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BLAZE-DEM: A GPU based large scale 3D discrete element particle transport framework

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Abstract content
   (Max 300 words)
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Understanding the dynamical behavior of particulate materials is extremely important to many industrial processes, with typical applications that range from hopper flows in agriculture to tumbling mills in the mining industry.

Simulation offers valuable insight into the dynamical behavior of particles and better a understanding of the industrial processes that allows for the optimization of these processes. The discrete element method (DEM) has become the defacto standard to simulate particulate materials. The DEM is a computationally intensive numerical approach that is limited to a moderate amount (thousands) of particles.

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 nonspherical particle. In addition spherical particles poorly approximate sharp edges, which may result in inaccurate bulk transport predictions when it is essential to resolve the edges accurately. Alternatively, polyhedra represent the geometry of most convex particulate materials well and when combined with appropriate contact models predicts realistic mechanical behavior to that of the actual system. However, detecting collisions between polyhedra is computationally expensive often limiting simulations to only hundreds of thousands 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.

We recently introduced the BLAZE-DEM 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. In this work we demonstrate the different types of simulations currently possible with the code.

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