Full-dimensional Sampling and Analysis of BSSRDF

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Overview

Full-dimensional (8-D) BSSRDF completely expresses various light interactions on object surface such as reflection and subsurface scattering. However, it is difficult to sample full-dimensional BSSRDF because it requires many illuminations and observations from various directions. There are many research which approximated BSSRDF as a low-dimensional function by only considering the medium as homogeneous or assuming isotropic scattering. Therefore, in this research, we show a novel sampling and analyzing method for full-dimensional BSSRDF of real scenes. We sample the BSSRDF using a polyhedral mirror system to place a lot of virtual cameras and projectors. In addition, we propose a method of decomposition of BSSRDF into isotropic and anisotropic components for scattering analysis. We show the empirical characteristics of subsurface scattering inside a real medium by analyzing sampled full-dimensional BSSRDF.

Full-dimensional BSSRDF

BSSRDF represents light interaction such as subsurface scattering. This phenomenon is parameterized by incident position $x_i$, incident angle $\omega_i$, outgoing position $x_o$, and outgoing angle $\omega_o$.

$$\text{BSSRDF: } f(x_i, \omega_i, x_o, \omega_o)$$

### Requirements:
- Surrounding the target object with a lot of cameras and projectors
- Cameras/projectors must be distributed with uniform density at constant distance

### Our solution:

**Turtleback reflector**

Polyhedral mirror which distributes 48 virtual cameras and projectors on a hemisphere

Sampling positions on a hemisphere

**Sampled BSSRDF and its visualization**

We sampled BSSRDF of three different types of target materials; epoxy resin (optically thin), rubber eraser (optically dense) and marble (inhomogeneous). We also visualize sampled BSSRDF as low dimensional slices.

Captured images with fixed illumination \((\theta_i, \phi_i)=(44.9^\circ, 74.8^\circ)\) \((g=4.5)\)

**Decomposition of BSSRDF into isotropic/anisotropic components**

We decompose sampled BSSRDF into isotropic (angular independent) and anisotropic (angular dependent) components for scattering analysis.

**Principle:** Scattering consists of anisotropic and isotropic components

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\text{Both components} = \text{Anisotropic component} + \text{Isotropic component}
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**Decomposed results:**

Rubber eraser  Marble

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