Building Parallel SPH Programs with a Unified Infrastructure

Liu Xu, Cao Xiaolin, Zhang Aiqing, Mo Zeyao

Institute of Applied Physics and Computational Mathematics

Abstract

Smoothed particle hydrodynamics (SPH) method has gain popularity because of its ability on dealing with problems with large deformation. SPH simulations with high accuracy often demand large amount of computation, which requires parallel computing. Although it is relatively easy to develop a serial SPH program, it is hard to develop a parallel SPH program running efficiently on thousands of CPU cores.

There are two fundamental and common problems in developing parallel SPH programs:
(1) SPH particle data structure;
(2) SPH particle communication.
Furthermore, load balancing, resilience, parallel IO and visualization analysis are also important for large scale simulations.

This report presents our current work:
(1) a data structure with “block-cell” compact storage for SPH particles;
(2) a particle communication component including migrating particles and filling ghost particles;
(3) a load balancing component supporting various load modeling methods and load balancing methods;
(4) a parallel IO library, a resilience library and a visualization analysis software.
This work has been implemented in a unified infrastructure called JASMIN. SPH program developers can build parallel SPH programs by integrating their serial programs with the above components.

Several parallel SPH programs have been built on JASMIN infrastructure, including incompressible flow simulation program, high velocity impaction program, etc. A simulation of three dimensional aluminum sphere impacting aluminum sheet with 300 million SPH particles has been run on 4608 CPU cores on TianHe-1A supercomputer, achieving a parallel efficiency of 45% comparing to 9 CPU cores.