Directly Visualizing Volume Data

Mike Bailey
mjb@cs.oregonstate.edu
Oregon State University

Volume Data: A Definition
A volume is a 3D discretely sampled data set where the size of the voxels have been expanded to occupy the space to the neighboring voxels.

Why Do We Care About Volume Visualization?
- Medical: CAT, MRI, 3D ultrasound
- Science and engineering: CFD, stress, thermal, molecular
- Volumes are normally very difficult to comprehend

How can you get a volume dataset? (Ewww…)
Researchers used a tool called a **microtome** to cut a brain into slices 20 micrometers thick.

Understanding Volume Data Usually Involves a Compromise

- **Point Clouds**: All values everywhere, hard to see very much, distracting artifacts
- **Interpolated-colors cutting planes**: All values in a single plane
- **Contours cutting plane**: Discrete values in a single plane
- **Isosurfaces**: A single value everywhere

Because of these compromises, these are all considered to be **indirect ways** to visualize volume data

Direct Volume Rendering

Composite the colors and alphas of the voxels
Transfer Function

Voxel Compositing
Recall this color blending equation from the OpenGL Transparency notes:

\[ C' = \alpha C_{\text{new}} + (1 - \alpha) C_{\text{old}} \]

In "Voxel World", things work the same way:

Voxel Compositing Example

1. What is the color of just this voxel?
2. What is the opacity of just this voxel?
3. What will the new running RGB values be when you are done compositing this voxel with the old running RGB values?

Cropping the Volume based on Data Value

Cropping the Volume based on Spatial Location
"Magic Lens" to Selectively Look Inside Volume Data

Volume Rendering with Parallel Texture Planes

Lighting

In a callback that is called whenever the opacity transfer function changes:

In a callback that is called whenever the opacity transfer function changes:

In Display(), I:

In Display(), II:

**Display Parameters #1**

**Display Parameters #2**

One Display

\[ \mathbf{n} \cdot \mathbf{S} = \frac{dS}{dx} \frac{dS}{dy} \frac{dS}{dz} = V \mathbf{S} \]

\( \alpha = 0.5 \) (for transparency)
To be manufactureable, there must be finite material between two isosurfaces.
Putting the Tools Together: Modeling and Making Anabolic Aortic Aneurysms

CAT scan slices from the UCSD VA hospital

Fabricated

Tesselated by OSU vx (Volume Explorer)