Ninth International Conference on CFD in the Minerals and Process Industries
CSIRO, Melbourne, Australia
10-12 December 2012

FROM SINGLE PARTICLE TRACKING TO MASSIVELY PARALLEL MULTIPHASE FLOW SIMULATION

Markus BRAUN*

ANSYS Germany GmbH, Birkenweg 14a, D-64295 Darmstadt, GERMANY

*Corresponding author, E-mail address: markus.braun@ansys.com

ABSTRACT

Lagrange Particle Tracking has been used in commercial CFD programs since the early eighties due to its simple mathematical modelling and easy way to add detailed physical sub models. The main application areas have been dilute flows such as coal combustion, thin sprays, and all kind of separators like cyclones. These application areas are characterised by consideration of large range of size distributions, negligible volume fractions of particle phase, large distances between individual particles, and negligible particle size compared to CFD cell size. Due to its simplicity the Lagrange Particle Tracking approach has been the workhorse in the field of dilute multi phase flows.

In the mean time the limits have been pushed to include coalescing effects between droplets, collisions, volume fraction, etc. This has extended the applicability of particle tracking methods tremendously and changes to the solution algorithms had become necessary.

The parallelization of the hosting CFD programs and increased computational resources further enlarged the application areas. This also had some impact on particle tracking methods. While the first parallel CFD programs simply transferred all necessary information on the host, where the particle tracks have been computed in serial, in the next step two different approaches have been followed:

In the first approach all particles on the host have been put on a work pile and each processor was taking one particle and tracking it until the end of its lifetime. This concept was basically a multi-threading approach and required large memory on the host. In addition only the processors on the host machine could be used, requiring the host to be a shared memory system.

In the second approach the particle is started to be tracked on the partition which contains the initial position and whenever the particle is crossing a partition boundary it is collected and communicated to the appropriate partition to continue the track.

While the latter approach is able to run in parallel on distributed machines for any problem size it requires communication between partitions which increases with the number of particle tracks and poses limits of scalability.

In the very recent past a new approach has been made available combining the advantages of the first two approaches.

In the presentation a survey is given on the current state of the art of Lagrange Particle Tracking Methods implemented into parallel CFD environments with particular emphasis of different approaches of parallelization. The development of the Dense Discrete Phase Model as a framework for dense flows (Popoff and Braun, 2007) and the implementation of a soft sphere Discrete Element Method (DEM) (Cundall and Strack, 1979) poses additional demands on parallelization in distributed computing environments which are discussed as well.

REFERENCES

POPOFF, B. and BRAUN, M.; (2007), "A Lagrangian Approach to Dense Particulate Flows", *6th International Conference on Multiphase Flows*, Leipzig, Germany, July 2007.

CUNDALL, P.A. and STRACK, O.D.L., (1979), "A discrete numerical model for granular assemblies", *Geotechnique*, **29**, pp. 47-65.

