Milestone Report:

Parallelization of Tree-Particle Mesh Algorithm for N-Body Galaxy Simulations

Alex Nguyen and Kaiwen Geng

Adjusted Schedule

Time	Plan
Week 1 - Week 2	Research and Proposal - Completed Setup initial testing and benchmarking for Barnes-Hut, Particle Mesh implementations of cosmological simulation - In Progress
Week 3	Milestone Report - Completed Begin implementation of combined Tree-Particle Mesh algorithm using OpenMPI, focusing on load balancing between each algorithm (separating particle calculations by distance) - In Progress
Week 4	Work on dynamic load balancing for particles within each individual algorithm, start work on message passing between threads for boundary calculations within each algorithm - Not started
Week5	Continue work on communication optimization between threads and test for calculation accuracy for overall combined algorithm - Not Started
Week 6	Test scalability of implementation, continue work on overall implementation with combined algorithms, reduce any bottlenecks resulting from timing conflicts and communication latencies - Not Started

	Final performance testing, prepare final demo, and complete final report - Not Started

Finished Goals

We have taken benchmarks for our beginning/initial implementations of each individual algorithm (both the Barnes-Hut Tree algorithm and the Mesh-Particle Algorithm). While we have also begun designing our combined algorithm, we do not have a correctly functioning implementation and have plenty of work to do to firstly complete an implementation that satisfies correctness, before we begin work on optimizing the algorithm through parallelization and differing load balancing strategies.

Plans For Poster Session

Our goal for the poster session is to present a set of speedup graphs comparing the initial computation benchmarks of the initial implementations of each algorithm individually when calculating the gravitational forces upon particles with our parallelized combined Tree-Particle Mesh implementation of the cosmological simulation. Something that we would like to be able to include in our demonstration would be a graphical representation of the particles in the simulation, however at our current progress, this would be a stretch goal and one that would not be attempted until all of our previous goals have been satisfactorily met.

Additionally, we would like to test the scalability of our algorithm because we believe the large number of inputs and interactions between particles lends well to the potential for significant speedup with larger numbers of processors. Accordingly, if we can achieve this we would like to include graphs comparing the speedup of our implementation on low numbers of processors to high numbers of processors.

Remaining Unknowns and Concerns/Obstacles

We have had a slower than expected start, due to several factors (including other important deadlines coinciding), thus we realize that we have much to do before the poster

session. However, it is our hope that now that these deadlines have passed, we will be able to spend all of our time on developing the combined algorithm, and working on optimization of the algorithm once it passes correctness.

One of our main obstacles so far has been figuring out how to combine the two algorithms in such a way that the calculations between particles of varying distance ranges do not interfere with calculations done by each individual algorithm. This is one of our highest priorities to figure out before the end of the week, because it is imperative that we are able to combine the individual algorithms before we can begin optimizing with parallelization of the combined algorithm.