Relighting with 4D Incident Light Fields

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Relighting: apply incident illumination to a real object
Reflectance field

• Transfer of light through the scene
Previous work

- 4D

Images ACM SIGGRAPH

2D incident (Environment map)

2D exitant (Image)
Previous work

- 6D

Images ACM SIGGRAPH

2D incident (Environment map)

4D exitant (Light field)
Incident Illumination

- Usually represented by an environment map

2D incident
Spatial varying incident illumination

- Environment Map: incident illumination at one point
Goal: relighting with angular and spatially varying illumination

- New effects:
  - Spot light
  - Shadows
  - ...

Goal: relighting with angular and spatially varying illumination

- One viewpoint
- Use artificial incident light fields or captured from real environment
Acquire the reflectance field

- Use camera to capture exitant light field
- Use projector to create incident light field
Data acquisition
Data acquisition
Data acquisition
Data acquisition
Data acquisition
Data Acquisition: setup

- Camera
- Projector
- Object
Data Acquisition: setup
Relighting

Incident Light Field

Scene

Apply

$W_1$

$W_1 \times$
Relighting

Scene

Incident Light Field

$W_1$ and $W_2$
Relighting

Scene

Incident Light Field

$W_3$

$x W_1$

$x W_2$

$x W_3$
Relighting

Scene

Incident Light Field

\[ W_1 \]

\[ W_2 \]

\[ W_3 \]

\[ \ldots \]

\[ W_n \]
Relighting
NxN light bundles
Speedup

- \#images per projector position = \( N^2 \)

- Reduce \#images per projector position: \( O(N) \)
O(N) Patterns
Reconstruct basis image
Reconstruct basis image

- Take the minimum value per pixel
Speedup

- #Patterns per projector position = $O(N)$
- Assumption: limited local influence
- Total complexity: $O(P \times N^2)$ to $O(P \times N)$ with $P =$ #projector positions
Results

- 32x7 projector positions
- 16x16 light bundles
- 57344 basis images reconstructed from 14336 photographs
Relighting with a captured 4D Incident Light Field

- Unger et al. EGSR2003
4D Incident light field vs. 2D Environment map
Comparison 4D vs. 2D Illumination
Results

- 32x7 projector positions
- 32x32 light bundles
- 229376 basis images reconstructed from 28672 photographs
Results
Results
Conclusion

- Acquire reflectance field to relight with 4D incident light fields
- Speedup: $O(P \times N^2)$ to $O(P \times N)$

Future work

- Use other illumination basis functions
  - Gaussians, Wavelets,...
- Smarter acquisition
  - What images do we really need?
- Move the camera
  - Capture the complete 8D reflection field