Fast Separation of Direct and Global Images Using High Frequency Illumination

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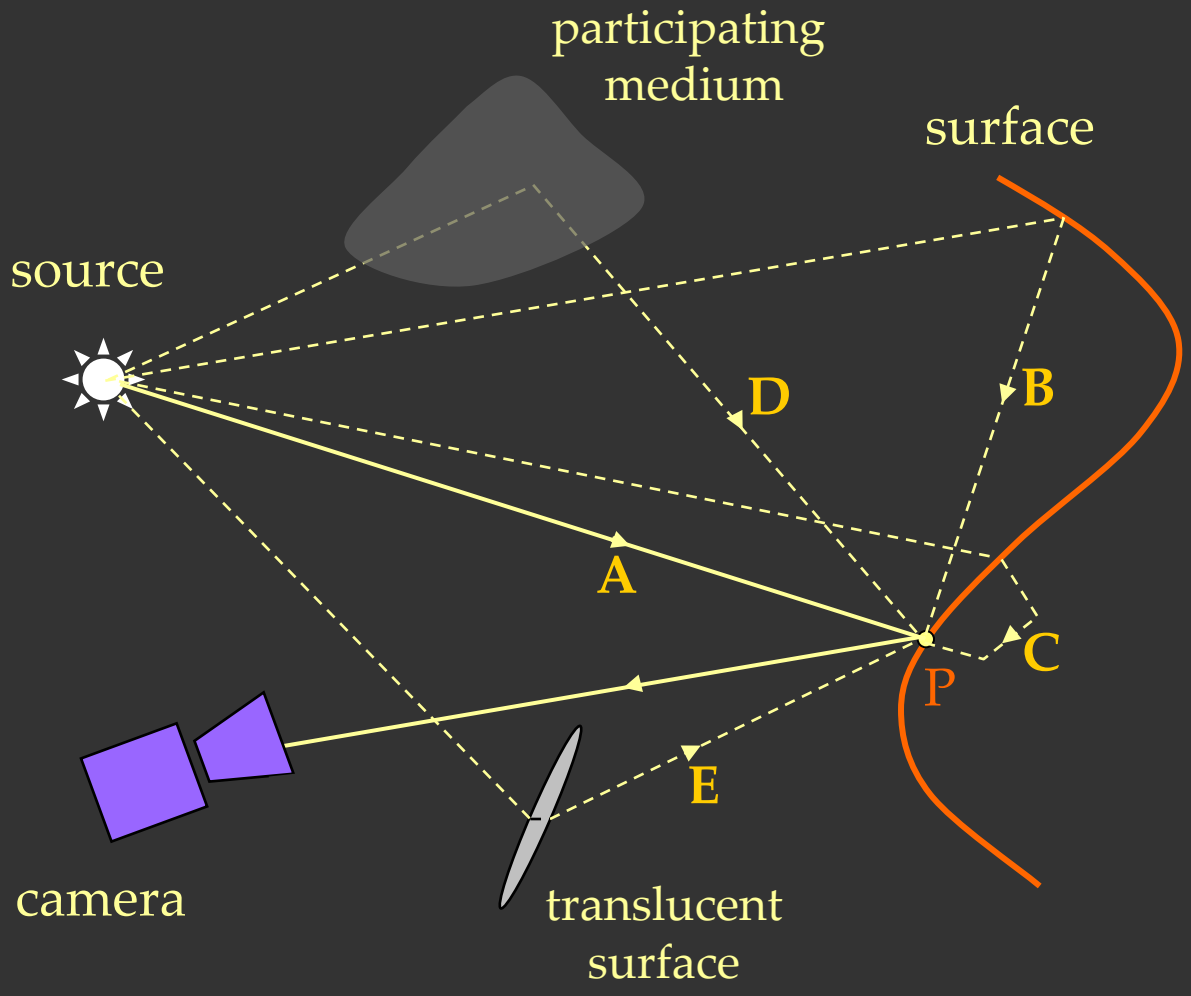
Direct and Global Illumination



A : Direct

B : Interrelection

C : Subsurface

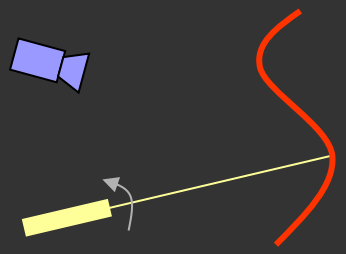
D : Volumetric

E : Diffusion

Related Work

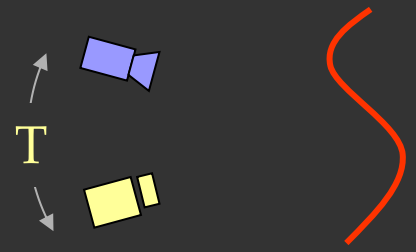
- Inverse Light Transport

  (Seitz et. al., ICCV 05)



- Dual Photography

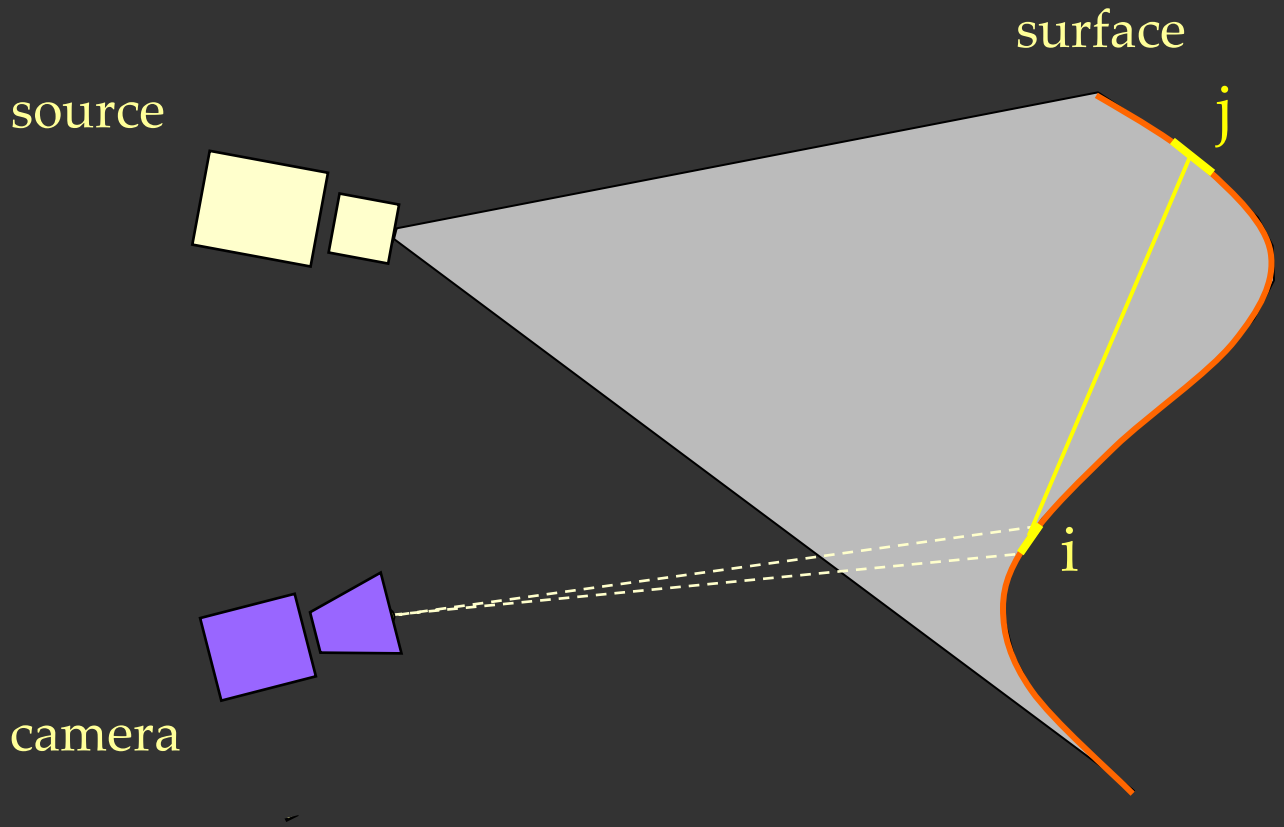
  (Sen et. al., Siggraph 05)



Fast Separation of Direct and Global Images

- Create Novel Images of the Scene
- Enhance Brightness Based Vision Methods
- New Insights into Material Properties

Direct and Global Components: Interreflections



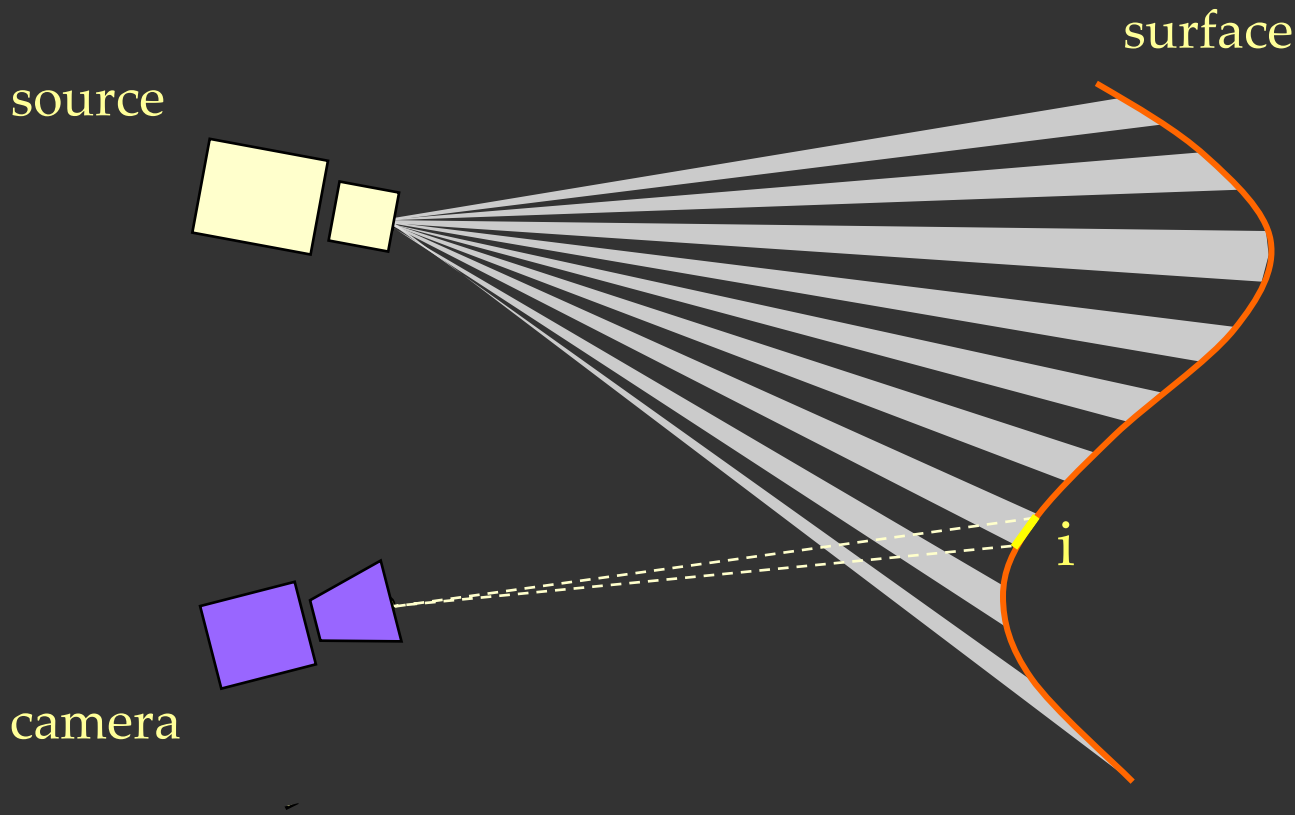
$$L[c,i] = L_d[c,i] + L_g[c,i]$$

radiance direct global

$$L_g[c,i] = \sum_P A[i,j]\, L[i,j]$$

BRDF and geometry

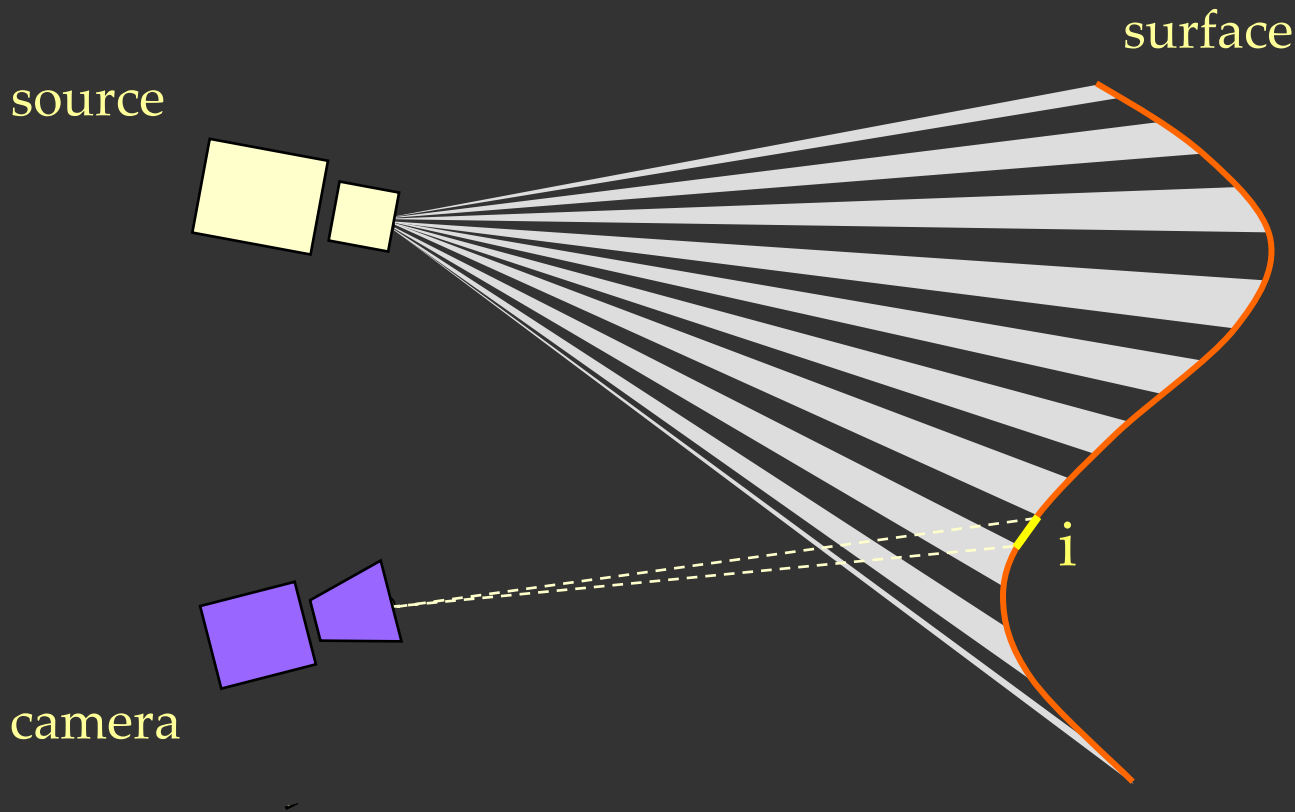
High Frequency Illumination Pattern



$$L^{+}[c,i] = L_d[c,i] + \alpha L_g[c,i]$$

fraction of activated source elements

High Frequency Illumination Pattern



$$L^{+}[c,i] = L_d[c,i] + \alpha\, L_g[c,i]$$

$$L^{-}[c,i] = (1-\alpha)\, L_g[c,i]$$

fraction of activated source elements

Example

Separation from Two Images

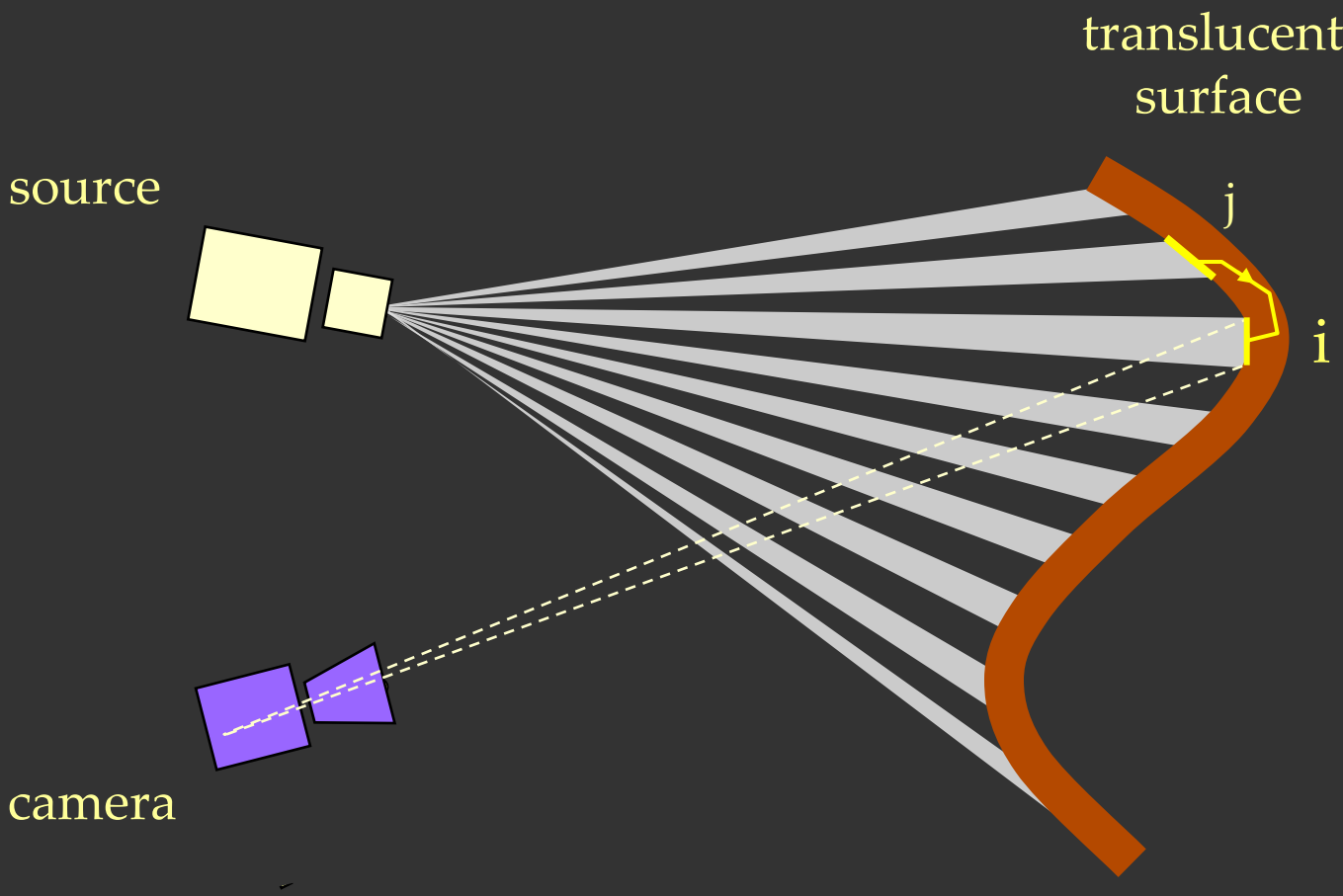
$\alpha = \frac{1}{2}$:

$$L_d = L_{\max} - L_{\min}, \quad L_g = 2L_{\min}$$

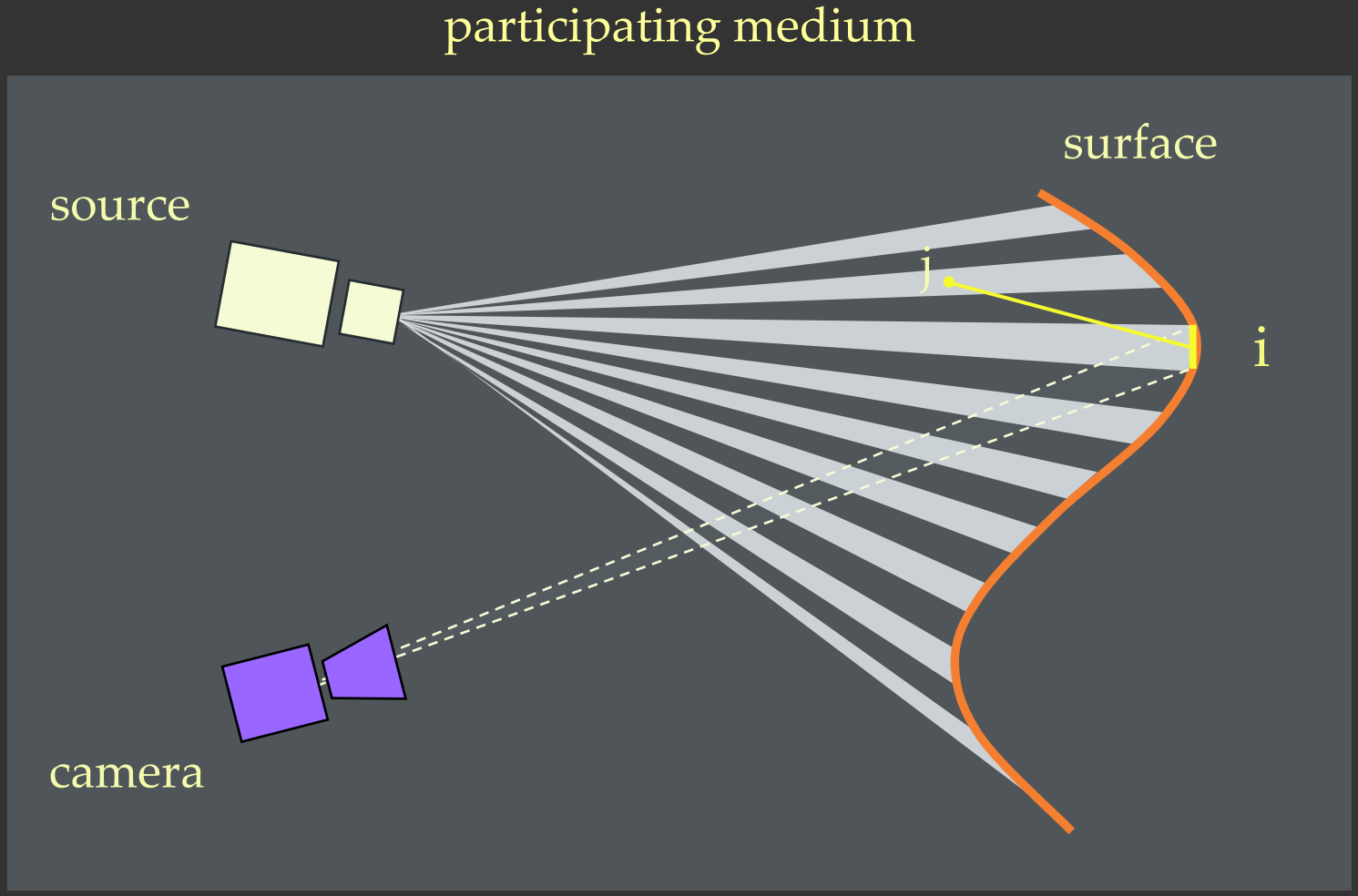
direct

global

Other Global Effects: Subsurface Scattering



Other Global Effects: Volumetric Scattering



Diffuse
Interreflections

Specular
Interreflections

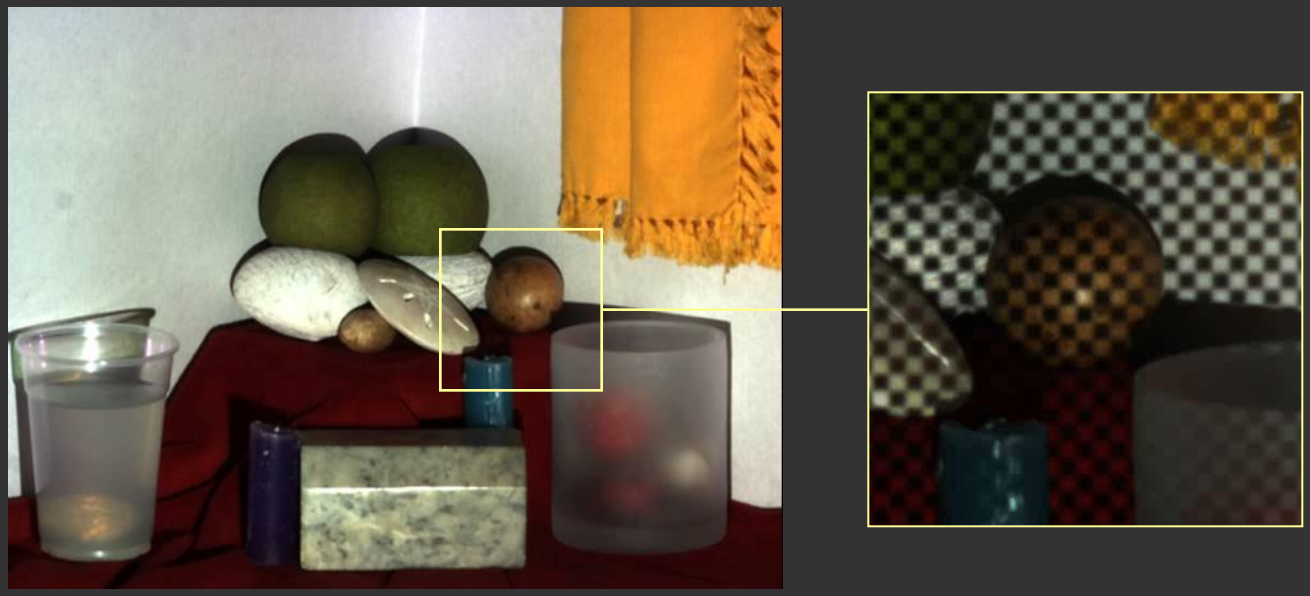
Diffusion

Volumetric
Scattering

Subsurface
Scattering

Scene

Scene



Direct

Global

Real World Examples:

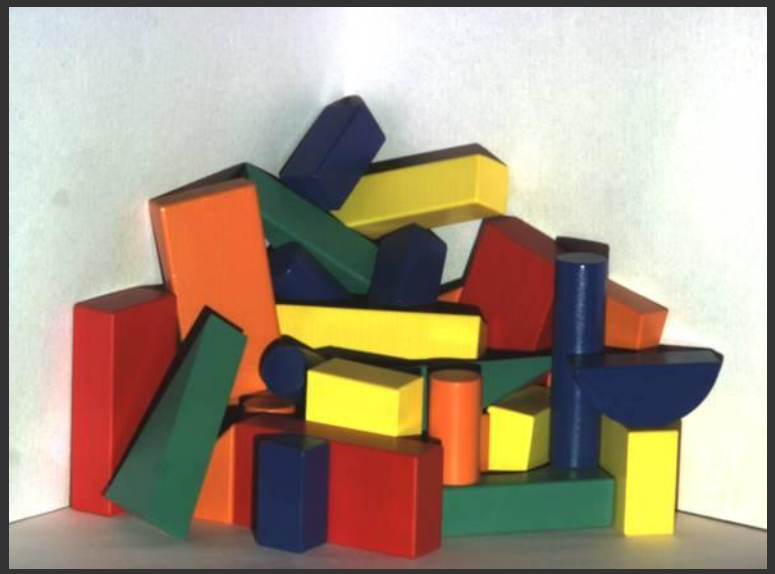
Can You Guess the Images?

Eggs: Diffuse Interreflections

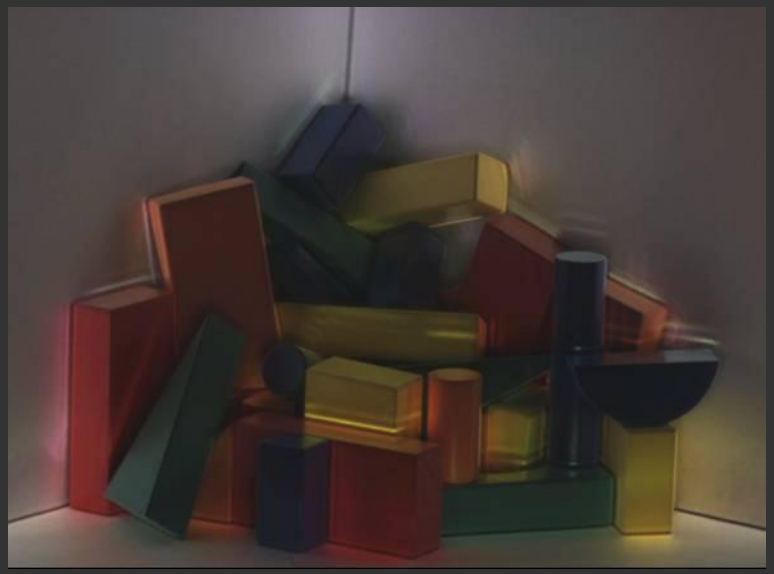
Direct

Global

Wooden Blocks: Specular Interreflections

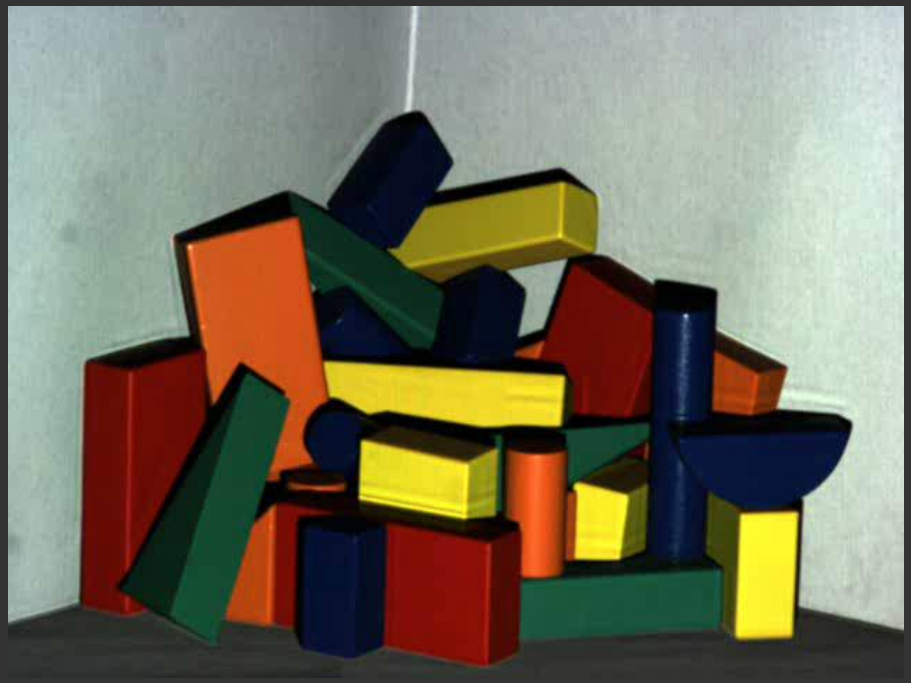


Direct

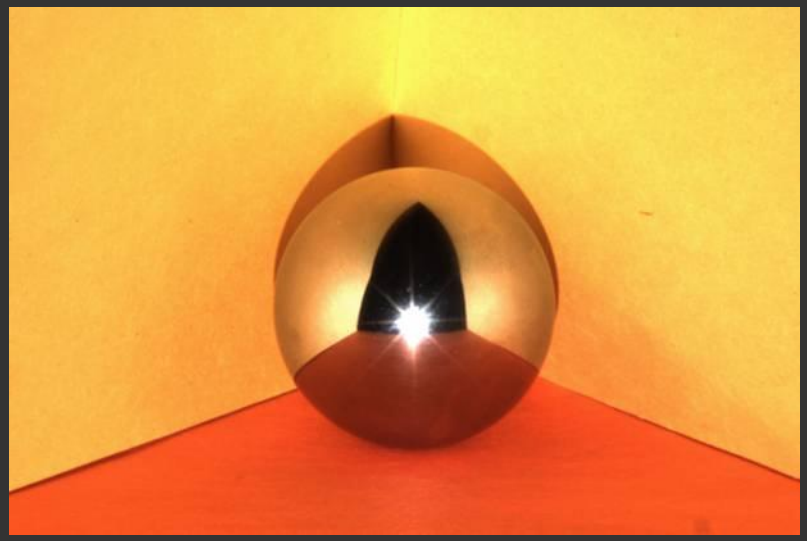


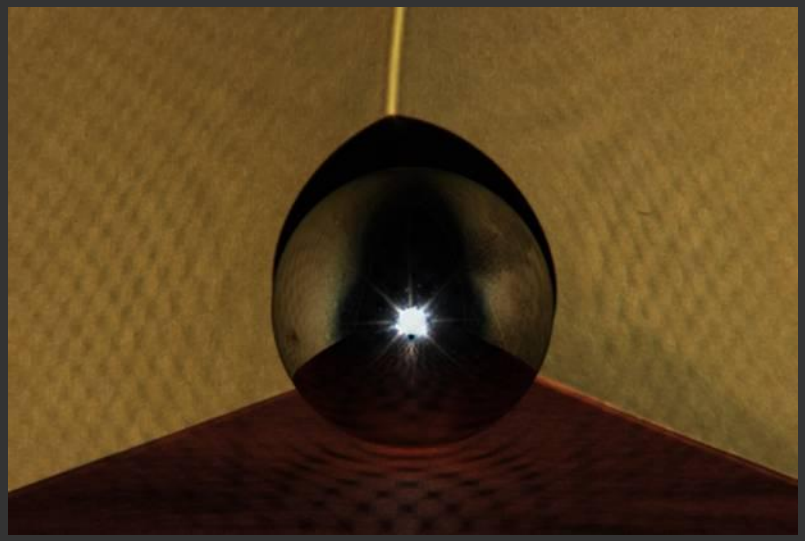
Global

Novel Images

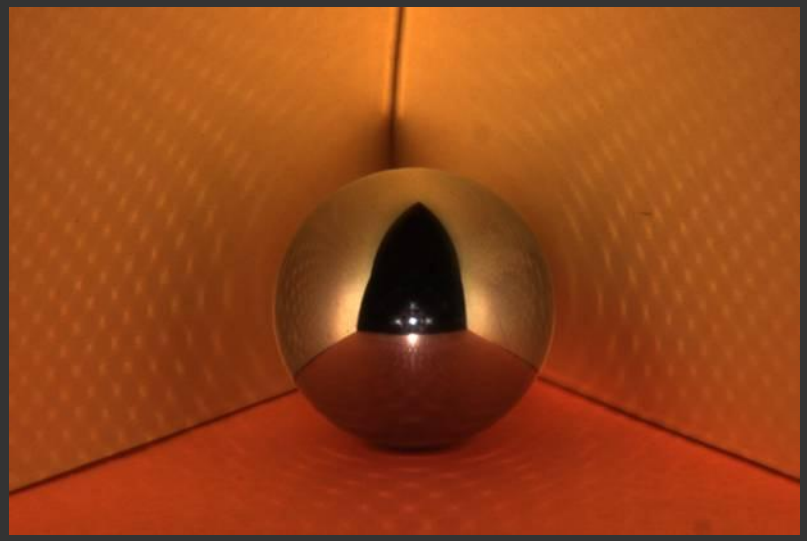


Mirror Ball: Failure Case





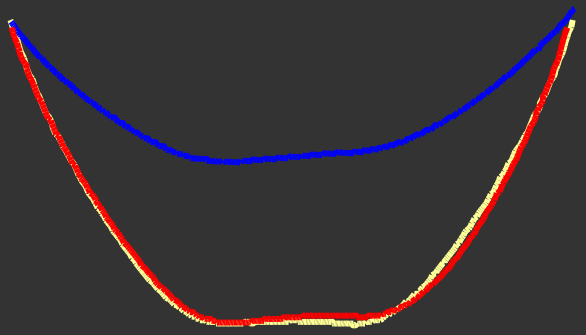
Direct



Global

Photometric Stereo using Direct Images

Shape



Nayar et al., 1991

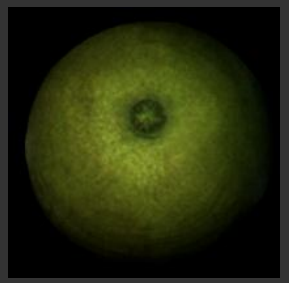
Kitchen Sink: Volumetric Scattering

Volumetric Scattering:
Chandrasekar 50, Ishimaru 78

Direct

Global

Novel Image



Peppers: Subsurface Scattering

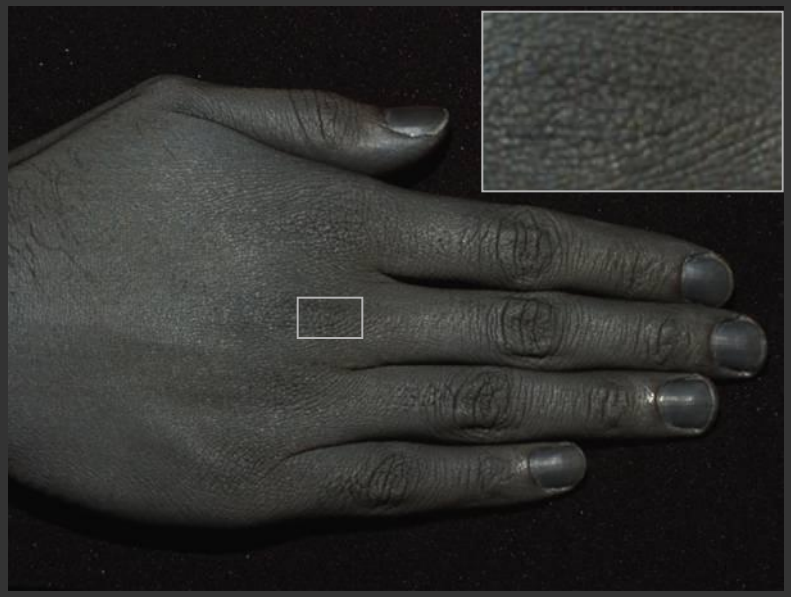
Direct

Global

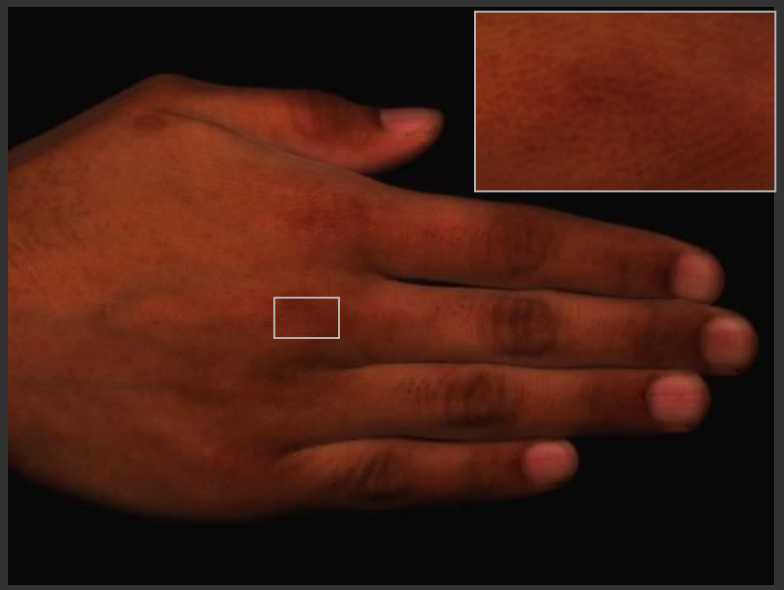
Novel Images

Hand

Skin: Hanrahan and Krueger 93, Uchida 96, Haro 01, Jensen et al. 01, Cula and Dana 02, Igarashi et al. 05, Weyrich et al. 05



Direct



Global

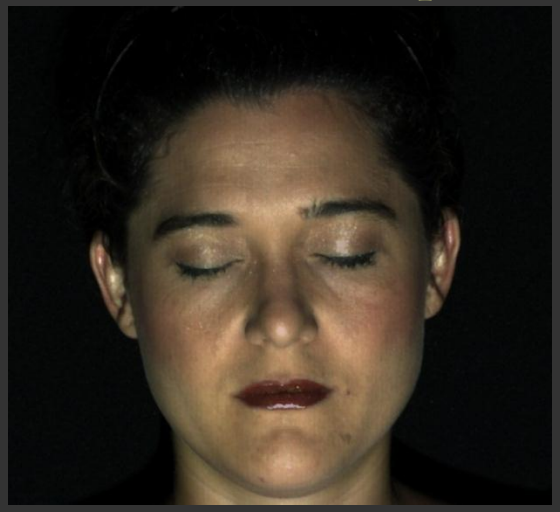
Face: Without and With Makeup

Without Makeup

Direct

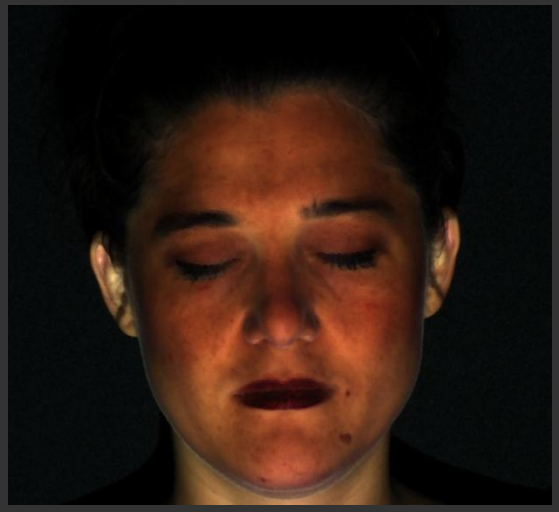
Global

With Makeup



Direct

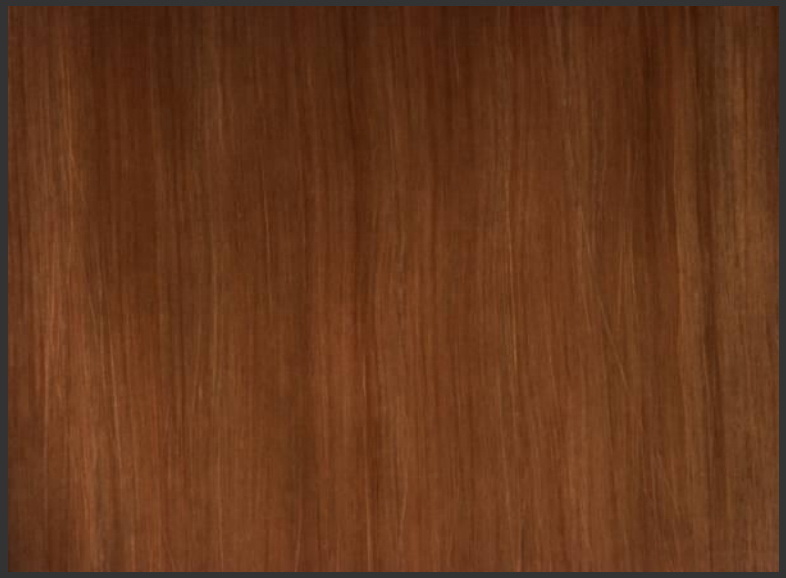
Global



Blonde Hair

Hair Scattering: Stamm et al. 77, Bustard and Smith 91, Lu et al. 00 Marschner et al. 03

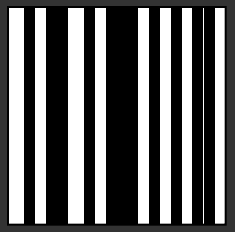
Direct



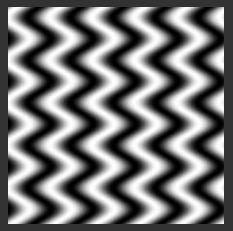
Global

Variants of Separation Method

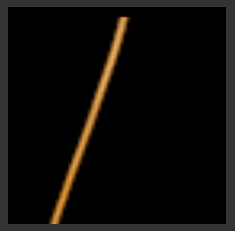
- Coded Structured Light



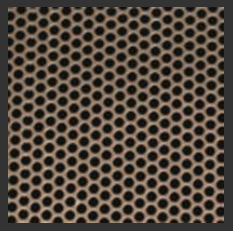
- Shifted Sinusoids



- Shadow of Line Occluder

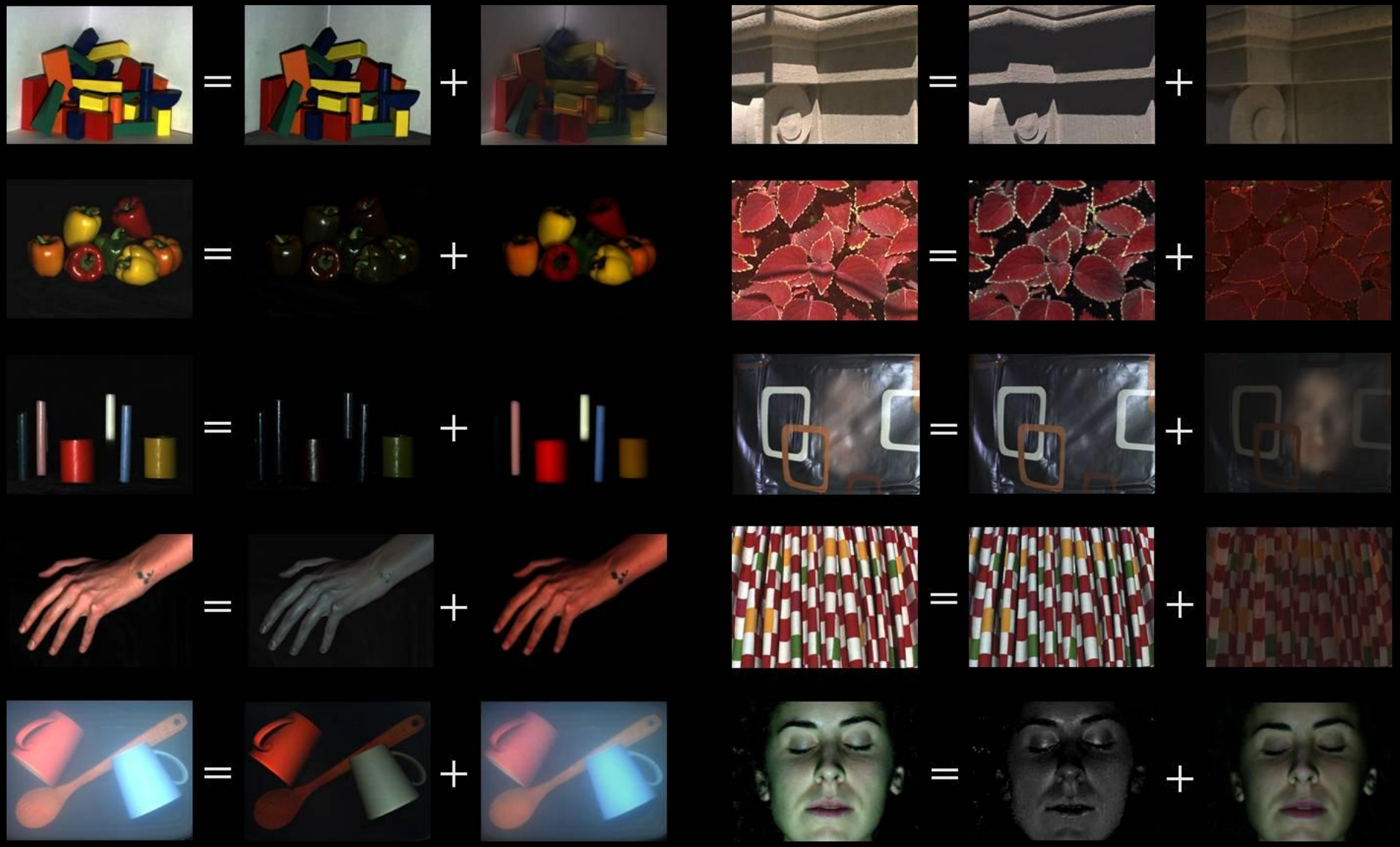


- Shadow of Mesh Occluders



Summary

- Fast and Simple Separation Method
- No Prior Knowledge of Material Properties
- Wide Variety of Global Effects
- Implications:
    - Generation of Novel Images
    - Enhance Computer Vision Methods
    - Insights into Properties of Materials



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