Simultaneous Acquisition of Polarimetric SVBRDF and Normals

Supplemental Material #2

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POLARIMETRIC SHADING MATRIX FOR REAL SAMPLES
Estimated Polarimetric Shading Matrix $H$

Positive

Negative
Estimated Polarimetric Shading Matrix $\mathbf{H}$

Positive

Negative
Estimated Polarimetric Shading Matrix $H$

<table>
<thead>
<tr>
<th>Positive</th>
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</table>
Estimated Polarimetric Shading Matrix $H$
Estimated Polarimetric Shading Matrix $H$
EXTENDED FIGURES
Extended Version of Figure 4

Light polarization [degree]
0  30  60  90

Input polarimetric images

Camera polarization [degree]
0  30  60  90

Estimated polarimetric shading matrix

Positive

Estimated polarimetric shading matrix

Negative

: Diffuse  : Specular  : Diffuse + specular
Extended Version of Figure 5

- Camera
  - FLIR Grasshopper GS3-U3-120S6C-C
  - 35mm lens
- DLP projector
  - AAXAP450Pro, 450 lumen
Degree of diffuse exitant polarization as the function of refractive index and surface zenith angle
Extended Version of Figure 7

Diffuse DOP of incident light

Diffuse DOP of exitant light

Specular image

Estimated refractive index

Incident diffuse

Exitant diffuse

Specular

Exitant diffuse + specular

\[ \eta_1 = 1.52 \]
\[ \eta_2 = 1.83 \]
\[ \eta_3 = 2.07 \]

\[ \eta_1 = 1.49 \]
\[ \eta_2 = 1.46 \]
\[ \eta_3 = 1.49 \]

\[ \eta_1 = 2.02 \]
\[ \eta_2 = 1.98 \]
\[ \eta_3 = 2.00 \]

\[ \eta_1 = 1.49 \]
\[ \eta_2 = 1.47 \]
\[ \eta_3 = 1.48 \]
Extended Version of Figure 8

Polarimetric shading element

Weight map

Positive

Negative

Estimated pBRDF
Extended Version of Figure 8

Polarimetric shading element

Weight map

Positive

Negative

Estimated pBRDF
Extended Version of Figure 8

Polarimetric shading element

Weight map

Estimated pBRDF
Extended Version of Figure 8

Polarimetric shading element

Weight map

Positive

Negative

Estimated pBRDF
Extended Version of Figure 9

Diffuse component

Shading term

Fresnel term

Diffuse albedo
Extended Version of Figure 10

- Ground truth normals
- Structured-light normals
- Polarization normals
- Diffuse normals
- Diffuse/specular normals
Extended Version of Figure 11

The graph shows the relationship between the Value of S and $\theta_h$ (degree) for different values of Roughness. The x-axis represents $\theta_h$ in degrees, ranging from 0 to 80, and the y-axis represents the Value of S. Different line colors indicate various Roughness values: 0.10, 0.15, 0.20, 0.30, 0.50, and 0.90.
Extended Version of Figure 12

Positive

Real capture

[Best-fit simulation]
Cook-Torrance

[Best-fit simulation]
Our pBRDF
(near coaxial)

[Best-fit simulation]
Our pBRDF
(ideal coaxial)
Extended Version of Figure 12

Reconstruction vs. Photograph

Validation of coaxial assumption

<table>
<thead>
<tr>
<th>Diagonal elements</th>
<th>Non diagonal elements</th>
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<tbody>
<tr>
<td>0</td>
<td>0.05</td>
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<tr>
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</table>

Average PSNR

- CT
- Our pBRDF (near coaxial)
- Our pBRDF (coaxial)
Extended Version of Figure 13

**Refraction Index**

- Red: Est. 1.51, GT 1.50
- Green: Est. 1.73, GT 1.70
- Blue: Est. 1.98, GT 1.90

**Specular Roughness**

- Estimation: 0.21
- GT: 0.20

**Specular Coefficient**

- Estimation: 3.14
- GT: 3.00
Extended Version of Figure 13

Ground truth normals  Rough base normal  Estimated normals  Normal errors

Normal error (radian)
Extended Version of Figure 14

Diffuse albedo
Specular roughness
Specular coefficient
Refractive index
Normals
Structured light
Polarimetric rendering
Photograph
Extended Version of Figure 14

Material #1

Material #2

Material #3

Material #4
Extended Version of Figure 14

Diffuse albedo
Specular roughness
Specular coefficient
Refractive index
Normals
Structured light
Polarimetric rendering
Photograph
Extended Version of Figure 14

Material #1

Material #2

Material #3

Material #4
Extended Version of Figure 14

- Diffuse albedo
- Specular roughness
- Specular coefficient
- Refractive index
- Normals
- Structured light
- Polarimetric rendering
- Photograph
Extended Version of Figure 14

<table>
<thead>
<tr>
<th>Material #1</th>
<th>Material #2</th>
<th>Material #3</th>
<th>Material #4</th>
<th>Material #5</th>
<th>Material #6</th>
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</table>
Extended Version of Figure 14

- Diffuse albedo
- Specular roughness
- Specular coefficient
- Refractive index
- Normals
- Structured light
- Polarimetric rendering
- Photograph
Extended Version of Figure 14

Material #1

Material #2
Extended Version of Figure 14

Weight

Positive

Negative
Extended Version of Figure 15

Real object (Acrylic paint)
Extended Version of Figure 17

Object

Ground truth

[Kadambi et al.]

Our normals
Extended Version of Figure 18

Diffuse albedo

Material #1

Material #2

Material #3

Material #4

[Miyazaki et al.] Without polarization

Rendering

Structured light

Normal

Material #1

Material #2

Material #3

Material #4

Without polarization

Ours
Extended Version of Figure 18

Normal

Appearance

Rendering

[Miyazaki et al.] Without polarization Ours

Diffuse albedo

St. Peter Point light

Material

St. Peter Point light

Diffuse albedo

St. Peter Point light

Diffuse albedo

St. Peter Point light
Extended Version of Figure 19

Diffuse

[Aittala et al.] Ours

Specular

Our rendering

Original illum.

Novel illum.

Reference photograph

Our rendering
Extended Version of Figure 20

Reference normals

Rough normals without noise

Our reconstruction

Input

Rough normals with noise

Our reconstruction

Input
## Extended Version of Figure 20

<table>
<thead>
<tr>
<th></th>
<th>Without noise/with noise/GT</th>
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<tbody>
<tr>
<td><strong>Diffuse albedo</strong></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>1.18/1.15/1.20</td>
</tr>
<tr>
<td>Green</td>
<td>1.17/1.19/1.20</td>
</tr>
<tr>
<td>Blue</td>
<td>1.16/1.25/1.20</td>
</tr>
<tr>
<td><strong>Refractive index</strong></td>
<td>1.29/1.36/1.30</td>
</tr>
<tr>
<td></td>
<td>1.63/1.83/1.65</td>
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<tr>
<td></td>
<td>1.96/2.33/2.00</td>
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<tr>
<td><strong>Roughness</strong></td>
<td>0.20/0.19/0.20</td>
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<tr>
<td><strong>Specular coefficient</strong></td>
<td>6.22/3.73/5.00</td>
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<tr>
<td><strong>Surface normals</strong></td>
<td>Average deviation angles from GT: 5.84/6.39 deg.</td>
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Extended Version of Figure 21

- Original illum.
- Novel illum.

<table>
<thead>
<tr>
<th>Reference photograph</th>
<th>Our rendering (# of materials: 1)</th>
<th>Our rendering (# of materials: 2)</th>
<th>Our rendering (# of materials: 3)</th>
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