Potential for Interactive Design Simulation in Discrete Element Modelling

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ABSTRACT

Discrete element modelling gained momentum from the mid 90s when small industrial scale simulations of a couple of thousand spherical particles in two dimensions were analysed on a more regular basis. A decade later discrete element modelling simulations allowed for moderate industrial scale simulations of a few hundred thousand spherical particles [1]. Over the last five years the landscape of large scale industrial simulations started to emerge with the utilization of the graphical processing unit (GPU) [2]. It is now common to simulate a couple of million polyhedral shaped particles and tens of millions of spherical particles [2] within a couple of days. In addition, moderate scale industrial simulations can now be modelled within hours on a workstation instead of weeks or months on a cluster merely a decade ago. Combining the advances in high performance GPU based discrete element modelling with sound computational complexity reduction techniques such as reduced order modelling [3] allows for the possibility of design optimization or design modification for industrial problems that involve granular flow. However, conventional design optimization remains characterised by either the analyse-wait-modify-analyse cycle or more recently the batch analyse-wait-modify-batch analyse cycle. High performance GPU based DEM modelling is enabling a new and alternative paradigm denoted interactive simulation and design (ISD) as demonstrated by Blaze-DEM-GPU.

BlazeDEM-GPU [2] allows for changes to be made during a simulation in real time utilizing multiple GPUs to conduct a simulation. This allows for an engineer to interactively engage with a simulation to study the effect of various model parameters, geometrical changes of the environment with which the particles interact or changes in boundary conditions in steady state processes or continuous bulk material handling processes e.g. changes in inter-particle cohesion in a feeder system, the effect of lifters height in a ball design or changes in flow rate in a continuous bulk materials handling application. This would allow engineers to interact with the simulation to both quantitatively and qualitatively engage with a design problem or granular material process, allowing for formalized and intuitive understanding of the factors that influence granular flow to ultimately drive towards an enhanced understanding of optimal design solutions.

The role that this paradigm will play in education is invaluable as an in-house corporate training tool for young engineers to actively train and develop understanding for specific industrial processes. This would also allow engineers to conduct just-in-time (JIT) simulation based assessment of processes before commencing on actual site visits, allowing for shorter and more focussed site excursions.

REFERENCES

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