Parallel Application in computing particle systems

A brief bio

My name is Fei Zheng, and I am a visiting PhD student at Department of Civil and Environmental Engineering in UC Berkeley. I audit CS267. My research focuses on failure process of rock materials and the discontinuous behavior of block systems. Aiming to solve the motion behavior of a particle system, the efficiency is a main concern. Contact analysis and computation of a global matrix of the particle systems may consume a large portion of the whole computation time, and with parallel computing method, the computing process may take less time than before. So, in this class, I focus on solving these problems using parallel computing method: domain decomposition method, efficient contact detection of numerous particles, and efficient solver for a large sparse, symmetric and positive definite matrix.

Description of the problem

In rock or soil mechanics, mechanical property of certain material can be simulated using the particle system, the meso contact interaction between small particles will determine the macro behavior of the material. For examples, brittle block failure process can be simulated using discrete element method, as a reference to real engineering problems.

Parallel computing tools & method

Spatial domain decomposition methods are used, each processor deal solves a sub-domain. Some important issue includes the basic data structure, communication between different processors and domain decomposition topology. MAKNICKAS et al[1] use MPI and distributed memory PC clusters VILKAS of Vilnius Gediminas Technical University, Lithuania to execute parallel computing. The speed-up equal to 11 has been obtained on 16 processors. Weak scaling of Parallel DEM computing by Gopalakrishnan et al[2] shows that global communication cost increases with problem size while the computational cost remains constant.

Challenges

- a well balanced workload among the processors
- a low level of inter-processor communication overhead
- find optimal domain subdivision for dynamic evolution of particle configuration

References
