Appearance Modeling & Physically Based Rendering

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About myself

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Postdoc @ ETHZ
Since 2016: Asst. prof @ EPFL
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Light transport in the real world

- Indirect light
- Direct light
- Shadow
- Caustic
- Volumetric scattering
- Glossy reflections
Light Transport 101

\[ \int_{S^2} \cdot d\omega \]

\[ = \int_{S^2} d\omega = \text{Final pixel color} \]
Path Tracing – illustrated

\[ \int_{S^2} \int_{S^2} \int_{S^2} \int_{S^2} \]
Measuring a material

Material sample
Costs of rendering

“.. if we'd rendered [Gravity] on a single processor instead of having a room full of computers, we would have had to start rendering in 5000 BC to finish in time to deliver the film. At the dawn of Egyptian civilisation.”

Tim Webber, Gravity VFX supervisor
Random algorithms: a bad match for today’s processors

NVIDIA

Intel
Resolution requirements

Stereo

High resolution

High frame rate
Use of coherence
Use of coherence
Navigating the space of light paths
Manifold walks in production
Materials

- Finished wood
- Silk Satin
- Steam
- Rough metal
- Snow
- Skin
- Pattern Glass
- Iridescence
Challenges in Material Appearance Modeling

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Structural description</th>
<th>Analytic model</th>
<th>User intent</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td>“shiny vivid green lacquer with a smooth pearlescent glow”</td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td>“make the material less shiny”</td>
</tr>
<tr>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
<td>“add more grain to the diffuse reflection”</td>
</tr>
</tbody>
</table>

Layer 1
- \( \mu = 0.05 \text{ mm} \)
- \( \eta = 1.35 \)
- \( \sigma_s = [0.4, 0.33, 0.2] \)

Layer 2
- ...
Machine learning + rendering
CS-328: Numerical Methods for Visual Computing

- Signal Processing
- Geometry processing
- Rendering
- Computer Vision
- Computational Photography
- Dynamics
CS-328: Numerical Methods for Visual Computing

Floating point fundamentals
Writing efficient numerical code
Solving large systems of equations
Numerical optimization
Interpolating scattered data
Numerical integration
Monte Carlo sampling
Dimensionality reduction
CS-440: Advanced Computer Graphics

1st place (2015): Tizian Zeltner
CS-440: Advanced Computer Graphics

1st place (2017): Quentin Kuenlin
CS-440: Advanced Computer Graphics

1st place (2018): Hannes Hergeth
Visual Computing Seminar

What?
- computational photography
- computer graphics
- geometry processing
- architecture
- human–computer interaction
- computer vision
- signal processing
- color science & printing

Why?
- shared interests
- learn about fancy tools
- interact!

Who?
- faculty, students, postdocs, guests

http://rgl.epfl.ch/courses/VCS16f