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

• Debevec et al. SIGGRAPH 2000

Images ACM SIGGRAPH
Previous work

- Matusik et al. SIGGRAPH2002
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 view point
- Use artificial incident light fields or captured from real environment

4D incident (Light Field)

2D exitant (Image)
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
Data Acquisition: setup
Relighting

Incident Light Field

Scene

Apply

$W_1 \times W_1$
Relighting

Scene

Incident Light Field

$W_1$

$W_2$
Relighting

Incident Light Field

Scene

W_1

W_2

W_3

W_3

Incident Light Field
Relighting

Scene

Incident Light Field

$W_1 \times W_2 \times W_3 \ldots \times W_n$
Relighting

\[
x W_1 + x W_2 + x W_3 + \ldots + x W_n
\]
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
• #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
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