Industrial Particle Simulations Using the Discrete Element Method on the GPU

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Abstract

Accurately predicting the dynamics of particulate materials is of importance to numerous scientific and industrial areas with applications ranging across particle scales from powder flow to ore crushing. Computational simulation is a viable option to aid in the understanding of particulate dynamics and design of devices such as mixers, silos and ball mills, as laboratory tests comes at a significant cost. However, the computational time required to simulate an industrial scale simulation which consists of tens of millions of particles can take months to complete on large CPU clusters, making the Discrete Element Method (DEM) unfeasible for industrial applications. Simulations are therefore typically restricted to tens of thousands of particles with detailed particle shapes or a few million of particles with often simplified particle shapes. However, numerous applications require accurate representation of the particle shape to capture the macroscopic behavior of the particulate system of tens of millions of particles. The advent of general purpose computing on the Graphics Processor Unit (GPU) over the last decade and the development of dedicated GPU based DEM codes such as the open-source software BlazeDEM and the commercial code XPS has resulted in simulations of tens of millions of particles to be simulated on a desktop computer. In this paper we discuss the computational algorithms that enable this performance and explore a variety of industrial applications that can be now be simulated in sufficient detail using a realistic number of particles.

References

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