Volume Rendering

Display of Surfaces from Volume Data

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Talk Limits

• Medical imaging application, no molecular visualization of electron density maps
• Poor media quality, diagrams, images, equations marginally legible
• Omitting complexity, quality, implementation
• Software not demo-friendly
Display of Surfaces from Volume Data

- IN: Sampled volume data, not drawn or mathematically generated
- OUT: Visualization for humans (surfaces)
Current Visualization Technique

1. Apply surface detector to sample data
2. Fit geometric primitives to surface
3. Render primitives like any other wireframe
Current Problem

• System needs to make a binary classification decision: Surface either passes through a sample data voxel or not.
• False positives display surfaces that aren’t there
• False negatives leave holes
Proposed Solution

• Volume Rendering
• Omit the intermediate geometric representation
• Images visualized directly from sample data
• Like ray tracing the data voxels
Advantages

• Still displays surfaces
• Removes the binary classification decision
• Improves shading by making it independent from classification
Rendering Pipeline

Diagram showing the process of rendering, starting with acquired values, moving through data preparation, prepared values, shading, vocal colors, sample colors, and ray tracing/re-sampling, followed by classification, vocal opacities, sample opacities, and ray tracing/re-sampling. The output is the image pixels.
Ray Tracing
Shading

• Phong illumination model
• Simplified by parallel light and ortho projection
• Surface normal from gradient averaged over neighboring voxels
Classification

- Doctors interested in tissue boundaries
- Simplified model
- Tissue types assigned arbitrary numbers
- A tissue type touches $\leq 2$ other types
- Each tissue type has an opacity
- Linear mapping from tissue type to opacity
Opacity of Boundary Surfaces

Figure 4. Calculation of opacities for region boundary surfaces.
Results

Old methods using binary classification would show holes where thin surfaces are
Conclusion

- Image quality and resolution equivalent to old techniques
- Fewer data interpretation errors
Technique Problems

• Sensitive to data acquisition artifacts
• Patient movement misaligns adjacent voxels, which disturbs gradient determination
• Internal soft tissues may have more than 2 adjacent tissue types