Large-scale DEM Simulations using Non-spherical Elements on GPU

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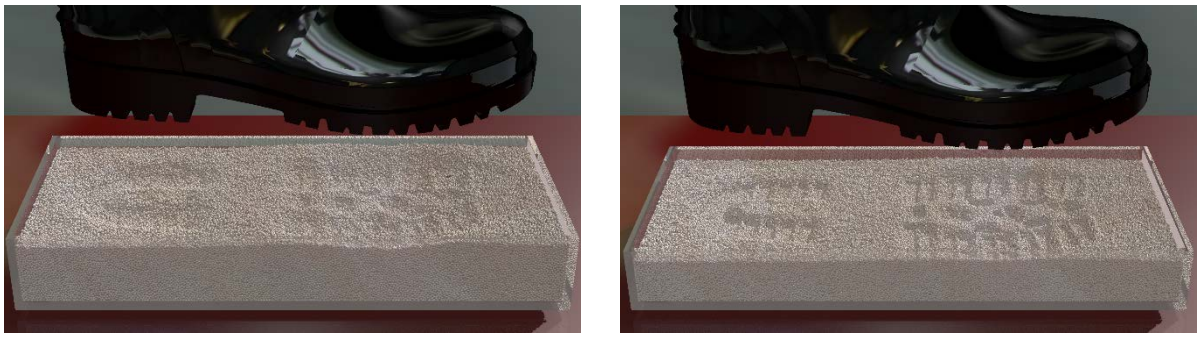
ABSTRACT

Granular simulations of Distinct Element Method (DEM) using a non-spherical element model require high computational cost and large memory usage. We represent complex shapes by using rigidly connected spherical particles.

In this paper, we introduce effective several techniques to speed up the computational performance of the DEM using non-spherical elements on GPU. To search contacting particles efficiently, we use a combinatorial neighbouring particle search method of the book-keeping method with a uniform grid list. The linked-list or hash sorting algorithms for the uniform grid list are used to save memory. The time-integrated variables are sorted by the particle positions every several hundred time steps to shorten the access time to the GPU on-board memory.

We demonstrate a foot stamp simulation using 405,000 non-spherical elements on NVIDIA GPU Tesla K20X. The non-spherical element representing a tetrapod shape consists of 4 same spherical particles, and each particle is located at the vertex of a tetrahedron. The numerical results of the footprint are shown in Figure 1. In comparison with a spherical element model, the footprint using the non-spherical elements is clearly due to enhanced shear frictions among tetrahedral elements.

We are developing a code for large scale DEM of non-spherical element models for multiple GPUs based on dynamic load balance [1].



(a) using a spherical element model (b) using a non-spherical element model

Fig.1 Foot stamp simulations of DEM

REFERENCES

[1] S. Tsuzuki, T. Aoki: Large-scale granular simulations using Dynamic load balance on a GPU supercomputer, SC14 Regular, Electronic, and Educational Poster, International Conference for High Performance Computing, Networking, Storage and Analysis 2014 (SC14).