

Note: These lecture notes are still rough, and have only have been mildly proofread.

15.1 Colorspaces- continued

Color - Distribution of spectral energy over wavelength.

15.1.1 RGB

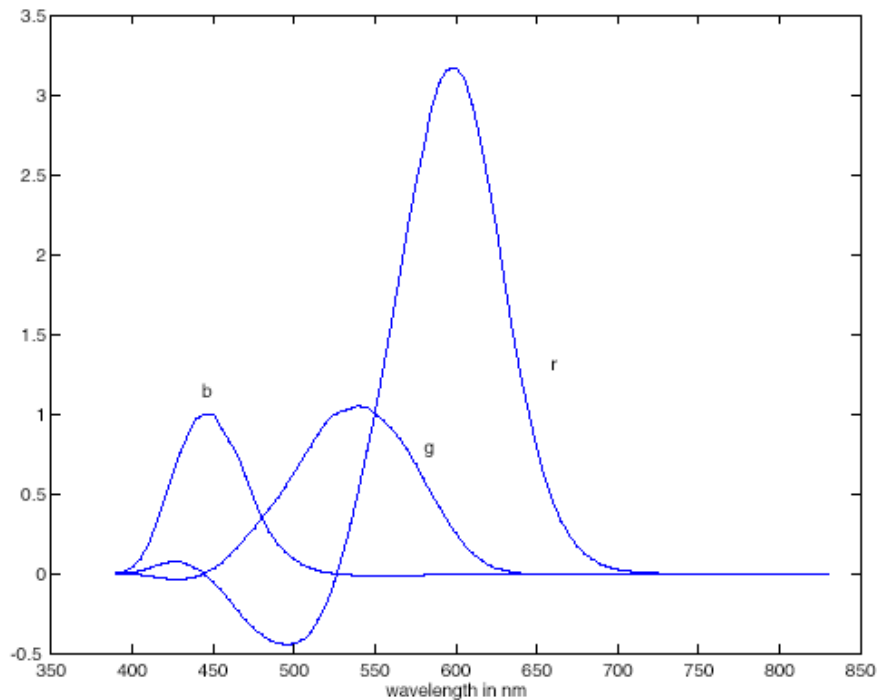


Figure 15.1. Color matching function of RGB

- Additive color scheme.
- R,G,B - Primary colors covering the visible spectrum
- Also, note the negative matching values, it means that some colors cannot be written as a combination of red, green, and blue illuminants

Color matching Experiment

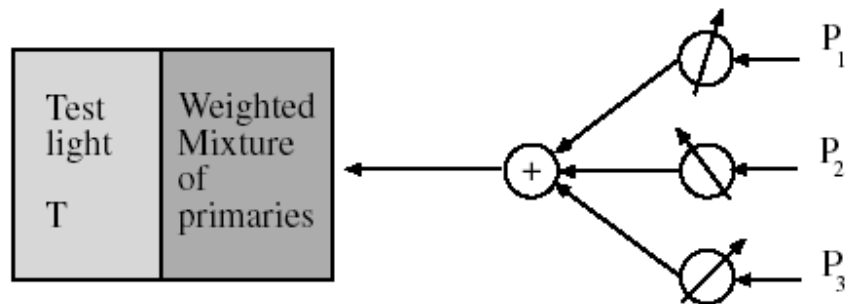
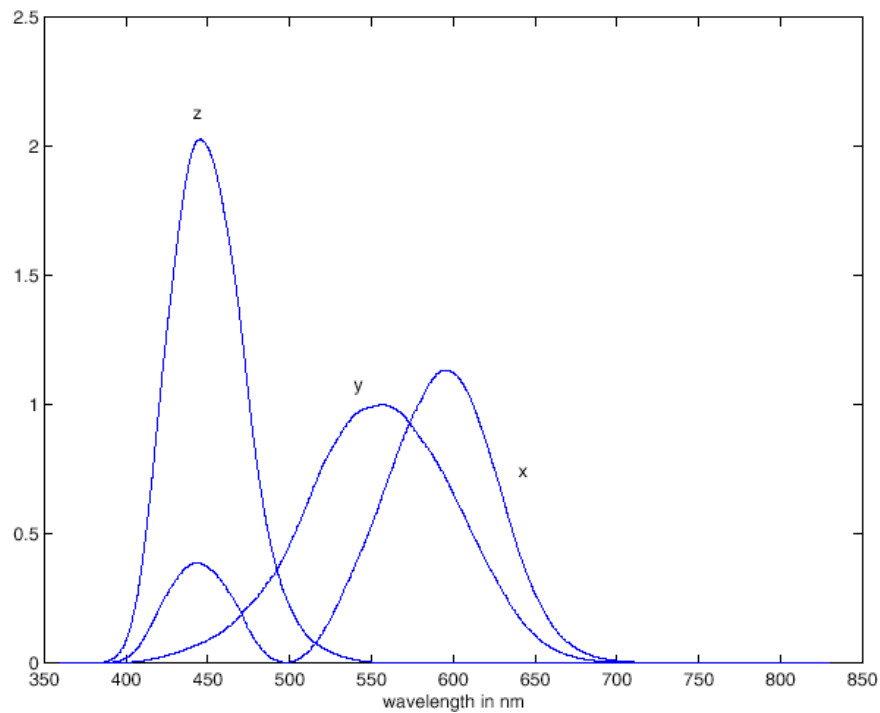


Figure 15.2. Illustration of color matching fn

- Show a split field to subjects; one side shows the light whose color one wants to measure, the other a weighted mixture of primaries (fixed lights).

15.1.2 CIE XYZ



Given, $S(\lambda)$, arbitrary color. Then, express it as $f_x(\lambda), f_y(\lambda), f_z(\lambda)$

$$X = \int f_x(\lambda) S(\lambda) d\lambda$$

$$Y = \int f_y(\lambda) S(\lambda) d\lambda$$

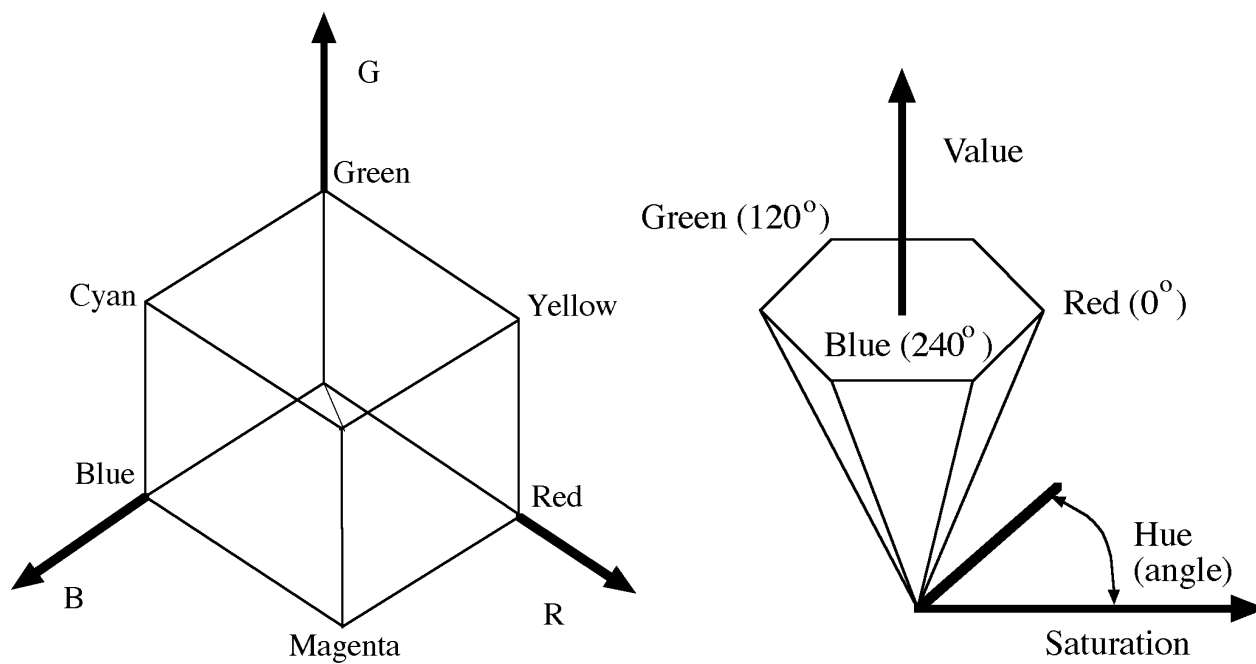
$$Z = \int f_z(\lambda) S(\lambda) d\lambda$$

For convenience, often we use a 2D projection of it, $(x, y) = \left(\frac{x}{x+y+z}, \frac{y}{x+y+z} \right)$

15.1.3 CMYK color spaces

- Secondary colors covering the visible spectrum.
- Subtractive color scheme.
- Surfaces/pigments behave subtractively (eg. Pigment looks yellow, because its spectral BRDF absorbs all its incoming blue light).
- Printing devices use 3/4 primary inks.
 - Cyan=W-R
 - Magenta=W-B
 - Yellow=W-B

15.1.4 HSV



- Intuition: Looking down the main diagonal of RGB cube.

- Also useful to consider behavior $E(\lambda)$. Consider $E(\lambda)$ to look gaussian. Then,
 - Hue: 'Mean' of gaussian.
 - Saturation: 'Variance' of gaussian.
 - Value: 'Area' of gaussian[scaled gaussian].

15.2 Color Distances

- It's difficult to be precise for large distances.
- Smaller, just noticeable differences are more meaningful.
- Ellipses of 'constant appearing colors' are not constant through space.
- $\left\| \begin{bmatrix} x_1 \\ y_1 \end{bmatrix} - \begin{bmatrix} x_2 \\ y_2 \end{bmatrix} \right\|$ - poor measure of perceptual difference.
- Non-linear transform into space where ellipses become circles (eg. Euclidean = perceptual distances for small distances).
- CIE Lab
 - L-luminance, a-b-hue and saturation
 - Claimed to be the right space to use.

15.3 Finding Specularities

Crude model for non-conducting surface

- Body Reflection: Photons penetrate the surface strike pigments randomly and leave.
- Surface Reflection: Photons are reflected at the surface. Specular surface takes a color of illuminant.

$$I(x, y) = g_d(x, y) \bar{d} + g_s(x, y) \bar{s}$$

where,

- $I(x, y)$ - Vector of values
- $g_d(x, y)$ - Color capturing geometry
- \bar{d} - Color albedo of object
- $g_s(x, y)$ - Scalar capturing geometry
- \bar{s} - Color of illuminant

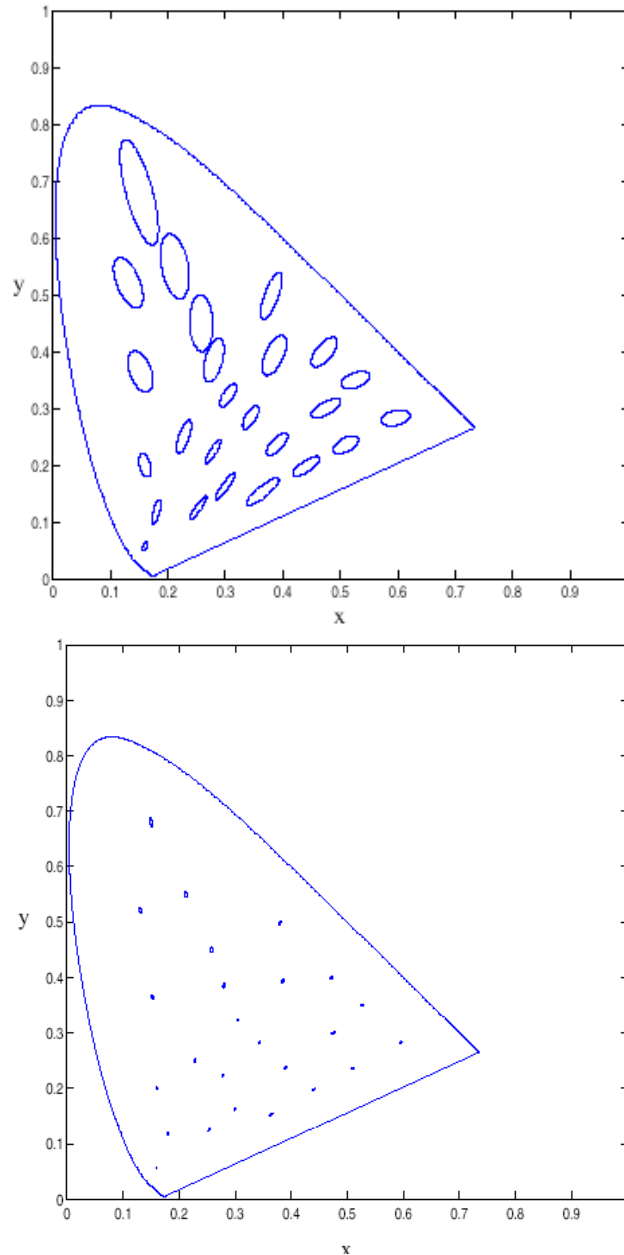


Figure 15.3. Variations in color matches on a CIE x, y space. At the center of the ellipse is the color of a test light; the size of the ellipse represents the scatter of lights that the human observers tested would match to the test color; the boundary shows where the just noticeable difference is. The ellipses on the left have been magnified 10x for clarity; on the right they are plotted to scale. The ellipses are known as MacAdam ellipses after their inventor. The ellipses at the top are larger than those at the bottom of the figure, and that they rotate as they move up. This means that the magnitude of the difference in x, y coordinates is a poor guide to the difference in color