Improved VPL Distribution

(part of the “Handling difficult light paths” section)

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1. Distribute VPLs

2. Render with VPLs

VPL rendering
Why alternate VPL distribution?

• VPLs may not end up where needed
Example: Large environments

Images courtesy of Ben Segovia and Bernard Péroche
Example: Local light inter-reflections

instant radiosity

reference

clamping

artifacts

no local light inter-reflections
Purpose & approach

• Purpose
  – Ensure VPLs end up where needed

• Approaches
  – Rejection of unimportant VPLs
  – Metropolis sampling for VPL distribution
  – Distribute VPLs by tracing paths from the camera
Rejection of unimportant VPLs
Rejection of unimportant VPLs

- Autodesk 360 Rendering
  - Covered by Adam later in the course

- [Georgiev et al., EG 2010]
  - Covered on the following slides
    (courtesy of Iliyan Georgiev)

- Good for large environments but not for local interactions
VPL rejection – Idea

• Accept VPLs proportionately to their total image contribution
  – Reject some of those that contribute less than average
VPL rejection – Idea

- Accept VPLs proportionately to their total image contribution
  - Reject some of those that contribute less than average
VPL rejection – Algorithm

• Want VPLs with equal image contribution $\Phi_v$

• For each VPL candidate $i$
  
  – Estimate total image contribution $\Phi_i$
  
  – Accept w/ probability

$$p_i = \min\left\{ \frac{\Phi_i}{\Phi_v} + \epsilon, 1 \right\}$$

(divide energy of an accepted VPL by $p_i$)
Estimating image contribution

• No need to be accurate

• Estimating $\Phi_v$ (average VPL contribution)
  – Based on a few pilot VPLs

• Estimating $\Phi_i$ (contribution of VPL candidate $i$)
  – Contribution to only a few image pixels
VPL rejection – Results

Instant Radiosity

[Georgiev et al. 2010]
(7% acceptance)
VPL rejection – Conclusion

- Cheap & simple
- Can help a lot
- “One-pixel image” assumption
  - Not suitable for local light inter-reflections
Metropolis sampling for VPL distribution
Metropolis sampling for VPL distrib.

- “Metropolis instant radiosity”
  [Segovia et al., EG 2007]

- Good for large environments but not for local interactions
Metropolis IR – Path mutation

VPL = 2nd vertex from the camera
Metropolis IR – Path mutation

$VPL = 2^{nd}$ vertex from the camera
Metropolis IR – Path mutation

\[ VPL = 2^{nd} \text{ vertex from the camera} \]
Metropolis IR – Resulting VPL set
Metropolis IR – Results

Images courtesy of Ben Segovia and Bernard Péroche
VPL rejection vs. Metropolis IR

- Same goal: VPLs with same image contribution
- Similar VPL set quality

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<thead>
<tr>
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<th>VPL rejection</th>
<th>Metropolis IR</th>
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<tr>
<td>Performance</td>
<td>✓</td>
<td>✓</td>
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<td>(not-so-complex cases)</td>
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<td>(difficult cases)</td>
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<tr>
<td>Implementation</td>
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Sampling VPLs from the camera

(Local VPLs)
Sampling VPLs from the camera

- Address the local inter-reflection problem

- Guaranteed to produce VPLs important for the image
Sampling VPLs from the camera

- “Bidirectional instant radiosity” [Segovia et al., EGSR 2006]
- “Local VPLs” [Davidovič et al., SIGGRAPH Asia 2010]
[Davidovič et al. 2010]

- Split illumination

Global component
- Classic VPLs

Local component
- Local VPLs
Review of compensation

- Kollig & Keller compensation

1) Shoot path

2) Connect

3) Contribute

Clamped energy
Local VPLs – Idea

- [Davidovič et al. 2010]

Create local light
Contribute to a tile
Local VPLs – Technical solution

- [Davidovič et al. 2010]
Local VPLs – Technical solution

- [Davidovič et al. 2010]

Key idea: **Tile visibility approximation**
The complete local solution

Generate local lights

Connect to global lights

Contribute to a tile

Local solution (compensation)
The complete local solution

Global solution (clamped)

Local solution (compensation)

Indirect illumination solution
Local VPLs – Results

- Local lights: 17,100,000

[Davidovič et al.]: 5 min 28 sec

VSL: 6 min 25 sec

Reference: 6360 min
Local VPLs – Results

- [Davidič et al.]: 5 min 28 sec
- VSL: 6 min 25 sec
- Reference: 6360 min

- Local lights: 17,100,000
Local VPLs – Limitations

- Loss of shadow definition
- Small loss of energy

[Davidovič et al.]: 5 min 28 sec

reference: 6360 min
Local VPLs – Conclusions

• Good for local inter-reflections

• Really useful only when used in conjunction with a separate “global” solution