Blinn-Phong Lighting

3 issues with surface shading

- 1) How to shade homogeneous regions

Surface shading

Normals/Gradients degraded by noise

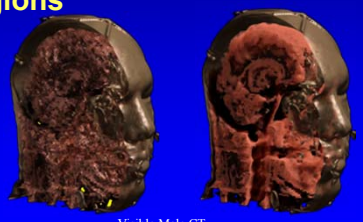
Visible Male CT

Blinn-Phong Lighting

3 issues with surface shading

- 1) How to shade homogeneous regions

Surface shading



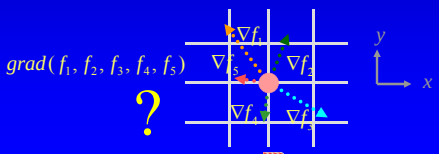
Translucent volume shading

Visible Male CT

Blinn-Phong Lighting

3 issues with surface shading

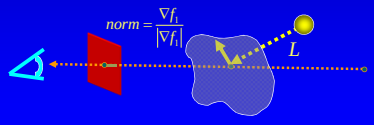
- 1) How to shade homogeneous regions
- 2) No surface normal for multivariate data
  - Can only extract orientation of greatest change
  - May not correspond to classified surface



Blinn-Phong Lighting

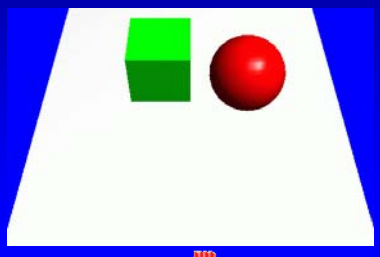
3 issues with surface shading

- 1) How to shade homogeneous regions
- 2) No surface normal for multivariate data
- 3) How did the light get there?



Importance of Global Info

Spatial relationship between objects



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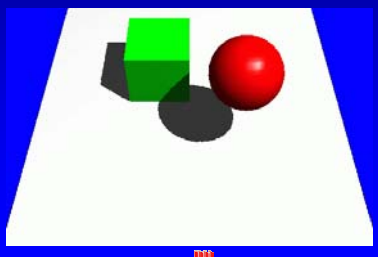
Univ of Waterloo

Importance of Global Info

Spatial relationship between objects



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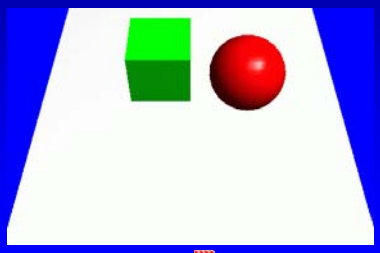
Importance of Global Info

Spatial relationship between objects



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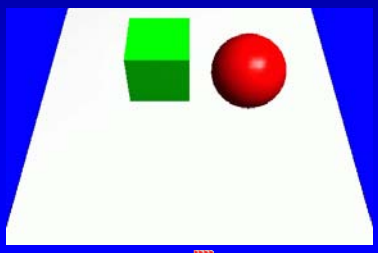
Importance of Global Info

Spatial relationship between objects



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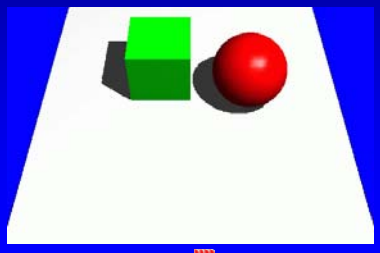
Importance of Global Info

Spatial relationship between objects



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Univ of Waterloo

Importance of Global Info

Shadows add visual acuity

without

with

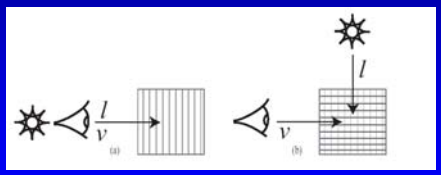
Translucent Lighting

Solution:

- Non-surface based light transport
- Step one: direct lighting (shadows)
- Step two: indirect lighting (forward scattering)

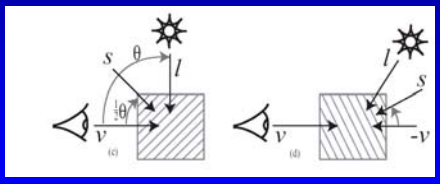
Translucent Lighting

Step one: direct lighting (shadows)



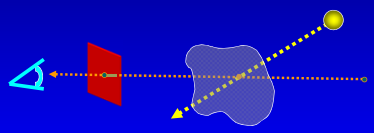
Translucent Lighting

Step one: direct lighting (shadows)



Translucent Lighting

Step one: direct lighting (shadows)



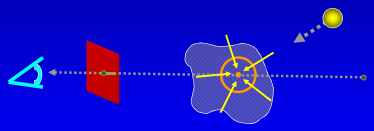
Volume Rendering + Shadows

2 Simultaneous 1D Integrals

Translucent Lighting

Step two: indirect lighting (scattering)

- Scattering is computationally expensive!



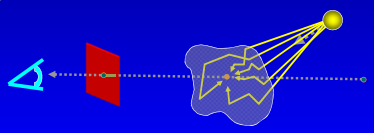
Volume Rendering + Scattering

3D Integral

Translucent Lighting

Step two: indirect lighting (scattering)

- Scattering is computationally expensive!



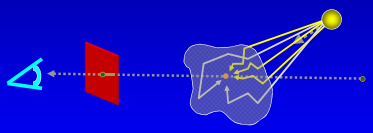
Volume Rendering + Scattering

3D Integral (recursive definition)

Translucent Lighting

Step two: indirect lighting (scattering)

- Scattering is computationally expensive!

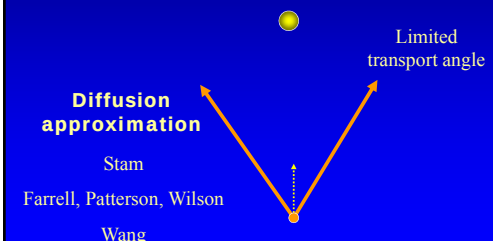


Volume Rendering + Scattering

3D Integral (recursive definition)

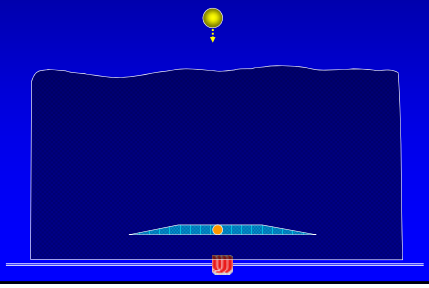
Translucency Model

1) Approximate global illumination



Translucency Model

1) Approximate global illumination
2) Blur indirect light contributions



Translucency Model

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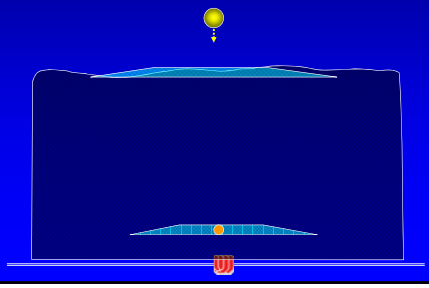

Translucency Model

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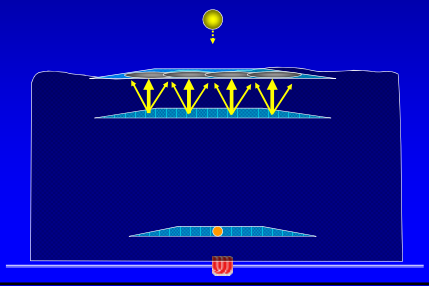

Translucency Model

1) Approximate global illumination
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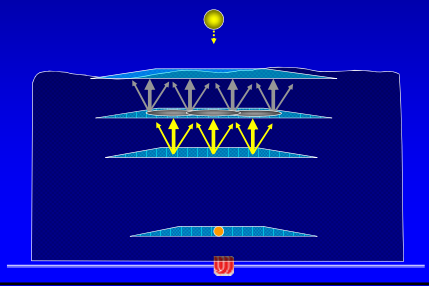

Translucency Model

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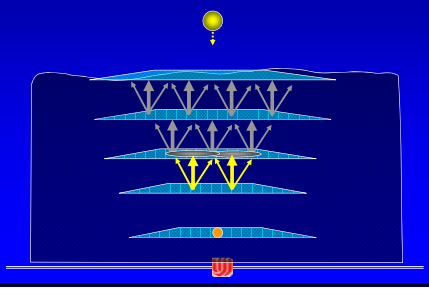

Translucency Model

1) Approximate global illumination
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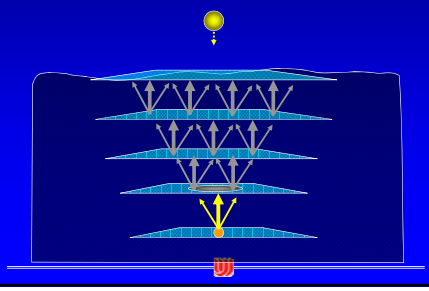

Translucency Model

1) Approximate global illumination
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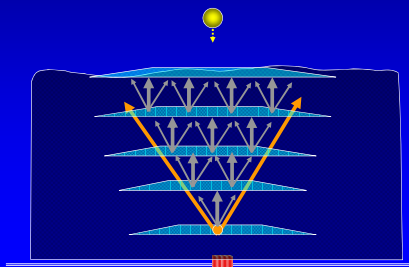


Translucency Model

1) Approximate global illumination
2) Blur indirect light contributions

Translucency Model

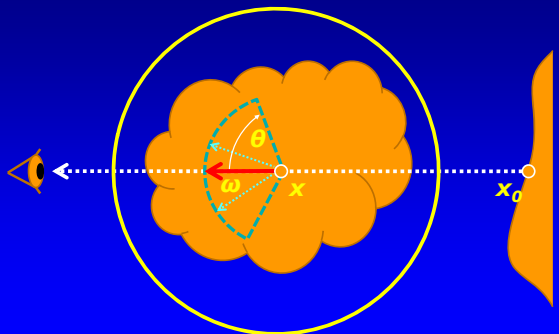
1) Approximate global illumination
2) Blur indirect light contributions
3) Make attenuation chromatic

Translucency Model

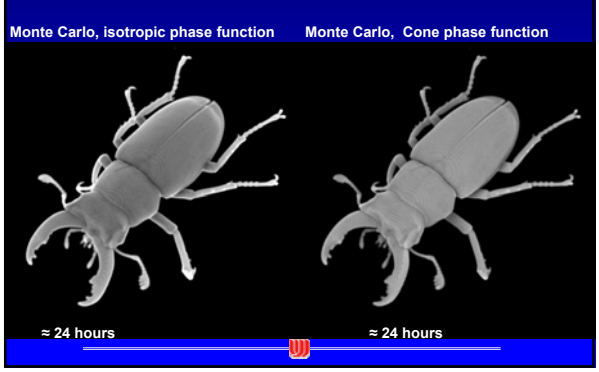
Approximates global illumination
"Local" light transport model
Capture translucency effect
- Light penetrates deep into material
- Saturation of hue

Translucency Model

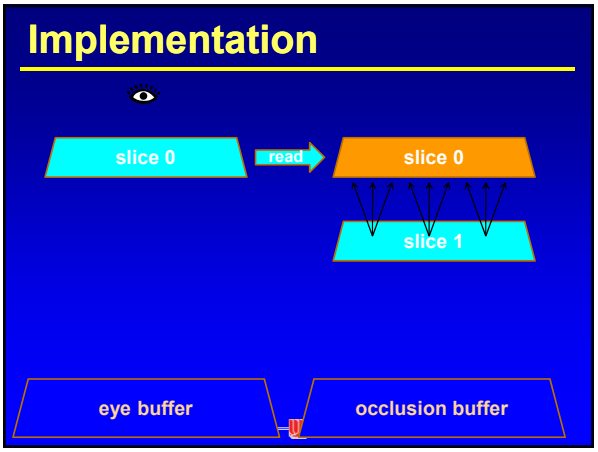
Directional Occlusion Shading



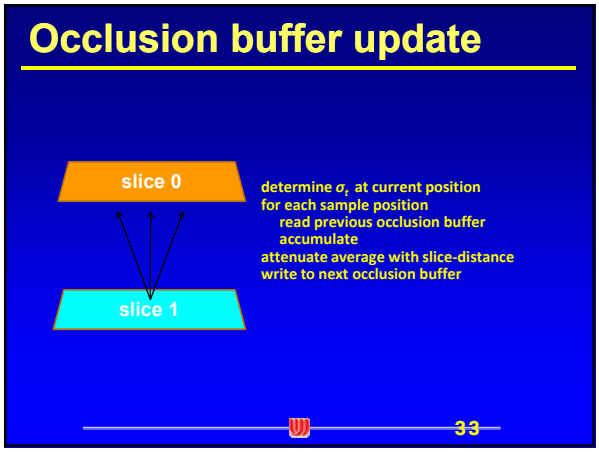
Spherical and Directional Occlusion



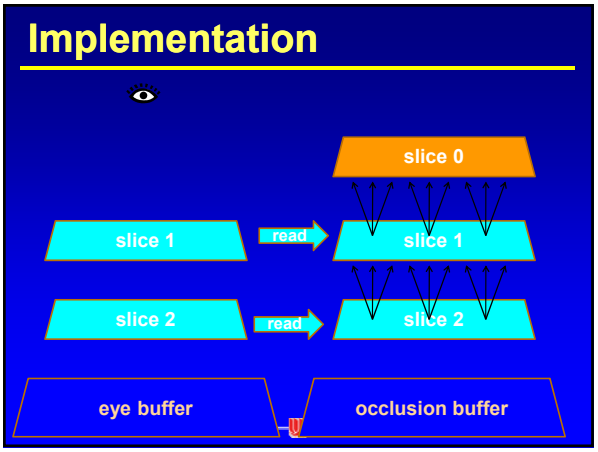
Implementation



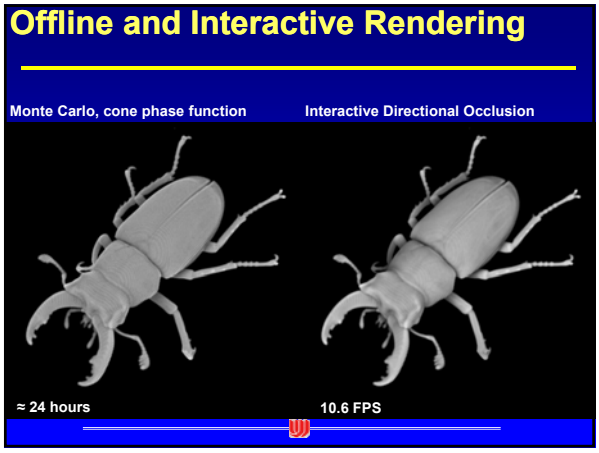
Occlusion buffer update



Implementation

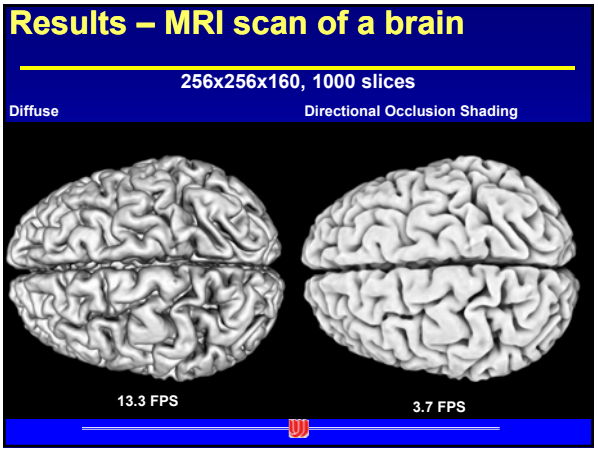


Offline and Interactive Rendering



Results – MRI scan of a brain

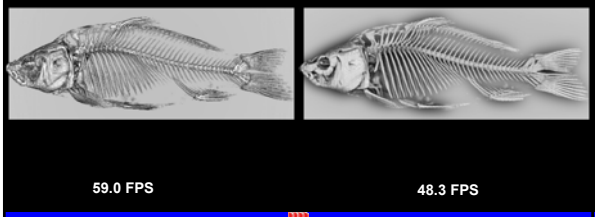
256x256x160, 1000 slices



Results – CT scan of a carp

128x256x256, 220 slices

Diffuse | Directional Occlusion Shading

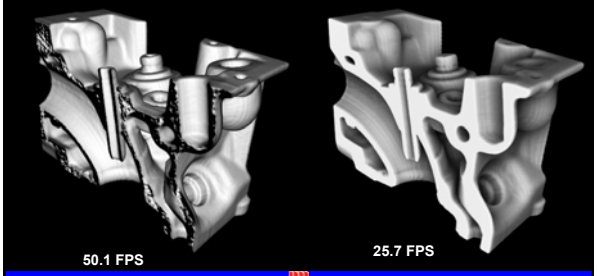


59.0 FPS | 48.3 FPS

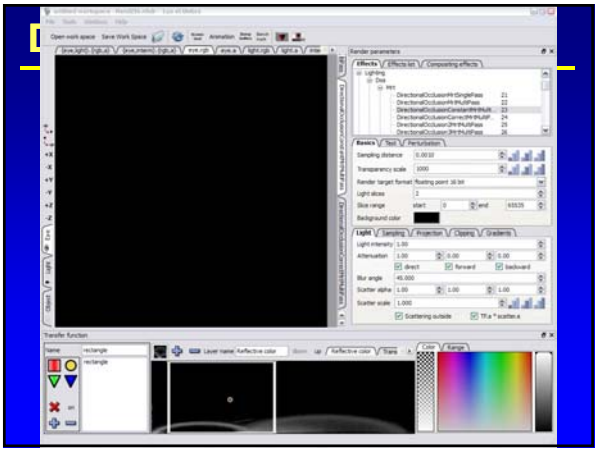
Results – CT scan of engine block

256x256x128, 679 slices

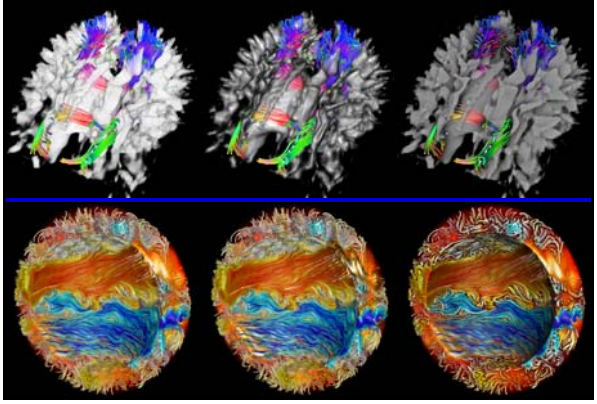
Diffuse | Directional Occlusion Shading



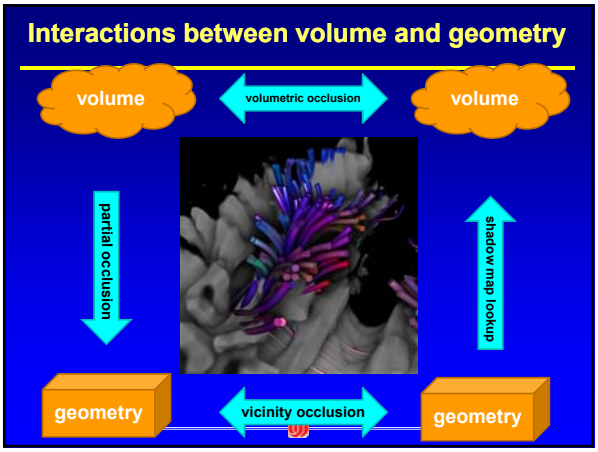
50.1 FPS | 25.7 FPS



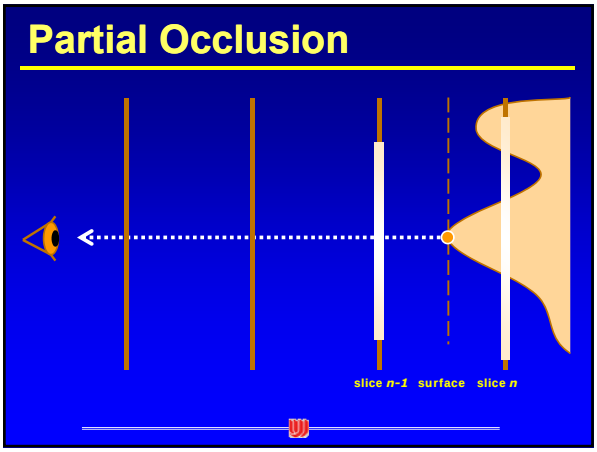
Combined Occlusion Shading



Interactions between volume and geometry



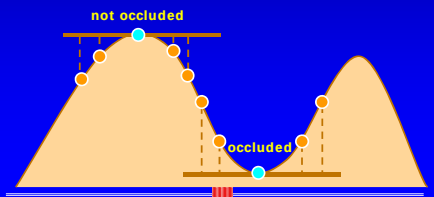
Partial Occlusion



Vicinity Occlusion

inspired by recent SSAO methods

- depth buffer = approximation of environment
- sample & compare depths of neighboring pixels



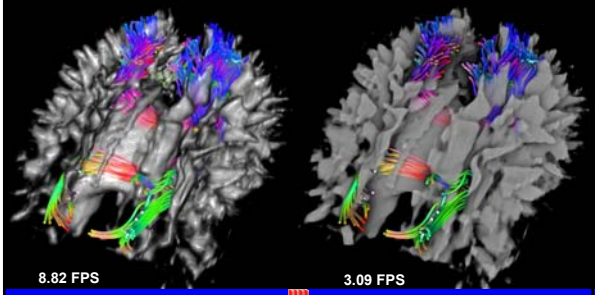
Combining the terms

partial occlusion vicinity occlusion combined occlusion

Results – DTI fibers

96x96x81, 720k triangles, 512 slices

Phong Shading Combined Occlusion Shading



8.82 FPS 3.09 FPS

Results – CFD Mixing Pipe

1800x121x121, 137k triangles, 574 slices

Phong Shading (51.76 FPS)

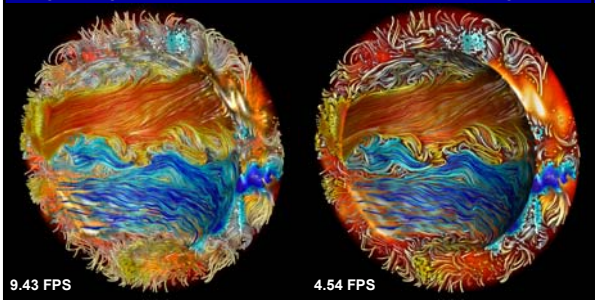
Vicinity occlusion (102.35 FPS)

Combined Occlusion Shading (11.79 FPS)

Results – Astrophysical Data

56x512x512, 7.9M triangles, 961 slices

Phong Shading Combined Occlusion Shading

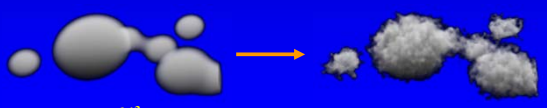


9.43 FPS 4.54 FPS

Volumetric Modeling

Procedural Perturbation

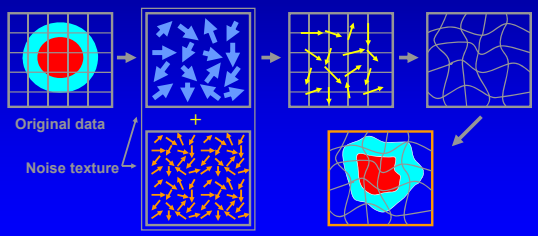
- Natural phenomena
- Fine detail
- Demonstrate decoupled volume and light transport resolution



64^3

Volumetric Perturbation

Texture coordinate perturbation

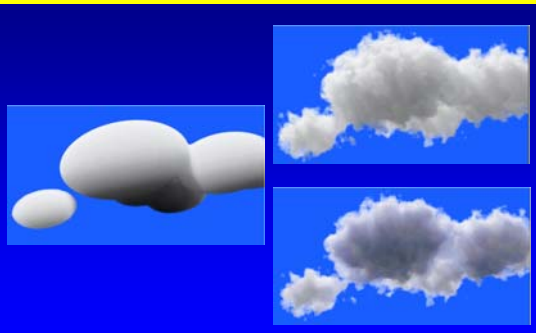


Volumetric Modeling

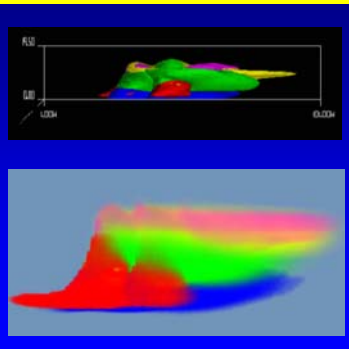
Adding detail

Volumetric Modeling

Volumetric Modeling

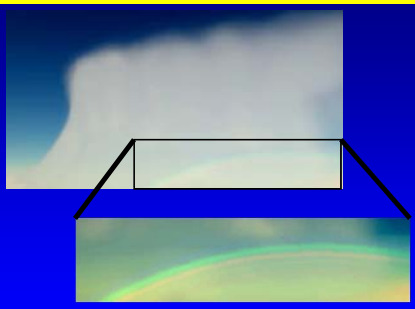


Atmospheric Illumination



Atmospheric Illumination

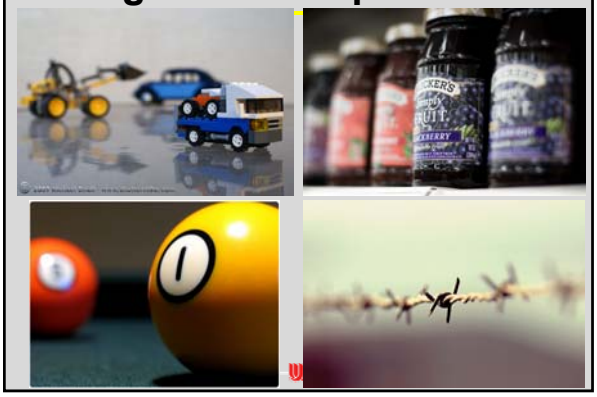
Atmospheric Illumination



Atmospheric Illumination

Atmospheric Illumination

Background – Depth of Field



Background - Depth of Field

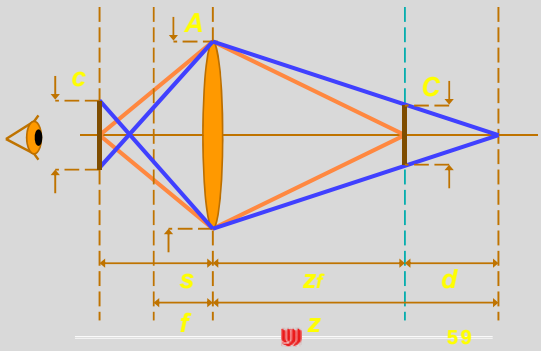
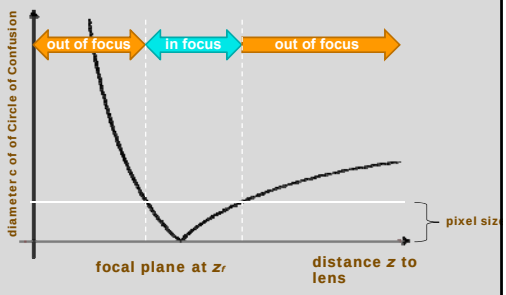
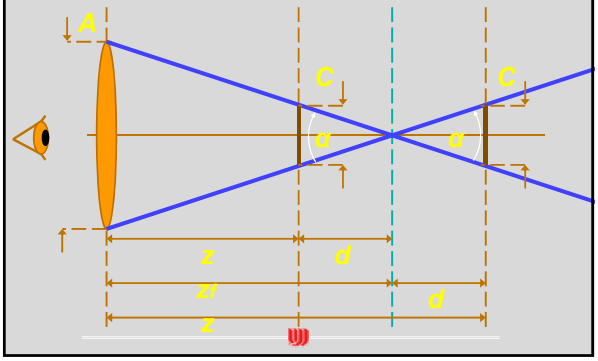


Image Space Circle of Confusion

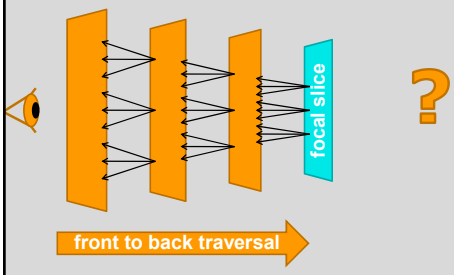


non-linear in image space, linear in view space

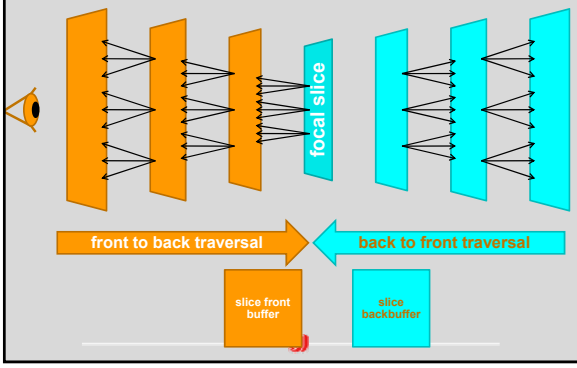
Simplified Model



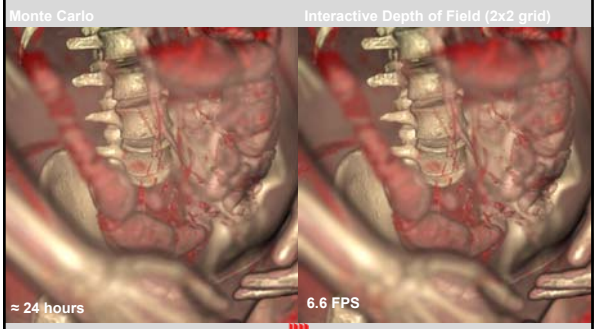
Implementation



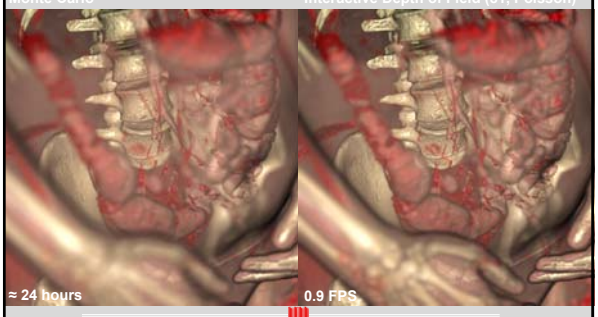
Implementation



Difference from Reference (1)



Difference from Reference (2)



Results – CT scan - Visible Human

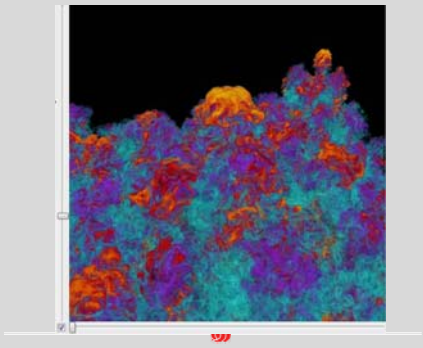
512x512x512, ~800 slices

Results – MRI scan of an aneurysm

256x256x256, ~600 slices

Results – CFD Richtmyer-Meshkov

1024x1024x384, ~1300 slices



Results – CT scan of a backpack

512x512x373, ~1500 slices