Fast, Flexible Particle Simulations: An Introduction to MercuryDPM

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Abstract

In this presentation we review some recent advances in discrete particle modelling (DEM/DPM) undertaken at the University of Twente. We introduce the open-source package MercuryDPM that we have been developing over the last few years.

MercuryDPM is an object-oriented C++ algorithm with an easy-to-use user interface and a flexible core, allowing developers to quickly add new features. Its open-source developers' community has developed many features, including moving and curved walls (polygons, cone sections, helices, screw threads, etc); state-of-the-art granular contact models (wet, charged, sintered, etc); specialised classes for common geometries (chutes, hoppers, etc); general interfaces (particles/walls/boundaries can all be changed with the same set of commands); restarting; visualisation (xBalls and Paraview); a large self-test suite; and numerous tutorials and demos.

In addition, MercuryDPM has two major components that cannot be found in other DPM packages. Firstly, it uses an advanced contact detection method, the hierarchical grid. This algorithm has a lower complexity than the traditional linked list algorithm for poly-dispersed flows, which allows for the first time large simulations with wide size distributions, as shown below in the right image.

Secondly, it uses coarse-graining, a novel way to extract continuum fields from discrete particle systems. Coarse-graining ensures *by definition* that the resulting continuum fields conserve mass, momentum and energy, a crucial requirement in continuum modelling. The approach is flexible and has been applied to model both bulk and mixtures, boundaries and interfaces, time-dependent, steady and static situations. It is available in MercuryDPM either as a post-processing tool, or it can be run in real-time, e.g. to define pressure-controlled walls.

We illustrate these tools and a selection of other MercuryDPM features via various applications, including size-driven segregation in chute flows, rotating drums, and dosing silos.

For more information about MercuryDPM please visit http://MercuryDPM.org; training and consultancy packages are available via our spin-off company MercuryLab (http://MercuryLab.org).

References

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