Chapter 15

Color Models and Color Applications

Section 15.3-15.7

References/Resources:
Computer Graphics, C Version (2nd Ed.), D. Hearn, M.P. Baker, Pearson Education

COLOR CONCEPTS

A color can be made lighter by adding white or darker by adding black. Therefore, graphics packages provide color palettes to a user which has two or more color models.

NOTE:

Hue: it is an actual color

Saturation: indicates amount of grey in a color

Brightness: tells the difference between a bread and a burnt toast i.e. how much black (or white) is mixed in a color

Types of Color Models

RGB

Eg. Monitors

YIQ

Eg. T.V

CMY

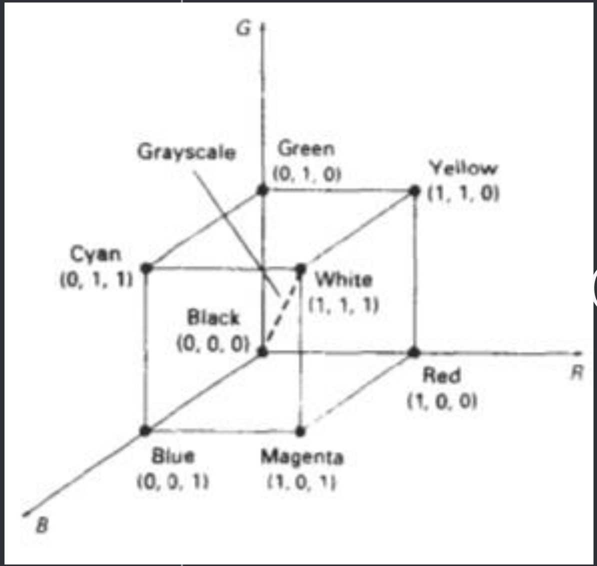
Eg. Printers & Plotters

HSV

Eg. Color palette

RGB COLOR MODEL

- This color model is represented by a unit cube with one corner located at the origin of a 3-d color co-ordinate system.



The origin represents black and the vertex with co-ordinates (1,1,1) is white. Vertices of the cube on the axes represent the primary colors, and the remaining vertices represent the complementary color for each of the primary colors.

(Complementary colors: are pair of colors which, when combined cancels each other out)

- The RGB color scheme is an additive model. Intensities of the primary colors are added to produce other colors.
- Each color point within the bounds of the cube can be represented as the triple (R , G, B), where values for R, G, and B are assigned in the range from 0 to 1.

Eg: It is an additive model means to produce magenta, vertex is obtained by adding red(1,0,0) blue (0,0,1) to get (1,0,1) which is the co-ordinate of magenta.

white at (1,1,1) is the sum of red(1,0,0), green(0,1,0), and blue (0,0,1).

Shades of gray are represented along the main diagonal of the cube from the origin (black) to the white vertex. Each point along this diagonal has an equal contribution from each primary color

YIQ COLOR MODEL

- In the YIQ color model, Luminance (brightness) information is contained in the Y parameter, while chromaticity information (hue and purity/saturation) is incorporated into the I and Q parameters.
- A combination of red, green, and blue intensities are chosen for the Y parameter.
- black-and-white television monitors use only the Y signal.
- Parameter I contains orange-cyan hue information
- Q carries green-magenta hue information.
- An RGB signal can be converted to a television signal using an NTSC encoder, which converts RGB values to YIQ values.

- The conversion from RGB values to YIQ values is accomplished with the transformation

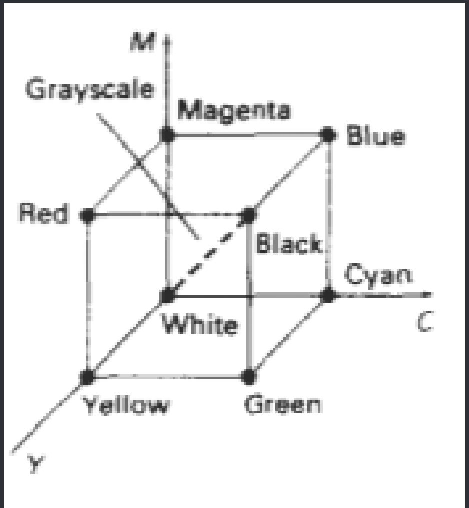
$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.144 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.528 & 0.311 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

- An NTSC video signal can be converted to an RGB signal using an NTSC decoder

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.000 & 0.956 & 0.620 \\ 1.000 & -0.272 & -0.647 \\ 1.000 & -1.108 & 1.705 \end{bmatrix} \cdot \begin{bmatrix} Y \\ I \\ Q \end{bmatrix}$$

CMY COLOR MODEL

- The primary color are Cyan, Magenta and Yellow (CMY).
- It is a subtractive model. CMY model defining color with a subtractive process inside a unit cube.



- In the CMY model, point (1, 1, 1) represents black, because all components of the incident light are subtracted.
- The origin represents white light.
- Equal amounts of each of the primary colors produce grays, along the main diagonal of he cube.
- A combination of cyan and magenta ink produces blue light, because the red and green components of the incident light are absorbed.
- Other color combinations are obtained by a similar subtractive process
- The conversion from an RGB representation to a CMY :-

$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

- Conversion from a CMY to RGB :-

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} C \\ M \\ Y \end{bmatrix}$$

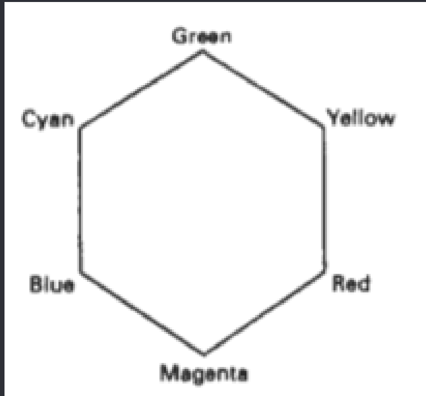
Where black is represented in the CMY system as the unit column vector

The printing process used with the CMY model generates a color point with a collection of four ink dots.
One dot is used for each of the primary colors and one dot is black.

A black dot is included because the combination of cyan, magenta, and yellow inks produce gray instead of black.

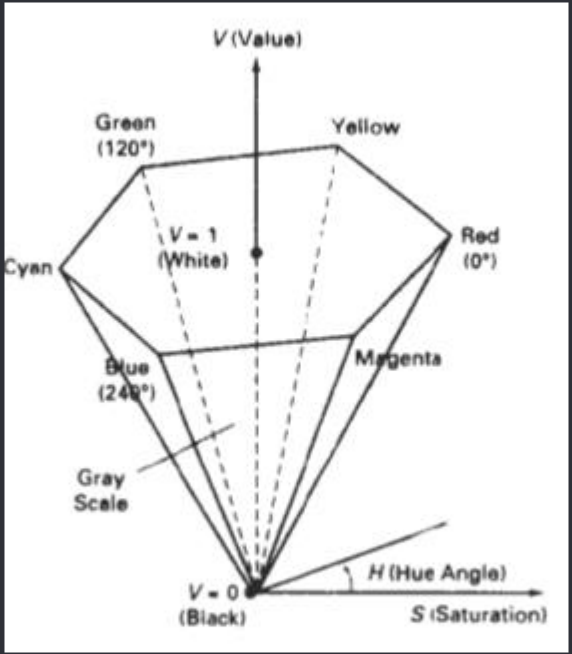
HSV COLOR MODEL

- It Color parameters in this model are hue (H), saturation (S) and value(V).
- The three-dimensional representation of the HSV model is derived from the RGB cube.
- Viewing the cube along the diagonal from the white vertex to the origin (black)



Color Hexagon

- The boundary of the hexagon represents the various hues, and it is used as the top of the HSV hexcone In the hexcone, saturation is measured along a horizontal axis, and value is along a vertical axis through the center of the hexcone.



- **Hue H** angle ranging from 0^0 red through 360^0.
- Vertices of the hexagon are separated by 60^0 intervals.
- Complementary colors are 180^0 apart.

- **Saturation S** varies from 0 to 1 .
- S can be defines as the ratio of the purity of a selected hue to its maximum purity at S = 1.
- At S = 0, we have the gray scale.

- **Value V** varies from 0 at the apex of the hexcone to 1 at the top.
- When V = 1 and S = 1, we have the "pure" hues.
- White is the point at V = 1 and S = 0.

- we describe the color we want in terms of adding either white or black to the pure hue.

- Adding black decreases the setting for V while S is held constant. To get a **dark blue**, V could be set to 0.4 with S = 1 and H = 240^0.
- Similarly, when white is to be added to the hue selected, parameter S is decreased while keeping V constant. A **light blue** could be designated with S = 0.3 while V = 1 and H = 240^0.

For color concepts in terms of shades, tints and tones please refer to page 597 of book.