COLOR IMAGE PROCESSING

∴ color image → chromatic image

image (monochromatic / grayscale), $f(x,y)$ → intensity has only one channel. However, in color image processing, we introduces additional channel of intensities to give a representation to color sensation of a human perception.

There are two main reasons to perform color image processing.
(a): Color is a powerful descriptor which can help to identify / extract an object from the scene.
(b): Human can perceive more color shades than gray scale shades.

Two major categories of color image processing:

1. **Full-color:**
Images are acquired using a full color sensor (color TV, camera or color scanner) — The sensors themselves can register the color information inherent in the scene.

2. **Pseudocolor:** assigns a color to a particular monochrome intensity or a range of intensities. — Register the information about the scene as a gray scale image (The sensors are not sensitive / perceptive to the color in the scene. Once the grayscale image is acquired, then pseudocolor assign a color to a certain range of intensities. e.g., the system assigns a particular color to gray intensities from 0 – 20 and so on.

Once the acquisition system whether full color acquisition or pseudo color acquisition Then whatever techniques we apply on these color images to enhance the To compress, to segment the image is called color image processing.

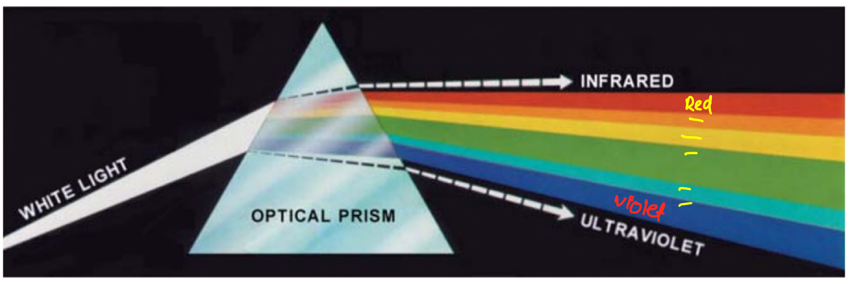


FIGURE 6.1 Color spectrum seen by passing white light through a prism. (Courtesy of the General Electric Co., Lamp Business Division.)

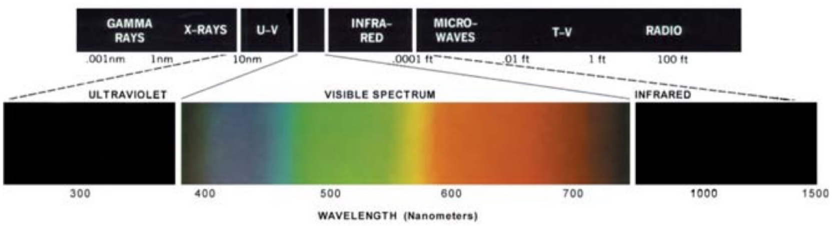


FIGURE 6.2 Wavelengths comprising the visible range of the electromagnetic spectrum. (Courtesy of the General Electric Co., Lamp Business Division.)

Color Fundamental :

→ The seperation of colors by a prism expose a continuous range of Spectral color.

- The human eyes are perceptive only to a narrow band of the entire EM Spectrum.
- Entire EM spectrum can be characterized either in terms of wavelength or frequencies.
- Colour : we can identify colors in an object is dependent on the nature of the light reflected from the object.
- An object that reflects light that is balanced in all visible wavelength is (white).

- If an object reflects light in the limited range of visible spectrum it will appear in some color shades e.g., green object reflects light with wavelength (500nm – 570nm) and absorb most of the energy in other wavelength.

- characterisation of light :

⊙ Achromatic light → same as monochromatic → such a light that is void of color and is characterised by a single attribute i.e intensity. In such case the intensity varies from the min (black) to the max (white).

⊙ Chromatic light : The chromatic light spans from wavelength of 400nm – 700nm. Three basic quantities can be used to charactirized the chromatic light or color light; These are

(a) Radiance (unit – watts) : It is the total amount of energy coming out of the light source.

(b) Luminance (unit – Lumens): measure of the amount of energy perceived by an observer from the light source.

e.g., light emitted from a source operating in the far infrared region of the spectrum could have significant energy (radiance), but an observer would hardly perceive it; its luminance would be almost zero.

(c) Brightness (no units :) is subjective measure corresponding to the achromatic attribute of intensity. When the observer is far, the brightness will be low and if the observer is close, the brightness will be high.

- Cones are the sensors in the eye responsible for color vision.
Three principal sensing categories, i.e., red, blue and green.
65% cones are sensitive to red light.
33% to the green & 2% to the blue.

Colors are seen as a variable combination of so called "the primary colors" red (R), green (G), and the blue (B).

The international commission on illumination standardize 3 specific wavelength to three primary colors: blue = 435.8nm, Green = 546.1nm & red = 700nm.

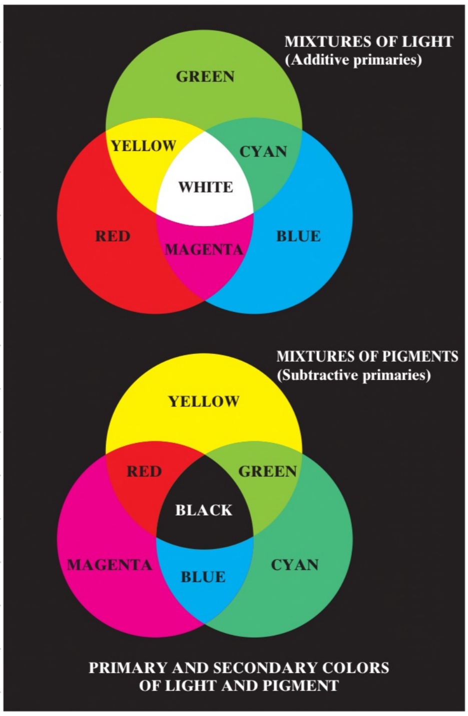
- These three colors mixed in different intensity proportions can produce all visible colors (wrong). If we need to acquire the colors in the visible range, we need to change the wavelength also.

- Primary colors & Secondary colors

- In case of light, we have 3 primary colors (RGB). When all of them combines, they produce white.
Any primary combines with its opposite secondary color will also produce white.

- In case of pigments, the YCM are the primary colors of pigments.

- All the primary colors combine together produces "black".



a
b

FIGURE 6.4 Primary and secondary colors of light and pigments. (Courtesy of the General Electric Co., Lamp Business Division.)

- A pigment is a substance that appears as yellow in the presence of white light; the blue is absorbed and the green & red is reflected.

When white light strike on pigment (magenta), the green is absorbed and only blue & red is reflected.

∴ characterising of color ∴

- One color can be distinguished from the other by using three characteristics:

1. **Brightness:** It embodies the achromatic notion of intensity.

2. **Hue:** Dominant color (wavelength of light) as perceived by an observer.

3. **Saturation:** relative purity or amount of white light mixed with a hue.

Degree of saturation is inversely proportional to the amount of white light added.

- Hue and saturation taken together are called "chromaticity"
- The amounts of red, green, and blue needed to form any particular color are called the "tristimulus value" and are denoted by X, Y & Z. A color is then specified by its trichromatic coefficients defined as:

$$x = \frac{X}{X+Y+Z}, \quad y = \frac{Y}{X+Y+Z} \quad \& \quad z = \frac{Z}{X+Y+Z}$$

$$\boxed{x+y+z = 1}$$

R = 700nm, G = 546.9nm, B = 438.8nm.

chromatic diagram: → represent all colors.

- useful for the mixing of the colours to get different shades.

$x = 0.35, \; y = 0.35$

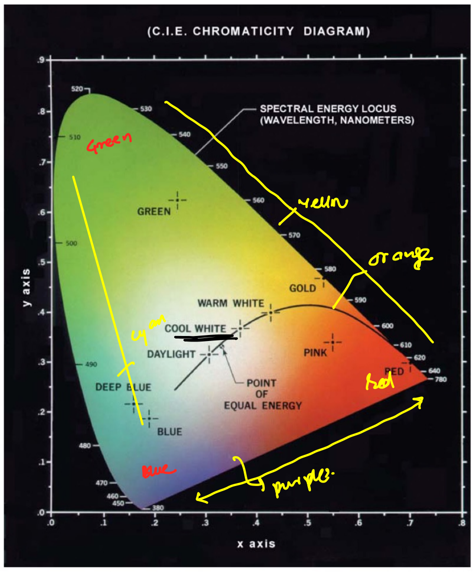


FIGURE 6.5 Chromaticity diagram. (Courtesy of the General Electric Co., Lamp Business Division.)

Color Gamut :

To determine the range of colors from any three given colors in the chromaticity diagram

- The triangle is called color gamut.
- Irregular shape inside the triangle → color gamut of the high quality printing device.

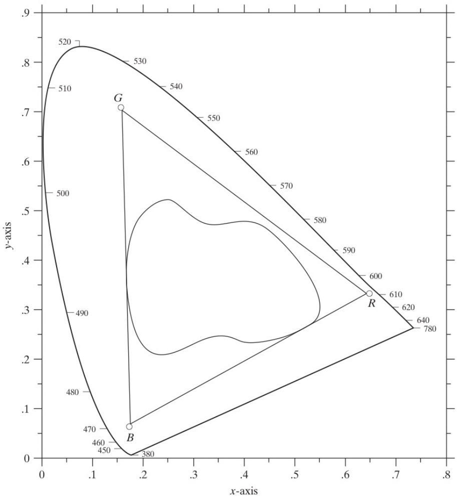


FIGURE 6.6 Typical color gamut of color monitors (triangle) and color printing devices (irregular region).

- Color printing is the combination of additive and subtractive color mixing

Color Model :