OpenVDB at DWA

DreamWorks Animation

Jeff Budsberg
Head of FX
Talk Overview

- Introduction
- Applications
  - Clouds
  - Liquids
  - Advection
  - Fluids
  - Volume deformation
  - Fracture + RBD
  - Visualization

+ new tools!
+ tips & tricks!
Introduction

• Powerful library

• Collection of flexible tools
  – Third-party
  – OpenVDB
  – Production
Volume Creation
Volume Creation

[Image of a software interface for volume creation, showing settings for a fog volume with a spreadsheet and visualization options.]
Level Sets
Arbitrary Grids
Level Sets

8.9M active voxels
1051 x 208 x 862
171 MB
2.7 sec
Volume Manipulation

\[ \Phi \equiv \text{noise}(\text{CPT}) \]

\[ \Phi \ast \equiv \text{noise}(\text{P}) \]
Combining Grids
Combining Grids
Miller, B., Museth, K., Penney, D. and Bin Zafar, N. Cloud modeling and rendering for Puss in Boots. Siggraph Talk, 2012
Clouds

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Cloud Modeling

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Frustum Buffers
Frustum Buffers

ortho/frustum visual comparison (same number of voxels)
Frustum Buffers

ortho/frustum visual comparison (same number of voxels)
Raster Primitives
Raster Primitives
Raster Primitives
Raster Primitives
Liquids

Van Opstal, B., Janin, L., Museth, K. Large Scale Simulation and Surfacing of Water and Ice in Dragon 2, Siggraph Talk, 2014
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Solvers

- **DWA Rapid**
  - substeps: 1/3, CFL: 1
  - voxel size: .04
  - particle count: 8-20 Million
  - Rapid up to 6X faster

- **Houdini 13 FLIP**
Particle to Level Set

Particle to Level Set

- Artists want control
  - Remove artifacts / holes
  - Accentuate sharp features
  - Smooth flat areas
  - And make it fast!

LS Filtering / Morphological Ops

LS Filtering / Morphological Ops

Smooth
Blur
Dilate
LS Filtering / Morphological Ops
Adaptive meshing

~1.1M polys

~177K polys
Masked Meshing
Simplification Masks

Van Opstal, B., Janin, L., Museth, K. Large Scale Simulation and Surfacing of Water and Ice in How to Train Your Dragon 2, Siggraph Talk, 2014
Simplification Masks

Property of DreamWorks Animation

Van Opstal, B., Janin, L., Museth, K. Large Scale Simulation and Surfacing of Water and Ice in How to Train Your Dragon 2, Siggraph Talk, 2014
Van Opstal, B., Janin, L., Museth, K. Large Scale Simulation and Surfacing of Water and Ice in How to Train Your Dragon 2, Siggraph Talk, 2014
Grid Analysis

gradient  curvature  velocity  vorticity
Grid Analysis
Grid Analysis
Grid Analysis
Grid Analysis
Secondary Elements
Secondary Elements

Losure, M.  *Surreal Night Swimming in Home.* Siggraph Dailies, 2015
Secondary Elements

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Vector Fields

\[ F(x, y, z) = \hat{y}x - \hat{x}y \]
Vector Fields
Vector Fields
Flow fields
Advection

Forward Euler  Runge-Kutta 4th order  Level Set
Constrained Advection
Constrained Advection
Constrained Advection
Flow fields


Flow fields

Flow fields

Lipton, D., Museth, K., Sutherland, B. Jack’s Frost: Controllable Magic Frost Sim. for Rise of The Guardians. Siggraph 2013

Henderson, R. Scalable Fluid Simulation in Linear Time on Shared Memory Multiprocessors. DigiPro, 2012
Fluid Simulation

Lee, F. Snow in How To Train Your Dragong 2. Siggraph Dailies, 2015
Fluid Simulation

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Volume Stamping
Volume Stamping
Volume Stamping
Volume deformation
Volume deformation
Volume deformation
Volume deformation
Volume Fracture

Desire better-looking fractures
• Art-directed shapes
• Organic
• Concave
• Interlocking

Volume Fracture

Volume Fracture

Volume Fracture

Volume Fracture

Volume Fracture
Decomposing yields degenerate initial RBD state!

Proxy Generation

Proxy Generation

Robust
- Concave features, holes, self-intersections
- Proxy always inside

Fast
- Takes full advantage of multi-threaded hardware

Elastic Deformation

Elastic Deformation

Elastic Deformation

Elastic Deformation

Collisions

Many options!

- Watertight polygonal
- Level set
- Spheres
Collisions

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- Level set
- Spheres
Collisions

Many options!

• Watertight polygonal
• Level set
• Spheres
Visualization

Visualization

Visualization

Conclusion

• Tons of applications
• Modular toolset
• Fast & efficient operations on huge datasets
• Easy to make new tools
Thanks!

FX R+D
- Ken Museth
- Mihai Alden
- David Hill
- Peter Cucka

Michael Losure
Baptiste Van Opstal
Mark Matthews
Questions?

Forget to ask something?
www.openvdb.org/forum