Sand Simulation

COMP 768 Project Proposal

Abhinav Golas
Motivation

- Simulation of granular materials like sand
- Per-particle simulation expensive – Billions to trillions of particles in medium sized scenes
- Complex behavior – between solids, liquids and gases due to multi particle interaction
- Applicability to multiple types of natural scenarios
  - Sand
  - Avalanches
  - Granular materials
State-of-the-art

- **Particle-Based Simulation of Granular Materials** – Bell et al. (2005)
  - Approximate all objects as sphere agglomerates
  - Visually accurate behavior
  - Few hundred thousand particles only for at least 3min/frame

- **Animating Sand as a Fluid** – Zhu & Bridson (2005)
  - Modify commodity fluid simulator for sand
  - Macro-level behavior – no concept of separate grains, approximation
  - 6 seconds per frame for $100^3$ grid
Desired Tasks

**Short term**
- Accurate physical model for sand simulation
  - Model all behavior – Pressure capped to a maxima
- Hybrid model with multiple LOD
  - Fluid
  - Particles
- Rendering improvements

**Long Term**
- Generalization to Granular material simulation w. multiple particle sizes
Ideas

- Use fluid model to begin with
- Better stress model
  - Handle pressure capping
- Look at unilateral incompressibility and LCP for modeling various behaviors $\rho \leq \rho_{\text{max}}$
  - Sparse sand
  - Solid contact
Timeline

- April 7, 2009
  - Complete physical simulator with unilaterally incompressible sand and stress/friction model
  - Basic renderer (OpenGL/Blender/POV-Ray/Renderman)

- May 6, 2009
  - Add LCP based contact handling
  - LOD for sand – Hybrid between fluids and particles
  - Improved renderer with better lighting
References

- **Animating Sand as a Fluid**, Zhu et al. (SIGGRAPH 2005)
- **Particle Based Simulation of Granular Materials**, Bell et al. (Eurographics 2005)
- **Granular solids, liquids, and gases**, Jaeger & Nagel (Reviews of Modern Physics, '96)
- Instability in the Evolution Equations Describing Granular Flow, **Schaeffer** (1985)
- **Two dimensional Lagrangian particle finite-difference method for modeling large soil deformations**, Konagai & Johannson (Structural Eng./Earthquake Eng, 2001)
- Mechanics of Materials, Third Edition, Gere & Timoshenko (For basic physics reference)