Physically-Based Simulation

N-Body Simulation

Group 9
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1. Gravitational forces acting between any objects
2. Collision detection & response
3. Scenes of stable solar systems
4. Brittle Fracture using FEM
   Fast N-Body Simulation
5. Renderings
   with texture, light, env maps, sound, ...
Method

- **Naïve Gravitation Loop:** $O(n^2)$
- **Fast Multipole:** $O(n \log n)$
  - Using multi-level grid

1. **Add Forces to Grid**
   - For each body and level
     - Compute force that body causes
     - Add force to each cell in certain vicinity

2. **Apply accumulated Forces**
   - For each body and level
     - Apply forces from cell where body lies in
Particle System

Meshes too expensive to render in great number

Unusable for 10k objects

1 million particles without lags
Fast Multipole Speedup

Results
100k Particles

Results

50x speedup (framework screen recording)

5.5s/frame, 330 frames parallel (8 cores, i7 4GHz)

serial naïve loop: ~100s/frame
Grid Artefact

for low initial velocities
Other Features

- Runtime Scene Swap
- Procedural Galaxy Generator
- Parallelization for further Speedup
- Debug Grid
Questions?