

BLAZE-DEM: A GPU Based Polyhedral DEM Particle Transport Code

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Abstract

This paper introduces the BLAZE-DEM code that is based on the Discrete Element Method (DEM) [1] and specifically targeted for Graphical Processing Unit (GPU) platforms. BLAZE-DEM uses actual polyhedral particle representations as opposed to multi-sphere[2] approaches, which approximate polyhedral geometries. The modeling of real particle shapes is critical for realistically simulating complex interaction phenomena in granular assemblies [3]. BLAZE-DEM primarily concerns itself with simulating the flow of granular materials for a variety of different geometries [4]. The use of computational modeling tools is essential in evaluation of various designs and processes as computational power increases [5]. However current DEM simulations are only able model a few hundred to thousands of particles in real time without the use of expensive and power consuming clusters [6]. The dramatic increase in GPU computing power has enabled the computational simulation of physical systems that was not possible a few years ago via CUDA API[8].

The DEM method involves computing the interactions of all particles that are in contact to determine the net force and subsequently its evolution in phase space, which is an N Body problem. Solving this problem for all N Bodies is too computationally expensive and cannot be done in real time. This paper will discuss methods and algorithms that substantially reduce the computational run-time of such simulations. An example is the spatial partitioning and hashing algorithm that allows just the nearest neighbors (NN) which are most likely to be in contact to be determined thus reducing the required computations. The computational strategy employed in BLAZE-DEM which makes use of multiple kernels on the GPU via CUDA will be discussed as well as the software design that allows for a variety of particle shapes and geometries. The BLAZE-DEM code which is still in development and achieves 166 FPS for 65536 8 Faced polyhedra compared to the 300 FPS for spheres obtained by [7]. The planned features in physics and computation will also be discussed.

References

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