Advanced Computer Graphics
CS 563: Project Proposal

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Real-time Simulation of Large Bodies of Water with Small Scale Details

- Eurographics 2010:
  - Nuttapong Chentanez and Matthias Müller
  - NVIDIA Corporation

- Combination of mesh grid and particle simulation of surface water

- Render particles in an efficient manner
Overview of Complete Algorithm

- Height field fluid simulation
- Solids simulation
- Two-way coupling of height field and solids
- Particles generation and simulation
- Rendering
Part I: Height Field Fluids

- Conservative expressions for mass and momentum over a regular 2D grid
- Boundary nodes can be marked for reflection or absorption
Part II: Solids Simulation

- This part was handled by some existing physics engine
- Might use Bullet Physics
- Easy to use / decent performance
- Will only use for particle static and field mesh interaction
Part III: Solids – Fields
Fields - Solids

- Compute interactions of the field with static and dynamic objects
- Simultaneously compute forces/displacements in both directions
- Will not be included in this implementation
  - More of an animation focus
Part IV: Particles

- Generated when the mesh grid cannot support water behavior
  - Discontinuities in height (waterfalls)
  - Waves breaking
  - Foam
Part V: Rendering

- Use tiled FFT to perturb surface height and normals
- Render particles as point sprites
- Render most in screen space, as spheres
  - Splats contain spherical density/depth information
Density
FFT
Most Critical Components

- Include:
  - Height field fluid simulation with boundary conditions
  - Some particle effects
  - Rendering

- Exclude:
  - Fields – Solid interaction
  - Solid – Fields interaction (might include)
  - Exotic particle effects

<table>
<thead>
<tr>
<th></th>
<th>Boat</th>
<th>WaterF</th>
<th>PML</th>
<th>Beach</th>
<th>Ocean</th>
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<td>Grid</td>
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<td>128x128</td>
<td>256x256</td>
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<td>56K</td>
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Optimistic Timeline

- Week 1: Fields Simulation + Integrate Physics Engine
- Week 2: Boundary Conditions + FFT
- Week 3: Particle Effects + SS Rendering
- Week 4: Final Presentation
Progress

- Partial Integration of Bullet Physics Engine
- Partial Implementation of conservative fields
References

- Nuttapong Chentanez, Matthias Müller, Real-time simulation of large bodies of water with small scale details, Proceedings of the 2010 ACM SIGGRAPH/Eurographics Symposium on Computer Animation, July 02-04, 2010, Madrid, Spain

- [http://www.youtube.com/watch?v=bojdpqi2l_o](http://www.youtube.com/watch?v=bojdpqi2l_o)
References

- Wladimir J. van der Laan, Simon Green, Miguel Sainz, Screen space fluid rendering with curvature flow, Proceedings of the 2009 symposium on Interactive 3D graphics and games, February 27-March 01, 2009, Boston, Massachusetts