Granular Media Simulations on the GPU

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Abstract

Numerical simulation of particulate materials using the discrete element method (DEM) is extremely important to many industrial processes with a wide range of applications such hopper flows in agriculture to tumbling mills in the mining industry. The DEM is however computationally expensive and computational viable simulations are typically restricted to a few particles with realistic particle shape or a larger number of particles with an often over-simplified particle shape. The most common approach to represent particle shape is by using a cluster of spheres to approximate the shape of a particle. This approach is computationally intensive as multiple spherical particles are required to represent a single non-spherical particle. Polyhedra represent the geometry of most convex particulate materials well and when combined with appropriate contact models exhibit realistic mechanical behavior to that of the actual system. However detecting collisions between the polyhedra is computationally expensive often limiting simulations to only a few thousand of particles. Driven by the demand for real-time graphics, the Graphical Processor Unit (GPU) offers cluster type performance at a fraction of the computational cost. The parallel nature of the GPU allows for a large number of simple independent processes to be executed in parallel. This results in a significant speed up over conventional implementations utilizing the Central Processing Unit (CPU) architecture, when algorithms are well aligned and optimized for the threading model of the GPU. In this talk we present a computational framework for the GPU architecture that can model (i) tens of millions of spherical particles and (ii) millions of polyhedral particles in a realistic time frame on a desktop computer using a single GPU.

References

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