Assessment of neighbour particles searching methods for DEM-based simulations using CPU and GPU architectures

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ABSTRACT

The discrete element method (DEM) is one of the most important particle-based simulation methods that has been used for applications in several fields such as chemical engineering, pharmaceutics, agriculture, energy, mining, environment and geological engineering [1]. In recent years, graphics processing units (GPUs) have been used in high performance computing (HPC) DEM-based applications because the DEM method is well suited for parallelization. Furthermore, parallelization using GPUs can be more easily implemented for engineering applications when compared to that based on central processing units (CPUs) because the cost associated with the installation and maintenance of hundreds of CPU cores is relatively high.

The performance of DEM simulations is highly dependent on computer memory usage and CPU time [2]. The computer memory usage depends mainly on the storage of the mesh and the particle neighbour related information. Computer CPU time heavily depends in turn on the identification of neighbouring particles and the computation of particle-particle interactions. Selecting the adequate neighbour particles searching methods and adjusting their associated parameters for GPU and CPU architectures is thus criterial for the accuracy of DEM simulations. There are several neighbour searching methods that have been used in the past. They include for instance the cell-linked and the Verlet list conventional methods, and the multi-grid-based GPU [3] and the dynamic cell-list [2] ones. This work assesses therefore the performance of the referred methods using GPU and CPU architectures in the context of the development of a new DEM-based tool. The neighbour searching methods performance and related computational costs are parametrically analysed and an assessment of their suitability for carrying the intended numerical simulations is provided. The referred numerical simulations are performed accounting for canonical configurations used for the validation of the new computational tool under development. The referred tool incorporating state of the art physical and numerical models will be used for modelling the mineral transport and milling processes present in concentrator plants following a CFD-DEM approach.

REFERENCES

[1] W. Zhong, X. L. Aibing Yu, Z. Tong y H. Zhang, «DEM/CFD-DEM Modelling of Non-spherical Particulate Systems: Theoretical Developments and Applications,» *Powder Technology,* vol. 302, pp. 108-152, 2016.

[2] R. Cai, L. Xu, J. Zheng y Y. Zhao, «Modified cell-linked list method using dynamic mesh for discrete element method,» *Powder Technology,* vol. 340, pp. 321-330, 2018.

[3] Y. He, T. Evans, A. Yu y R. Yang, «A GPU-based DEM for modelling large scale powder compaction with wide size distributions,» *Powder Technology,* vol. 333, p. 219–228, 2018.