Ptcls: Stimulation of Dynamic Particle Movement

W4995 003, Final Project Proposal
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1 N-body Stimulation

The N-body problem is a common physical simulation problem. In the N-body system, each particle body interacts with the rest of the other particles, resulting in corresponding physical phenomena. Celestial body simulation is a very classic N-body system. The trajectory of a celestial body ultimately depends on the combined force of the gravitational forces of all the remaining celestial bodies on it.

2 Current Solution

One of the simplest methods to solve the N-body is the brute force method, called the all-pairs method, which directly calculates the interaction between a particle body and all the remaining particle bodies. The computational complexity can be $O(N^2)$, but all-pairs is usually combined with a far-field approximation method, such as Barnes-Hut method, fast multi-pole method, particle grid method.

3 Goal

The most time-consuming part of the several approximation methods mentioned above is still the all-pairs part. If this part can be accelerated, the simulation speed will be greatly improved. This project plans to stimulate dynamic particle movement by using fast multi-pole method (FMM).
I plan to refer to a parallel version of FMM described in https://doi.org/10.1016/0898-1221(90)90349-O. To validate the parallel improvement, I will compare the runtime of my program and the standard all-pairs implement. The stimulating result can be visualized by combining Python libs.