Interactive Direct Volume Rendering with Many-light Methods and Transmittance Caching

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Participating Media Rendering

Direct Illumination

Global Illumination
Previous Work - Global Illumination

Instant Radiosity [Keller 1998], first practical adaptation to PM [Engelhardt et al. 2012], VSL [Hašan 2009]
Previous Work - Transmittance Caching

Adaptive Volumetric Shadow Maps [Salvi 2010]

transmittance caching per direction and VL (cubemap)
Interim Conclusion I

- Precaching of light transport
  - Virtual Lights
    - Adaptive Volumetric Shadow Maps
- Interactive rendering
- Changes to the medium require full recomputation
- Relatively few VL (100s)
Transfer Function Editing

Air | Leaves | Wood
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Input Medium

Opacity

Graphs showing the transfer function editing for different materials: Air, Leaves, and Wood. The opacity function is plotted with peaks for each material, demonstrating how the transfer function can be adjusted to control the visual appearance of each component.
Transfer Function Editing (special case - global scaling)
Our Method: Fixed VL Positions

- Retracing of "same" light path
  - Fixed positions
  - Update of color and intensity
Problem: Altering the Transfer Function

- Outdated VLs
- Outdated AVSMs
Problem: Outdated VLs

**complete absorption**

**no scattering**
Problem: Outdated AVSMs
Our Method: Progressive Redistribution

1. ▶ Initial configuration  
   ▶ VLs are distributed throughout the medium

2. ▶ Edit of transfer function  
   ▶ Retracing of light paths  
   ▶ AVSMs unchanged
Our Method: Progressive Redistribution

3. ▶ Per frame: Delete N light paths and . . .

4. ▶ . . . redistribute VLs
   ▶ Create new AVSMs
   ▶ Repeat 3 & 4

5. ▶ Complete redistribution
   ▶ Quick stabilization
Interim Conclusion II

- Precaching of light transport
- Interactive rendering
- Arbitrary changes of the medium

Next: Special case - global scaling of density
Our Method: Restricted TF Editing - Global Density Scaling

VL position based on transmittance
Our Method: Restricted TF Editing - Global Density Scaling

- Heterogeneity of the medium does not change
- AVSMs do not need recomputation (scaling during rendering)
- VL positions can be kept (no progressive redistribution)

Problem: Find VL positions suitable for all scaling configurations
Solution: Distribute according to average penetration depth - average transmittance
Conclusion

+ Interactive editing
+ Immediate updates
+ Temporal coherence
+ Convergence to stable results
Conclusion

Thank you!