Acceleration Structures for Large Particle Systems

Toren Monson
Framework: Splash
Motivation

- For CPU implementations:
  - No iPhone SDK to target the GPU.
  - Provides good simulations for potential GPU implementations
- For GPU implementations
  - Potential iPhone SDK to target the GPU (math library)
Discrete Element Method

- Computes interaction forces between particles
- Uses quasi-physical quantities
  - Electro-Magnetic Repel
  - Electro-Magnetic Attract
  - Collision Tangential Shear
  - Collision Damping
Basic Implementation

For each particle, compare against all other particles

- $N^2$
- Very Little Overhead
- Easily Parallelized
Grid Implementation

For each particle, insert into a grid cell doing force calculations between it and all previously inserted cells

- N
- High Overhead
- Good luck Parallelizing this one
Sorted Implementation

Re-sort particles each time-step according to some axis. Iterate to the left and right of each particle checking when to stop.

- $N^{(5/3)}$ to $N^{(4/3)}$
- Sorting Overhead (not too significant)
- Parallelized with a bit more overhead
Double Sorted Implementation (Slabs)

Re-sort particles each time-step according to some axis. Then, grab sections of the sorted list and sort on another axis. Iterate to the left and right of each particle checking when to stop for 3 slabs

- $N^{(4/3)}$ to $N$
- Double Sorting Overhead (significant)
- Parallelized with a more overhead
Results:

Will get done later tonight