fastDEM: A method for faster DEM simulations of granular media

Christoph Kloss*†, Andreas Aigner*, Arno Mayrhofer* and Christoph Goniva*†

* DCS Computing GmbH
Industriezeile 35, 4020 Linz
e-mail: {firstname}.{lastname}@dcs-computing.com, web page: http://www.dcs-computing.com
† CFDEMresearch GmbH
Industriezeile 35, 4020 Linz

ABSTRACT

One of the main challenges for the simulation of particulate processes is the ability to perform simulations of large-scale processes on the equipment scale. The goal is to reproduce accurate macro-scale representation of granular dynamics. However, this granular dynamics is controlled via the micro-scale mechanics which is cannot be explicitly resolved for many applications, since this would be computationally infeasible. One common approach is to derive constitutive model relationships for continuum models which provide for faster calculations. An alternative approach is to use meso-particles in Discrete Element Method (DEM) simulations [1], sometimes also referred to as parcel, coarse-graining or up-scaling method.

Here, we present a method which can be combined with the parcel-based DEM method. It is useful to simulate longer time-scales with DEM for steady-state (or pseudo steady-state) processes. It consists of the following steps: (i) Calculate the flow field with DEM until it reaches a (pseudo) steady-state, (ii) Average the flow field on a Eulerian grid, (iii) and move the particles along the steady-state velocity field ("forward projection"). Steps (ii) and (iii) are then repeated iteratively to update the steady state flow field. We term this iterative coupling between DEM and forward projection "fastDEM". The method presented has been implemented in our DEM software LIGGGHTS [2].

For the forward projection phase, time-steps of up to 0.01 sec can be applied, which is a factor 100-1000 higher than typical DEM time-step sizes. Fig. 1. shows the result for a silo discharge simulation. An effective speed-up of ~10 could be obtained in this case using the fastDEM method with almost identical outflow rate prediction.

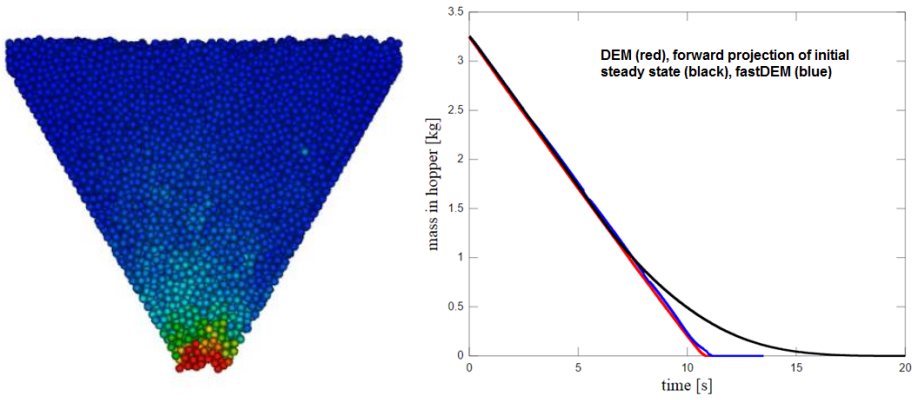

Fig. 1.: Silo discharge setup (left) and mass-flow rate over time (right) with classical DEM (red), pure forward projection using the initial steady state (black) and fastDEM (blue)

REFERENCES

[1] C. Bierwisch, "*Numerical Simulations of Granular Flow and Filling"*, PhD thesis, Albert-Ludwigs-University Freiberg , (2009).

[2] C Kloss, C Goniva, A Hager, S Amberger, S Pirker, "Models, algorithms and validation for opensource DEM and CFD–DEM", *Progress in Comp. Fluid Dynamics, ,* **12**, 140-152 (2012).