 577$ lattice nodes and 8 GPUs.

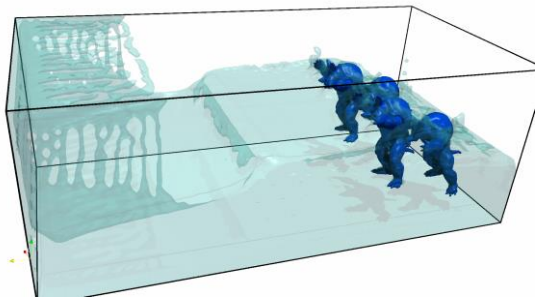

Fig. 2 A result of a dam-breaking simulation interacting with complex shape objects.

REFERENCES

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