Master thesis project
Octree light propagation volumes

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Octree light propagation volumes

- Global illumination
- Indirect diffuse lighting
- Real time

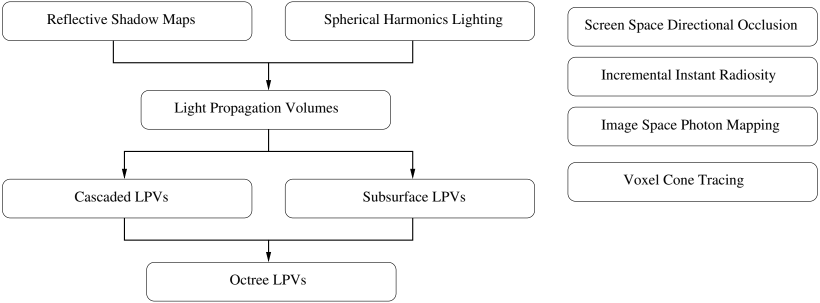
Octree light propagation volumes

- Global illumination
- Indirect diffuse lighting
- Real time
- Based on traditional light propagation volumes
- Using an octree based data structure

Outline

1. Previous work
2. Spherical harmonics
3. Light propagation volumes
4. Octree light propagation volumes
5. Results

Previous work



Spherical harmonics

Functions over the unit sphere

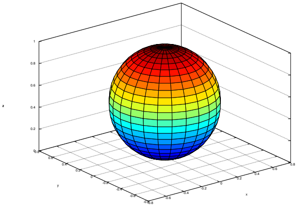
- Defined for points s on the unit sphere
- $f(s)$
- Cartesian: $s = (x, y, z)$, $x^2 + y^2 + z^2 = 1$, normalized vector
- Spherical $s = (\theta, \varphi)$
- Here: Represented using four coefficients

Example

Functions taking *normalized direction vectors* as their argument.

Clamped cosine lobe

- Useful for LPVs
- $f(\theta, \varphi) = \max(\cos\theta, 0)$
- Rotationally symmetric around Z-axis
- Rotated into direction d



Steps

1. Create virtual point lights
2. Inject light into grid
3. Propagate
4. Render

Create virtual point lights

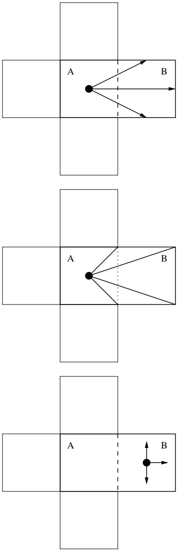
- Texels of reflective shadow map
- Stores depth, normal and color

Inject light into grid

- Each VPL as a clamped cosine lobe
- Mapped to a grid position
- Added to existing value

Propagation

- For each grid element
- To each adjacent element
- Evaluate stored SH
- Directed towards each face
- Reproject as clamped cosine lobe



Propagation

- Perform multiple iterations
- Use sum of all iterations

Light propagation volumes

Render

- For each fragment
- Find grid position
- Evaluate towards negative normal
- Add to direct lighting

Octree LPVs

- Octree instead of uniform grid
- Two parts
  - Data storage levels
  - Index volume
- Some new steps

Octree light propagation volumes

Data storage levels

- Hierarchy of 3D grids, *levels*
- Sizes are powers of two

Example

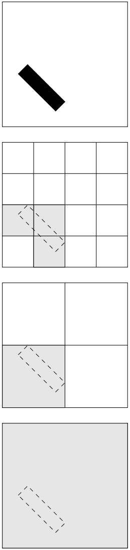
Level sizes

0. $32 \times 32 \times 32$
1. $16 \times 16 \times 16$
2. $8 \times 8 \times 8$
3. $4 \times 4 \times 4$
4. $\ldots$

Octree light propagation volumes

Data storage levels

- Hierarchy of 3D grids, *levels*
- Sizes are powers of two



Index volume

- Stores the octree structure
- Same sizes as data storage
- One for each data storage level
- Contains: Which data storage level to use
- Sample: Minimum stored level

Light injection

- Inject everything to first level
- Leave other levels empty
- Index volume zero for injected elements

Downsampling

- Populate other levels
- Average from higher resolutions
- Update index volume

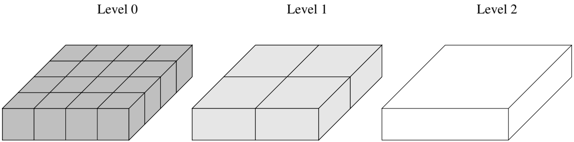
Propagation

- Individually on each level
- Same scheme as traditional LPVs
- Update index volume

Octree light propagation volumes

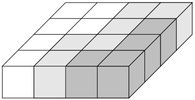
Merging

- Merge hierarchy into single LPV
- Sample index volume



2	2	1	1
2	2	1	0
2	1	1	0
2	1	0	0

Index volume



Resulting sampling

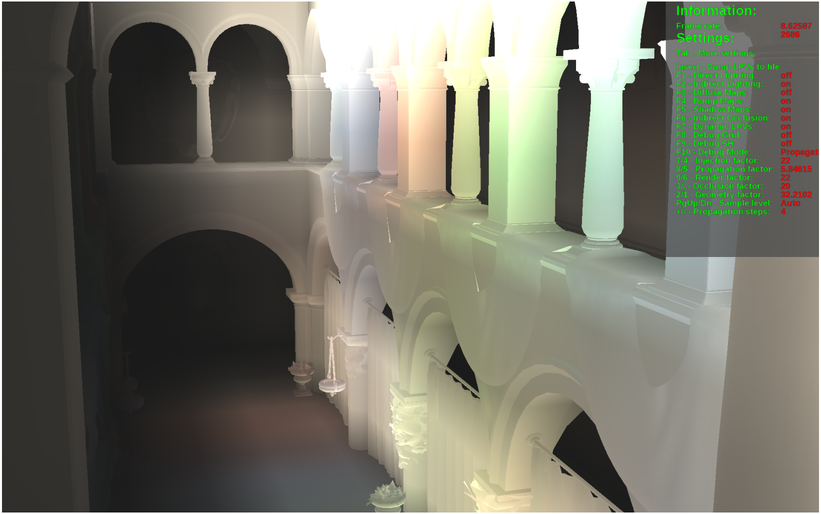
Rendering

- Use the merged LPV
- Same rendering as regular LPVs

Results

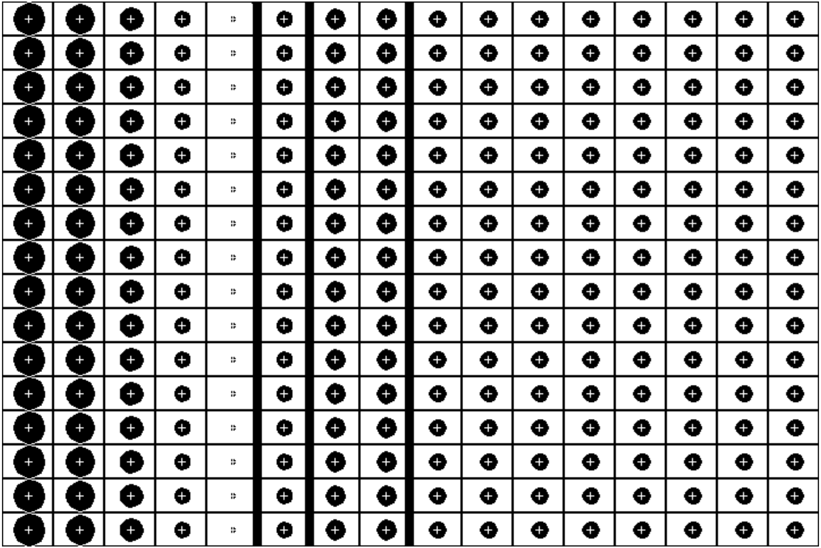

Information:
Frame rate: 7.9004
2115
Settings:
Tab - More settings
Insert - Dump LPVs to file
4/6 - Light center x: 0
8/2 - Light center y: -300
9/3 - Light center z: 1800
5 - Reset light center
+/- - Light speed: 0.1
Light animation type: off
F12 - Animate lights: Static
F1 - Static lights
F2 - Z-Axis animation
F3 - Rotating animation
F4 - Y-Axis animation

Results



Information:
Frame rate: 8.62587
2686
Settings:
Tab - More settings
Insert - Dump LPVs to file
F1 - Direct Lighting: off
F2 - Indirect Lighting: on
F3 - Diffuse Maps: off
F4 - Bump Maps: on
F5 - Shadow Maps: on
F6 - Indirect Occlusion: on
F7 - Dynamic LPVs: on
F8 - Debug Grid: off
F9 - Debug SH: off
F10 - Debug Mode: Propagati
7/4 - Injection factor: 22
8/5 - Propagation factor: 5.84615
9/6 - Render factor: 22
3/, - Occlusion factor: 20
2/1 - Geometry factor: 32.2102
PgUp/Dn - Sample level: Auto
+/- - Propagation steps: 4

Results



Results

Performance

		Octree		Uniform
Part	Count	Total	Diff	Total
Frame	500	53193	-4801	57994
RSMCreate	9000	3053	316	2737
GVClear	500	671	-50	721
GVInject	1500	15593	-110	15703
GVDownsample	500	55	55	-
IXClear	500	2923	2923	-
LPVClear	500	4461	270	4191
LPVInject	1500	19929	-2884	22813
LPVDownsample	500	142	142	-
LPVPropagate	500	3788	-5615	9403
LPVMerge	500	39	39	-
Total			-4914 **8.28%**	

Follow up

Post-presentation

- Opponent questions
- Other questions

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Thanks for listening!