

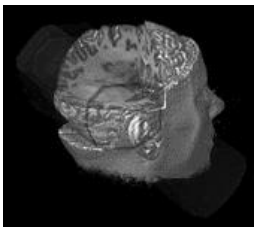
Volume Visualization with Ray Casting

<http://web.cs.wpi.edu/~matt/courses/cs563/talks/powwie/p1/ray-cast.htm>
www.cs.technion.ac.il/~zdevir/volume/Volume.ppt

Volume Rendering

- render an image a volume
 - ✦ CT, X-ray, PET, MRI scans
 - ✦ Clouds
 - ✦ Compressible fluids
- volume represented by 3D cell grid

Volume Rendering

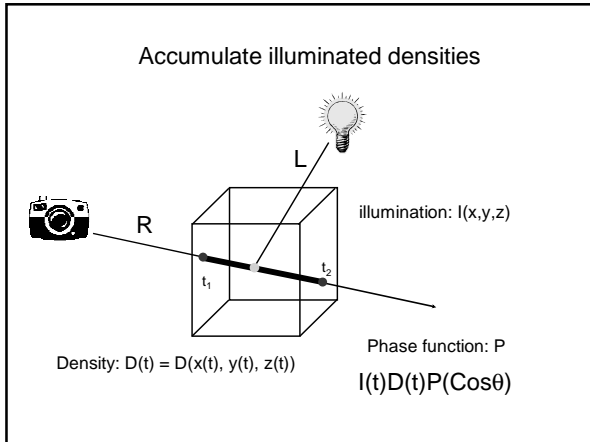


Typical sizes
128x128x128
256x256x256

Display approaches
Extract surfaces
Ray trace

Ray Casting

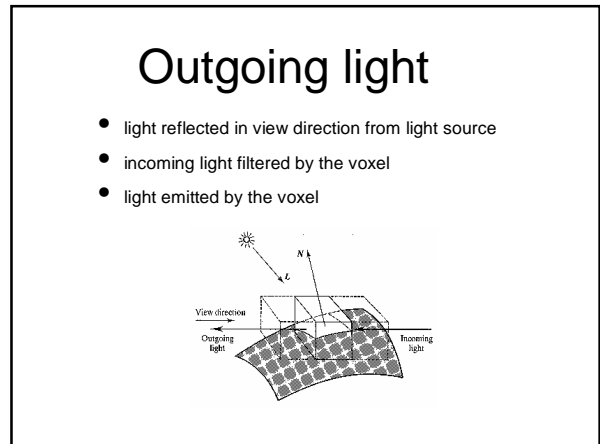
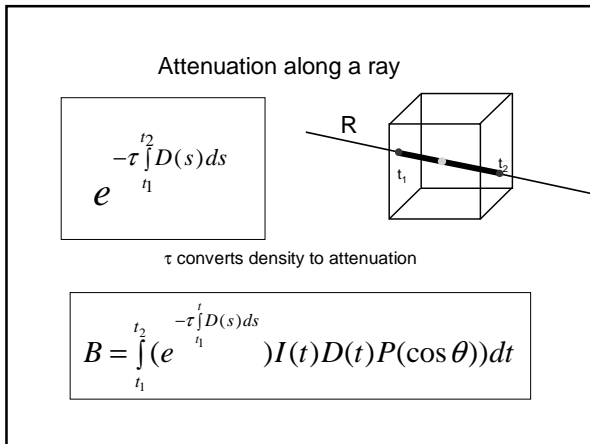
- Generate image directly from density data
- Cast ray through density volume
- Accumulate colors as ray passes through semi-transparent cells



$I(t)$

Radiation from light source
Attenuated, shadowed by volume

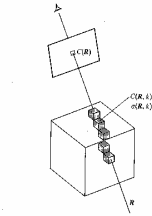
Only needed where internal shadows are important
e.g., clouds, fire, smoke



Ray casting algorithm

For every pixel in output image

- shoot ray into volume
- at evenly spaced ray locations, obtain color and opacity by interpolation
- merge color and opacities
 - front to back
 - back to front



Visualization pipeline

- Shade volume data
- compute local gradient -> voxel normal
- produce RGB intensity for every voxel
- determine opacity of each voxel
 - application dependent
 - e.g. X-ray absorption coefficient
- Ray cast volume

Voxel values

- $C(X)$ - shade
- $a(X)$ - opacity
- $C_{out} = C_{in}(1-a(X_i)) + c(X_i)a(X_i)$

Often parallel projection is used to simplify calcs

Packages

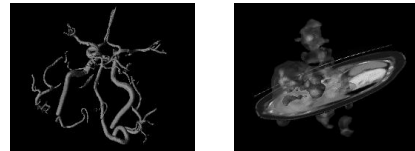
- AVS: Application Visualization System
- IBM Data Explorer (DX)
- Data Visualizer

Display issues

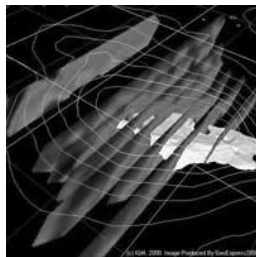
How to represent:

- Temporal information
- Non-spatial information
- Multi-dimensional information

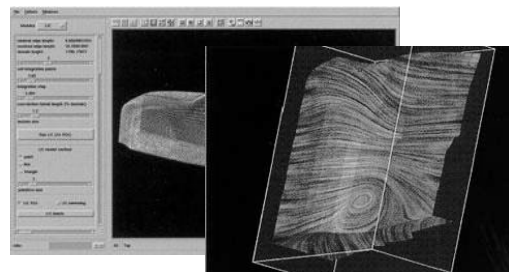
Examples



Examples



Examples



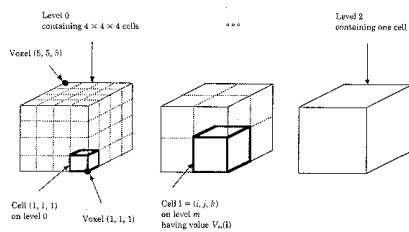
Examples



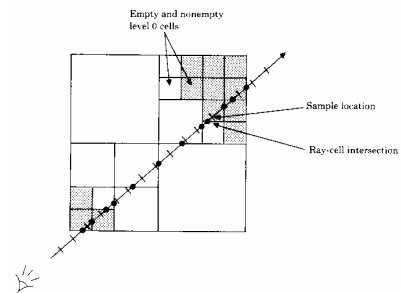
Speed-ups

- Hierarchical spatial enumeration
- adaptive termination

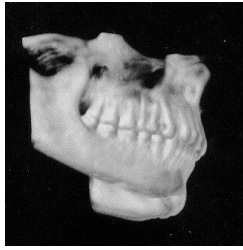
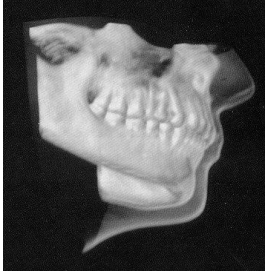
Hierarchical Spatial Enumeration



Traversing Volume



Examples



Examples

