

Fast Separation of Direct and Global Images Using High Frequency Illumination

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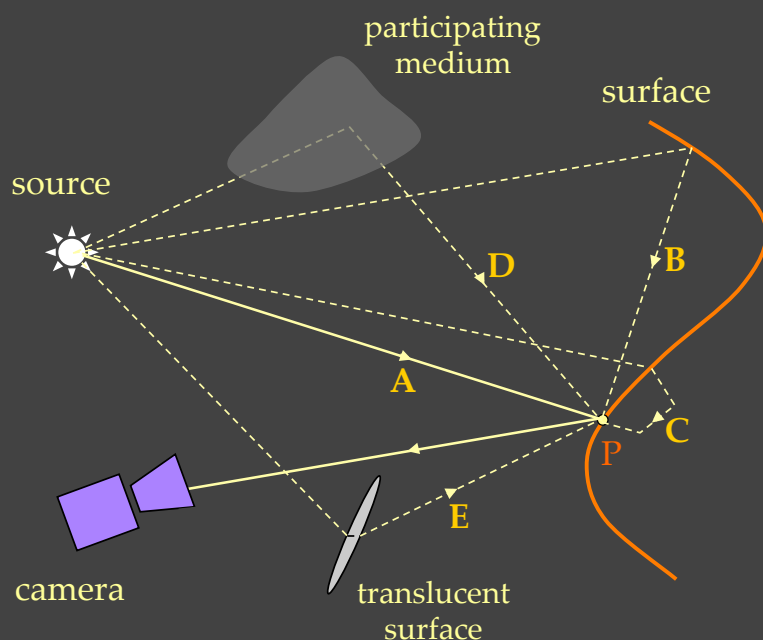
MERL

SIGGRAPH Conference

Boston, July 2006

Support: ONR, NSF, MERL

Direct and Global Illumination



A : Direct

B : Interreflection

C : Subsurface

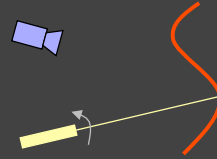
D : Volumetric

E : Diffusion

Related Work

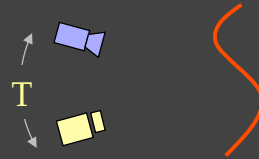
- Inverse Light Transport

(Seitz et. al., ICCV 05)



- Dual Photography

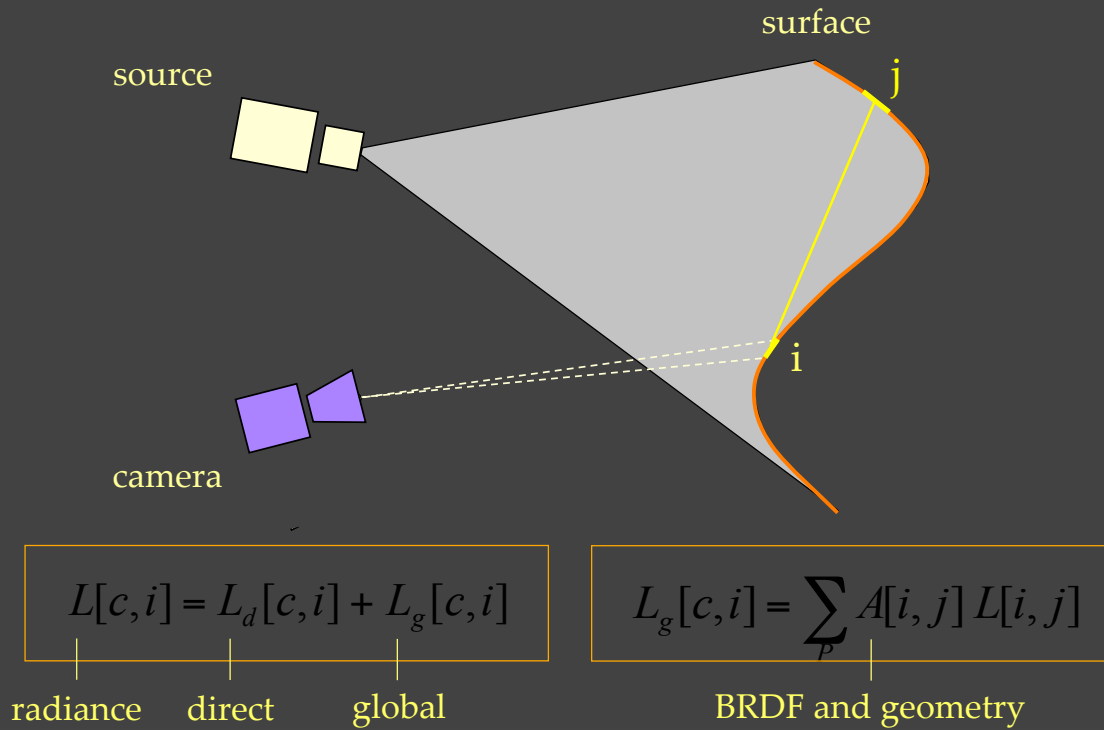
(Sen et. al., Siggraph 05)



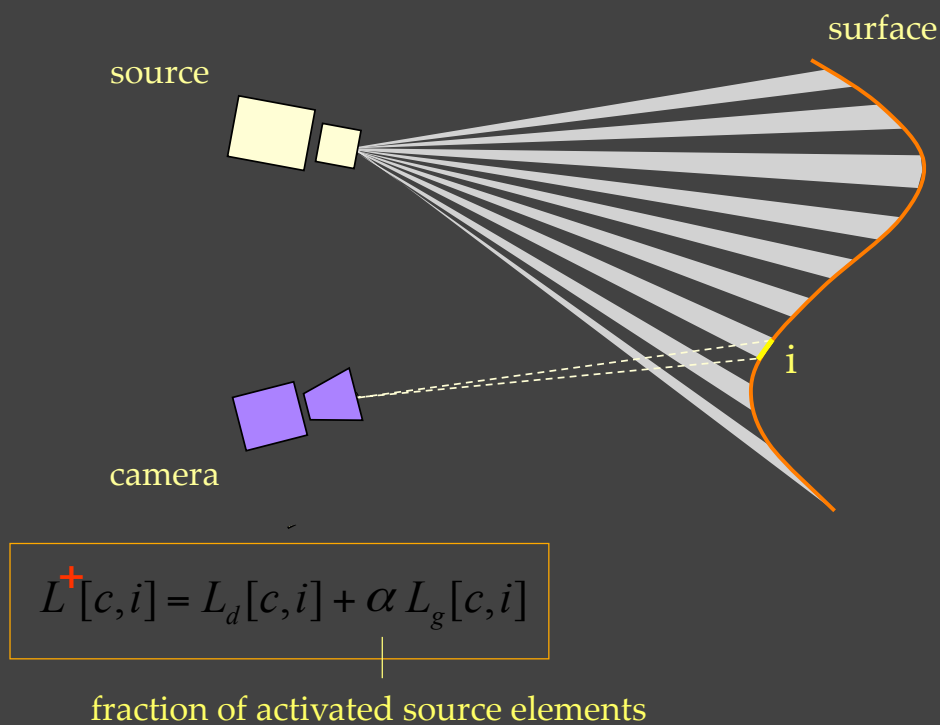
Fast Separation of Direct and Global Images

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

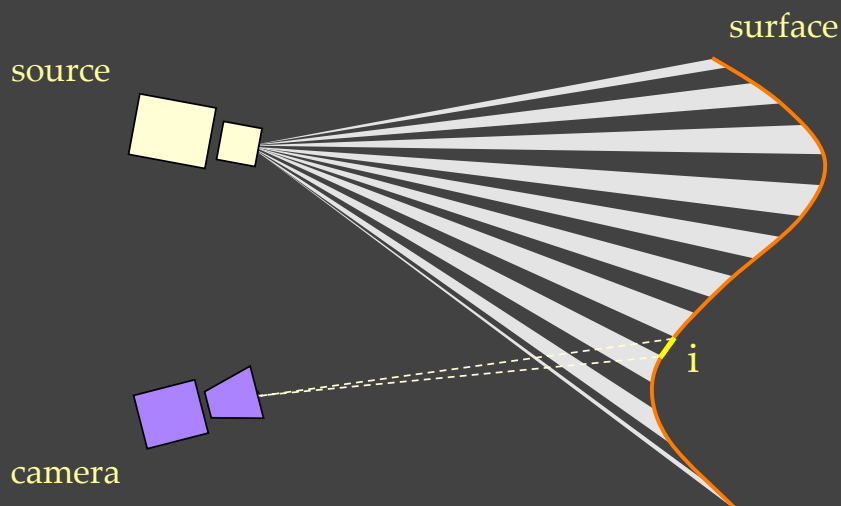
Direct and Global Components: Interreflections



High Frequency Illumination Pattern



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

Separation from Two Images

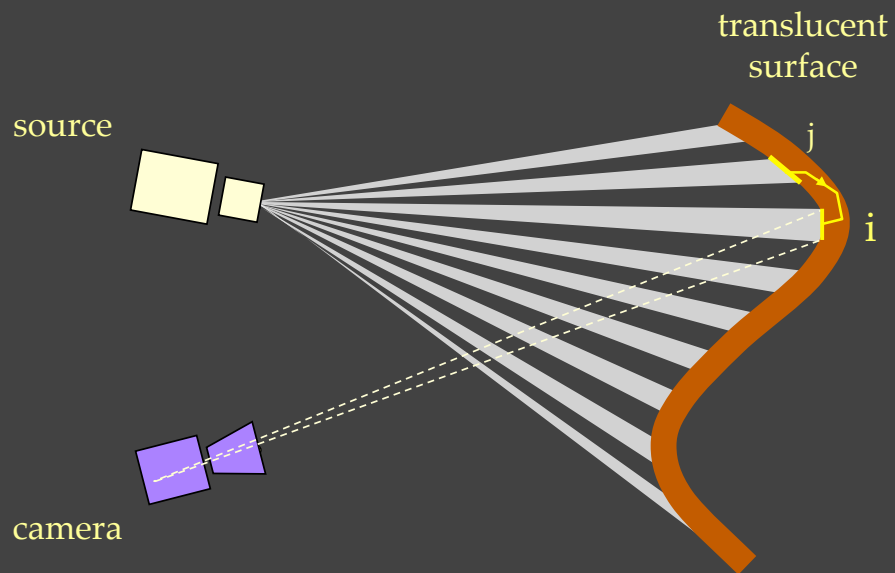
$$\alpha = \frac{1}{2}:$$

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

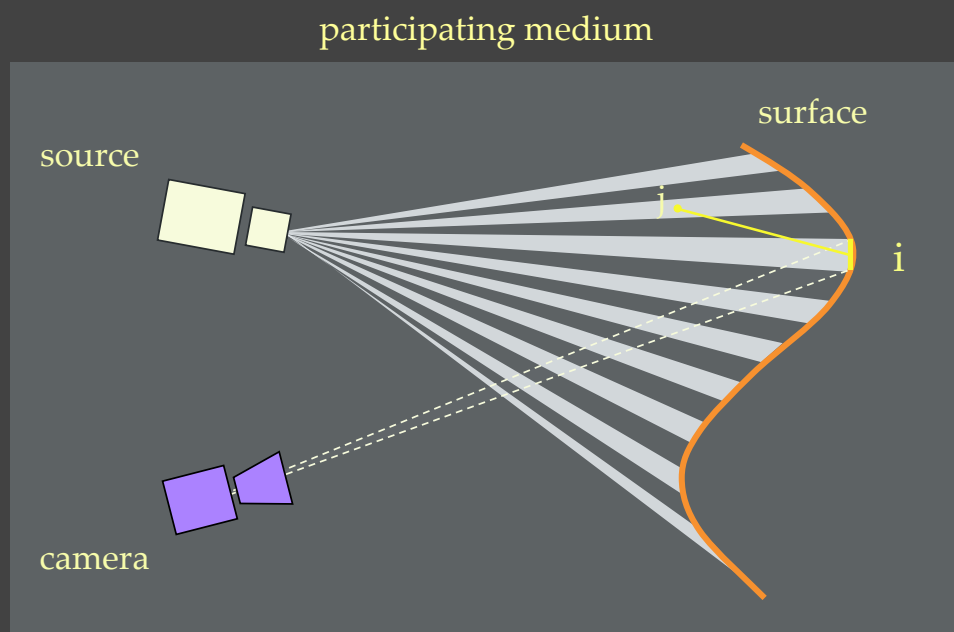
direct

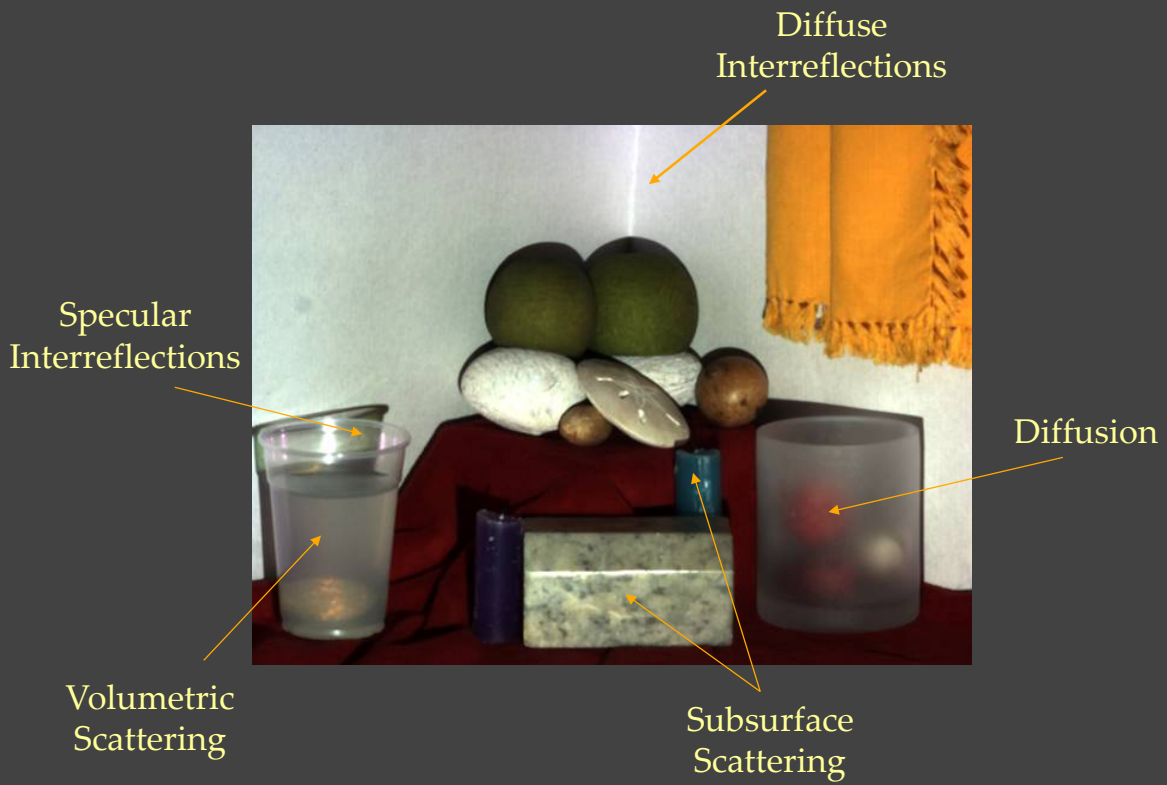
global

Other Global Effects: Subsurface Scattering



Other Global Effects: Volumetric Scattering

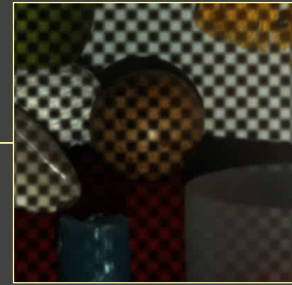
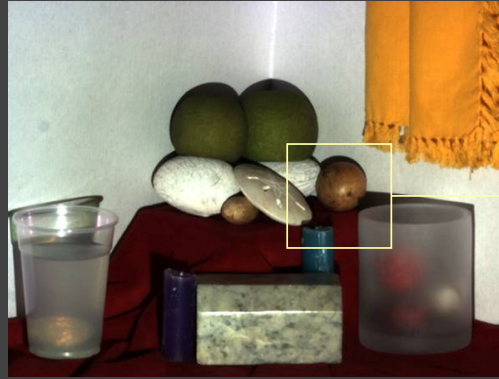




Scene



Scene



Direct



Global

Real World Examples:

Can You Guess the Images?

Eggs: Diffuse Interreflections



Direct



Global

Wooden Blocks: Specular Interreflections

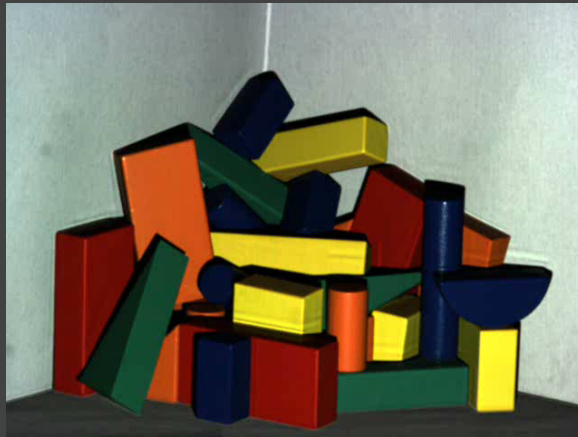


Direct

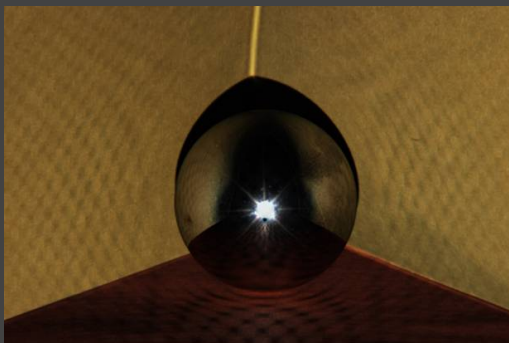
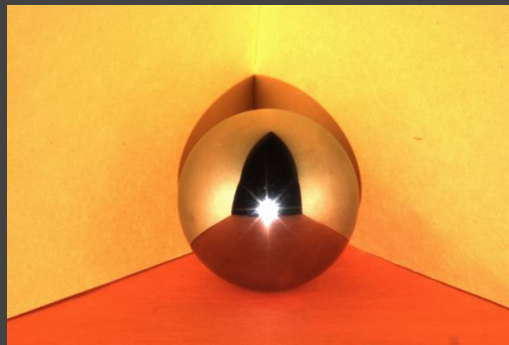


Global

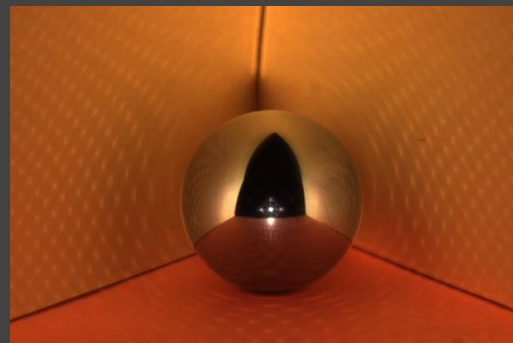
Novel Images



Mirror Ball: Failure Case

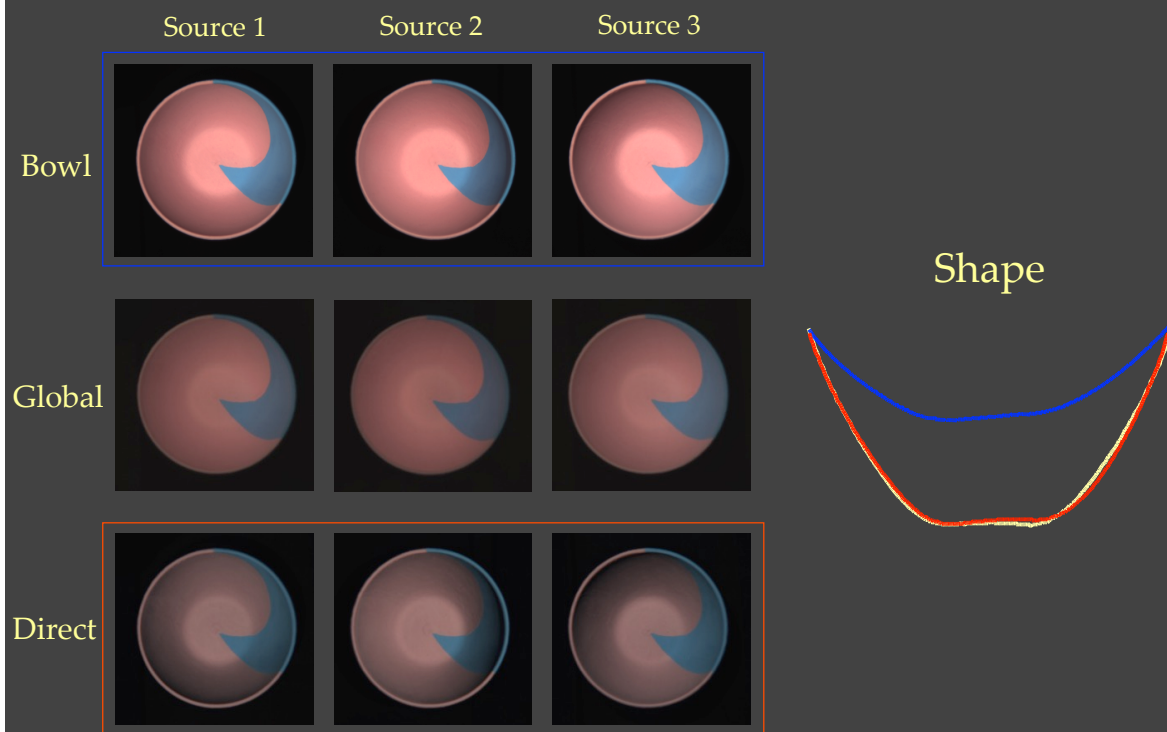


Direct



Global

Photometric Stereo using Direct Images



Nayar et al., 1991

Kitchen Sink: Volumetric Scattering



Volumetric Scattering:
Chandrasekar 50, Ishimaru 78

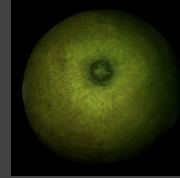


Direct



Global

Novel Image



Peppers: Subsurface Scattering



Direct



Global

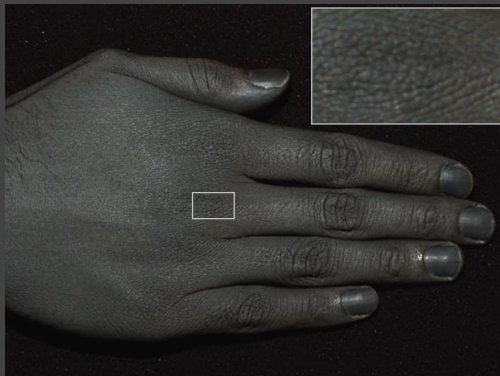
Novel Images



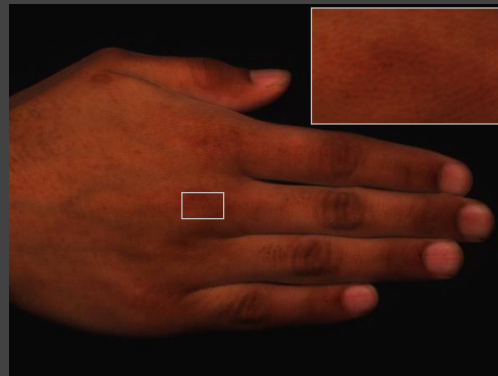
Hand



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

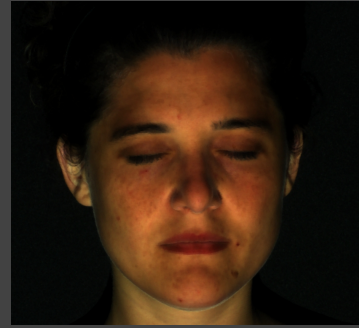
Without Makeup



Direct



Global



With Makeup



Direct



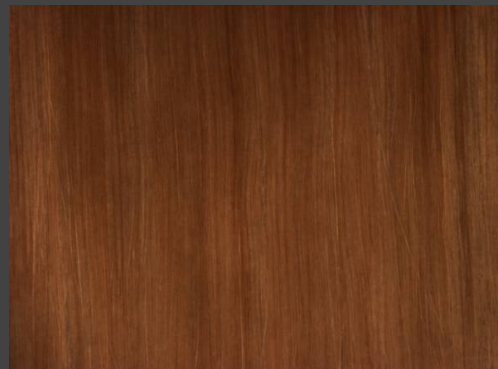
Global



Blonde Hair



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

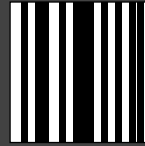


Direct

Global

Variants of Separation Method

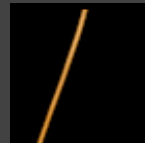
- Coded Structured Light



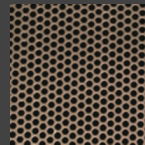
- Shifted Sinusoids



- Shadow of Line Occluder

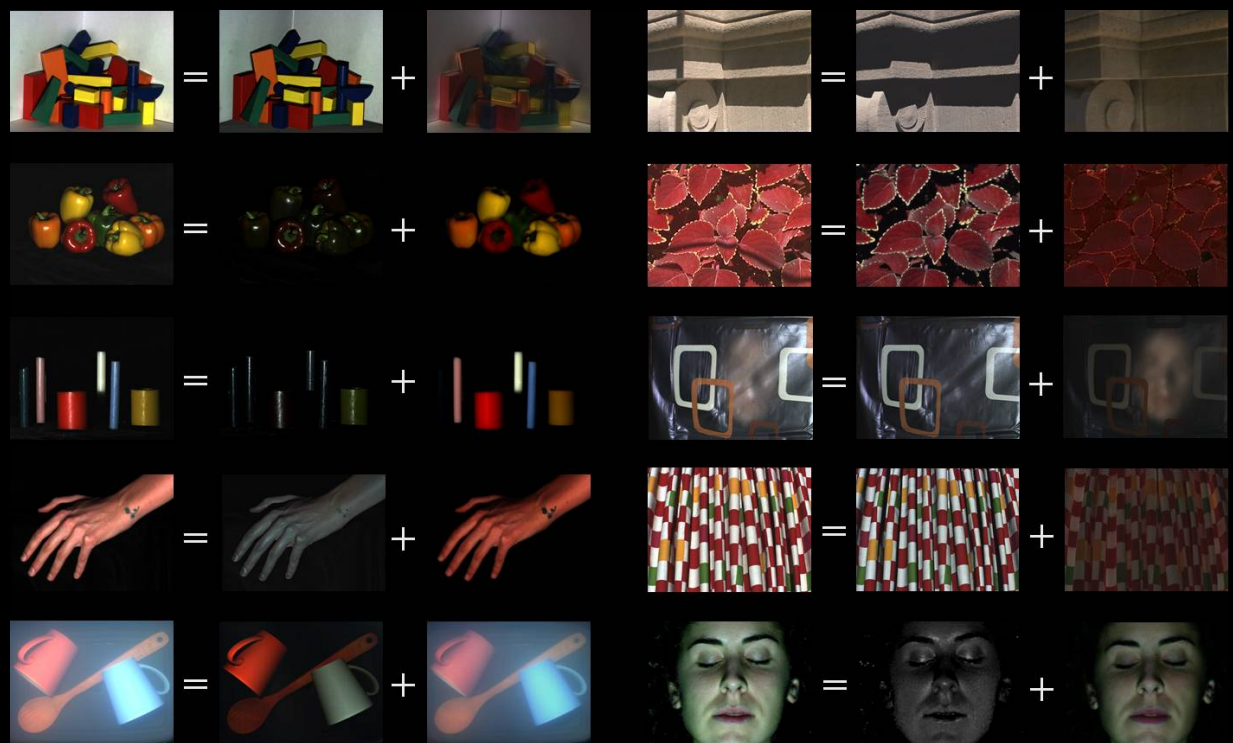


- Shadow of Mesh Occluders



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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