Adaptive Volumetric Shadow Maps

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## Pre-existed Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Opacity shadow Maps [Kim et al. 2001]</td>
<td>Numerous variants optimized to handle special case (i.e. hair).</td>
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<tr>
<td>Fourier Opacity Mapping [Jansen et al. 2010]</td>
<td>Converge slowly, especially around sharp features</td>
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<td></td>
<td>Depth range dependent.</td>
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</tbody>
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Adaptive Volumetric Shadow Maps
Introduction

- Streaming simplification algorithm.

- Generates an adaptive volumetric light attenuation function using a small fixed memory footprint.

- Does not require prior knowledge about spatial distribution of the light blockers.
Algorithm Overview

AVSM

- Map generation
- Stream compression
- Texel sampling
AVSM - Generation

\[ t(z) = e^{- \int_0^1 f(x) \, dx} \]

Light transmittance

Attenuation function: light absorbed

Adaptive Volumetric Shadow Maps
AVSM – Generation

• Render the scene from the light’s viewpoint.
• Insert and render a non-opaque occluder.
  • Record density, entry and exit points.
• Insert segments representing the ray’s traversal through the particle.
AVSM – Generation

• Store fixed-size array including nodes for each texel.
• Node \( \rightarrow (d_i, t_i) \)
• Adaptively place nodes
  • Various shadow blocker representation.
• \( N \geq 2 \)

Adaptive Volumetric Shadow Maps
AVSM – Generation

Integrate and composite transmittance over the segment with existing values

Adaptive Volumetric Shadow Maps
AVSM – Compression

- Real-time *lossy* compression of transmittance data
  - Inexpensive
  - Small error rate
- Remove the node that contributes less
- Keep first and last node intact
- Compression must not re-arrange node positions
  - Nodes can drift unpredictably
  - Artifacts (black/bright shadows, temporal aliasing)
AVSM – Compression

- Assume linear variation to simplify computations
- Compute integral variation
- Removing a node affects only the area of the involved trapezoids

\[ I_t = \sum_{i=0}^{N-1} \frac{1}{2} (d_{i+1} - d_i) (t_i + t_{i+1}) \]

Adaptive Volumetric Shadow Maps
AVSM – Compression

Triangle area represents the Integral variation

max nodes: 5
current nodes: 5

Adaptive Volumetric Shadow Maps
AVSM – Sampling

- Compute overall transmittance
  - Find bounding nodes of shadow receiver in depth $d$
- Bilinear filtering

$$T(d) = t_l + (d - d_l) \frac{t_r - t_l}{d_r - d_l}$$

($t_l, d_l$) $\rightarrow$ texel $\rightarrow$ ($t_r, d_r$)
Evaluation

Uncompressed (238 Nodes)
Adaptive Volumetric Shadow Maps (12 Nodes)
Fourier Opacity Maps (16 terms)
Opacity Shadow Maps (32 slices)
Deep Shadow Maps
Smoke + Hair Comparisons
Benefits – Limitations

- Higher image quality via adaptive sampling in real-time.
- Predefined knowledge of light blockers type and spatial distribution is not required.
- Possible to balance image quality over speed and storage.

- Sacrifices quality over performance.
  - Not preferable for offline rendering (e.g. film rendering).
- In case of low number of nodes
  - Re-sort nodes to avoid temporal artifacts.

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References


Thank you for your attention!

Questions?