3-Chip Color Camera

Color Image Components

Single Chip Color Camera

Additive Colors
Tristimulus Values

- Tristimulus values are three sets of values which describe a color (like Red, Green and Blue).
- There are no unique set of primary colors provided that the selected colors are widely separated.
- CIE primary colors are 700 nm (red), 546.1 nm (green) and 435.8 nm (blue).
CIE Chromaticity Diagram

CIE (Commission Internationale de L’Eclairage, International Commission on Illumination) system of color specification

y axis: red
y axis: green

The point marked with green:
x: 25%, y: 62%, z: 13%.

CIE Colors

Television Primary colors

R, G, B - Primaries used for PAL
R'G'B' - Primaries used for NTSC
D65 - reference white for PAL
C - reference white for NTSC

Color Wheel

Green, Yellow, Cyan, Red, Blue, Magenta
RGB Color Model

- Red 0 or 360 degrees Primary
- Yellow 60 degrees Secondary (Green + Red)
- Green 120 degrees Primary
- Cyan 180 degrees Secondary (Blue + Green)
- Blue 240 degrees Primary
- Magenta 300 degrees Secondary (Red + Blue)

HSI Coordinate System

- Hue Interpretation
  - Saturation is a measure of the purity of the color specified by the hue component. For example,
  - navy blue is more saturated than sky blue.
  - As a color component, saturation assumes a measure from 0.0 to 1.0. A saturation of 0.0 indicates the absence of color, or a shade of gray.
  - A saturation of 1.0 indicates a pure color as specified by the hue component.
**L*a*b* Coordinate System**

\[ a^* = 500 \left[ \frac{(X/X_0)^{1/3} - (Y/Y_0)^{1/3}}{(Z/Z_0)^{1/3}} \right] \]

\[ b^* = 200 \left[ \frac{(X/X_0)^{1/3} - (Z/Z_0)^{1/3}}{(Y/Y_0)^{1/3}} \right] \]

\[ L^* = \begin{cases} 
116(Y/Y_0)^{1/3} - 16 & \text{for } Y/Y_0 > 0.01 \\
903(Y/Y_0) & \text{otherwise} 
\end{cases} \]

\[ X_0, Y_0, Z_0 = \text{coordinates of reference white} \]

**YIQ Color Coordinate System**

- YIQ is defined by the National Television System Committee (NTSC)
  - Y describes the luminance, I and Q describes the chrominance.
  - A more compact representation of the color.
  - YUV plays similar role in PAL and SECAM.

- Conversion between RGB and YIQ

\[
\begin{bmatrix}
Y \\
I \\
Q
\end{bmatrix} = 
\begin{bmatrix}
0.299 & 0.587 & 0.114 \\
-0.1687 & -0.3313 & 0.5 \,
0.5 & -0.439 & -0.0714 \,
0.4186 & -0.291 & 0.1\,1
\end{bmatrix} 
\begin{bmatrix}
R \\
G \\
B
\end{bmatrix} + 
\begin{bmatrix}
16 & 0 & 0 \\
13 & -65 & 13 \,
13 & 13 & -65
\end{bmatrix} 
\begin{bmatrix}
Y \\
I \\
Q
\end{bmatrix}
\]

**Lab Interpretation**

- L is brightness
- a is associated with redness and greeness
- b is associated with yellowness and blueness

http://www.cybercollege.com/tvp015.htm