Separating Illumination and Surface Spectral from Multiple Color Signals

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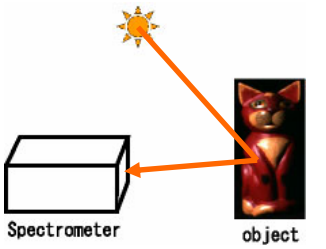
To separate a color signal into its components: illumination spectral power distribution and surface spectral reflectance, is an important issue on computer vision. And to separate, we use spectral power distribution, we proposed a minimization technique that, unlike the existing methods, uses multiple color signals. In our implementation, we introduce three different approaches: first, color signals obtained from two different surface reflectance lit by an identical illumination spectral power distribution; second, color signal from an identical surface reflectance lit by different illumination spectral power distributions; and third, color signals from identical surface reflectance but with different types of reflection components (diffuse and specular reflectance) lit by identical illumination spectral power distribution. Using multiple color signals can improve the robustness of the estimation, since we can obtain more constraints in the input data.

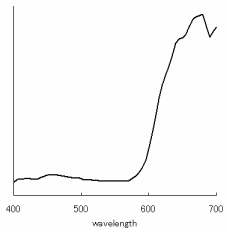
Publication

1. A. Ikari, Robby T.Tan and K. Ikeuchi, “Separating Illumination and Surface Spectral from Multiple Color Signals”, Asian Conference on Computer Vision, 2004, p264-269.

Single point approach:

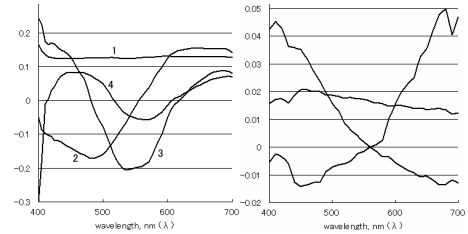


Equipment



Obtained spectral

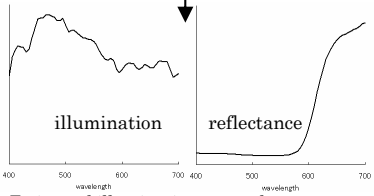
Illumination and reflectance basis function



$$I(\lambda) \approx \sum_{i=1}^{m} e_i E_i(\lambda) \sum_{j=1}^{n} s_j S_j(\lambda)$$

$$\sum_{\lambda} \left\{ I(\lambda) - \sum_{i=1}^{m} e_i E_i(\lambda) \sum_{j=1}^{n} s_j S_j(\lambda) \right\}^2$$

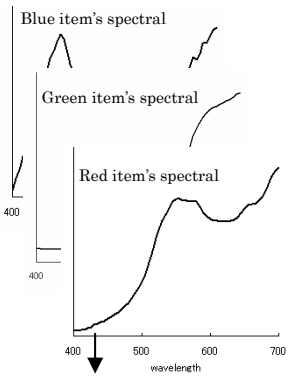
Minimize the difference between obtained spectral and estimated spectral.



Estimated illumination spectral power distribution and surface spectral reflectance.

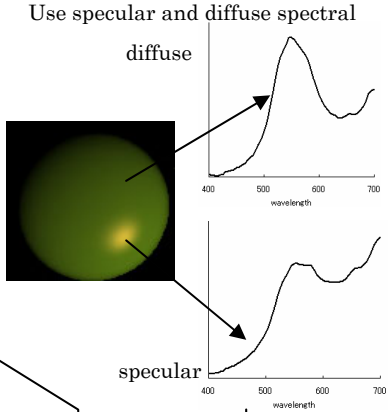
Multi point approach:

Use multi spectral distribution



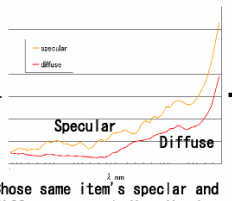
$$\sum_{p=1} \sum_{\lambda} \left\{ I_p(\lambda) - \sum_{i=1}^{m} e_i E_i(\lambda) \sum_{j=1}^{n} s_{p,j} S_j(\lambda) \right\}^2$$

Use specular and diffuse spectral

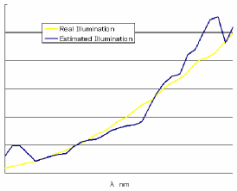


$$I_{specular}(\lambda) - kI_{diffuse}(\lambda) \cong \sum_{i=1}^{m} e_i E_i(\lambda)$$

Multi spectral image.
Each point has a spectral distribution.



Chose same item's specular and diffuse spectral distribution.



Estimate an illumination distribution.

Estimated surface spectral reflectance image.
Each point has a spectral reflectance.