Joint Material and Illumination Estimation from Photo Sets in the Wild

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University College London
task: insert a yellow chair?
task: insert a yellow chair?

geometry
task: insert a yellow chair?

geometry + material
task: insert a yellow chair?

geometry + material + illumination
task: insert a yellow chair?

geometry + material + illumination =
task: insert a yellow chair?

geometry + material + illumination =

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task: insert a yellow chair?

gameometry + material + illumination =

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task: insert a yellow chair?

geometry + material + illumination =

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Challenge 1: unknown structure
Challenge 1: unknown structure

Challenge 2: scale ambiguity

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Illumination representation

Ground Truth

Spherical Harmonic fitting

Spherical Gaussian Mixture Model
Illumination representation

Ground Truth

Spherical Harmonic fitting

Spherical Gaussian Mixedure Model
Material representation

Diffuse (Lambertian)
Material representation

Diffuse (Lambertian)  Diffuse + Specular
Material representation

Diffuse (Lambertian)

Diffuse + Specular

Cook-Torr
Int: 1.0, Hard: 100

Phong
Int: 0.5, Hard: 50

Blinn
Int: 1.5, Hard: 100
IOR: 5.0

Toon
Int: 0.5, Size: 0.5
Smooth: 0.5

Wardiso
Int: 1.0, Slope: 0.1

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Problem formulation
Problem formulation

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Problem formulation

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Problem formulation
Problem formulation
Problem formulation

\[
\min \sum \left| \mathbf{I} - \left( \mathbf{M} \otimes \mathbf{R} \right) \right|_2
\]

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\[
\min \sum |I - (I_e \otimes I_x)|_2
\]

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\[
\min \sum |I - (\overline{I} \odot \overline{\mathbf{X}}) - \overline{\mathbf{X}}_b)|_2
\]
\[
\min \sum | \quad \quad \rightarrow \quad (\quad \quad )|_2
\]

Expectation for a renderer
1. efficient
2. differentiable
\[
\min \sum | \text{error} | \quad (\text{1. efficient}) \quad (\text{2. differentiable})
\]

Expectation for a renderer

Assumption: pixel-wise rendering

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\[
\min \sum |r - \langle I_{\text{dir.}} + \text{var.}, N, \theta \rangle |^2
\]

Expectation for a renderer
1. efficient
2. differentiable

Assumption: pixel-wise rendering

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\[
\min \sum |e_{\text{diff}}| + \text{var.} \quad \text{Normal} + \text{diffuse} \quad \text{NN} \\
\text{Specular NN} \\
\text{Half angle} \\
\min \sum |e_{\text{diff}}| + \text{var.} \quad \text{Normal} + \text{diffuse} \quad \text{NN} \\
\text{Specular NN} \\
\text{Half angle}
\]

Expectation for a renderer
1. efficient
2. differentiable

Assumption: pixel-wise rendering

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\[ \min \sum | | \]

Expectation for a renderer
1. efficient
2. differentiable

Assumption: pixel-wise rendering

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\[ R(\text{Image}) = R(\text{Material}) = R(\text{Illumination}) + R(\text{Diffuse}) \]
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\[ R = R + D + S + D + S + D + S + D \]

\[ S = \text{Material PMM 1} \]

\[ D = \text{Illumination PMM 1} \]

\[ URM 1/1 \]

\[ URM 1/2 \]

\[ URM 2/1 \]

\[ URM 2/2 \]

\[ k \]

\[ s \]

\[ g \]
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Input image

1x1

3x3

Full

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Projective texturing

SIRFS

Ours

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Limitations
Limitations

self shadow
Limitations

self shadow  
realistic illumination
Limitations

self shadow

realistic illumination

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Thank you!

Acknowledgement
- ERC StartingGrant SmartGeometry (StG-2013-335373)
- Microsoft PhD fellowship program
- Rabin Ezra Scholarship

Joint Material and Illumination Estimation from Photo Collections

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