A Flexible Multi-Volume Shader Framework for Arbitrarily Intersecting Multi-Resolution Datasets

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Visualization in the Oil & Gas Industry
Octreemizer™: Out-of-core Multi-Resolution Volume Rendering
Multi-Volume Data

- Arbitrarily overlapping volume data
  - Temporal snapshots
  - Multi-gigabyte volumes
  - Multiple attributes
  - Clip volumes
- Resampling sometimes not desirable
  - Dynamic scenes
  - Only partial overlapping
  - Pre-processing time
  - Numerical inaccuracies
  - Different resolutions
Overview

- **Geometry Pipeline**
  - Identify regions with different sets of volumes
  - Create proxy geometry for volume rendering

- **Interactive Shader Composer**
  - Define compositing technique
Overlapping Volumes
Different Sets of Overlapping Volumes
Overlapping *Multi-Resolution* Volumes
Different Sets of Overlapping Bricks
Overlapping Volumes
Overlapping **Multi-Resolution** Volumes
Geometry Pipeline

1. Clip at view frustum and volume boundaries
2. Cut overlapping geometry
3. Cut geometry at brick boundaries
4. Slice transparent polyhedrons
5. View-dependent sorting
Clip at Volume Boundaries
Clip at Volume Boundaries
Clip at View Frustum
Lens in Two Overlapping Volumes
Trimmed Lenses

Trim1

Trim2
Lenslets

Lenslet2 = Intersection(Trim1, Trim2)

Lenslet1 = Trim1 – Trim2

Lenslet3 = Trim2 – Trim1
Convex Lenslets
Lens Fragments: Bricked Lenslets

Multi-Volume Octree insertion
Sliced Lens Fragments
View-Dependent Sorting
Interactive Shader Composer
Interactive Shader Composer

- Unlimited number of volumes (current hardware supports up to 16 textures)
- Interactive data flow definition with field connections
- Single- and multi-component fields
- Dynamic field type check
- Dynamic data flow validation (red and green lines)
- On-the-fly generation of GPU-based shader programs
Shader Composer Nodes

- Volumes and geometries (e.g. lens and slice)
- 1D and 2D color palettes
- On-the-fly multi-volume gradients
- Phong lighting with multiple light sources
- Operators
  - Inverse, Negative, Blend, Product, Sum, Minimum, Maximum
- Multi-component combiner / swizzler
- Uncertainty
  - Desaturation, Blur and Deformation
- Waveform signal generator
- Constants
“Visual” Collision Detection
Overlapping Multi-Gigabyte Volumes

2 GB

4.5 GB

33.4 fps

NVIDIA GeForce 8800 GTX SLI
512 x 512 window size
Difference Visualization
Conclusions and Future Work

- Flexible multi-volume rendering and shading framework for multi-resolution datasets
- No resampling of the overlapping datasets
- Fast and numerically robust geometry pipeline
- Interactive frame rates only for a few overlapping multi-resolution volumes
- Interactive shader composer
  - Specifies the volume composition and rendering technique
  - Extensible and expressive tool, also for users without programming skills
  - New visualization techniques can be interactively developed and explored
- Future work
  - GPU-based proxy geometry generation
  - Volume ray casting
  - Pre-integration techniques
Thank you!

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