Colour Image processing

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The use of Color Image processing is motivated by two Principal factors

① Color is a powerful descriptor that offten simplifies Object Identification and Extraction from sence

2) human can discern thousands of Color shades and Intensities, compared to about two dozens of gray

- discern → to recognize or seperate and distinct.

Color fundermentals

In 1666 Sir Isaac Newton discovered that when beam of Sunlight passes through a glass prism. The Emerging beam Consists of Continuous spectrum of colors ranging from Violent to red. Fig 1 shows the Color spectrum which is divided into six broad regions namely Violent, blue green, yellow, orange and red.

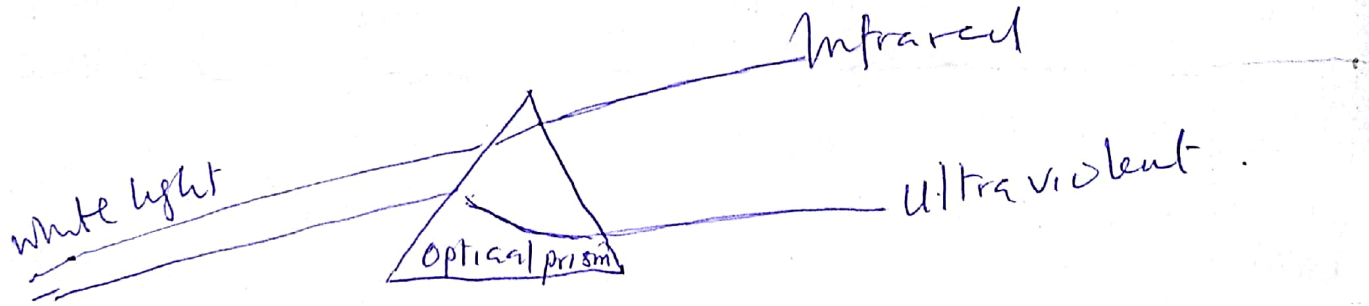


Fig 1 ; Colors spectrum seen by passing white light through a prism.

The Colors that humans and some other animals perceive in an object is determined by the nature of light reflected from the object. as illustrated in fig 2 (slide). A body that reflect light that is balanced in all visible wavelength appear white to the observer. However a body that favours reflectance in a limited range of the visible spectrum exhibits some shade of colors.

e.g green objects reflect light with wave lenghts primarily the 500 to 570nm range while absorbing most of the energy other wavelengths.

Characterization of light is central to the science of colour. If the light is achromatic (void of color) it only attribute is its intensity. Chromatic light spans the electromagnetic spectrum from approximately 400 to 700nm. Three basic quantities are used to describe the quality of a chromatic light source. radiance, luminance and brightness. Radiance is the total amount of energy that flows from the light source, it is measure in ~~Lumens~~ Watts. Luminance, measured in Lumens, gives a measure of the amount of energy an observer perceives from the light source. Finally, brightness is a subjective descriptor that is impossible to measure. However, it should be noted that for ~~an~~ chromatic light intensity is one key factor for describing color sensation.

Details Experimental evidence has established that 6 to 7 million cones in the human eye can be divided roughly to red, green and blue. Approximately 65% of all cones are sensitive to red light, 33% are sensitive to green light and only about 2% are sensitive to blue (but blue cones are the most sensitive). Due to the absorption characteristics of the human eye, Colors are seen as variable combinations of primary colors red (R), green (G) and (B).

The primary colors can be added to produce the secondary colors of light as shown in figure 2 (a)

e.g. Magenta = red + blue.

Cyan = green + blue

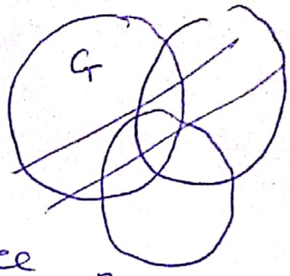
Yellow = red + green.

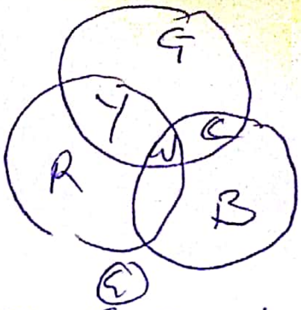
(5)

~~Mixing~~

Light

Pigment





Mixing the three primaryes or secondary with its Opposite color in the right intensities produces white light

Differentiating b/t primary colors of light and primary colors of pigments is importance. In the latter, a primary color is defined as one that substracts or absorbs a primary colors of light and reflects or transmits the other two. Therefore, the primary colors of pigments are Magenta Cyan and yellow and secondary colors are red green and blue. as shown in Fig 2(b). A proper combination of the three pigment primaries or secondary with its opposite primary produces black.

The characteristics that generally used to distinguish one color from another are brightness, hue and saturation. As ealier indicated, brightness embodies the chromatic notion of intensity. Hue is an attributes associated with the dominat colors perceived by an observer. Thus when describe an object by it color e.g red green and blue we are specifying its hue. Saturation refers to the relative purity or the amount of white light mixed with a hue. The pure spectrum colors are fully saturated. Colors such as pink (red and white) and lavender (valent and white) are less saturated with the degree of saturation being inversely proportion to the amount of white light added.

dominat wave lenght in a mixture of colors — color sen

Hue and saturation — pure color sensation

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Hue and saturation taken together are called chromaticity (4) and therefore a color may be characterized by its brightness and chromaticity. The amounts of red, green and blue needed to form any particular color are called the tristimulus value and are denoted as (X, Y and Z) respectively. A color is then specified by its trichromatic coefficients defined as

$$x = \frac{X}{X+Y+Z} \quad \text{---} \quad (1)$$

$$y = \frac{Y}{X+Y+Z}$$

$$z = \frac{Z}{X+Y+Z}$$

it is noted that these equation that

$$x + y + z = 1$$ (represented Normalize form?).

Colour Models

The purpose of a color model (also called color space or color system) is to facilitate the specification of colors ~~in some~~ using establish standard or generally acceptable way

Most colour models in use today are oriented either toward hardware (such as for colour models and printers) or toward applications where color manipulation is a goal (such as in creation of colour graphics for animation).

There are numeous color model in use today due to the fact the color science is a broad field that encompasses many areas of application.

In the study three basic colors models namely; i) RGB (red green blue) model (ii) CMY (Cyan magents, yellow) and CMYK (Cyan magents, yellow black) model, and (iii) ~~HS model~~ HSI (Hue, Saturation and Intensity) model will be discussed.

In terms of DIP the hardware oriented models most commonly used in practice are the RGB model for color monitor and colur video cameras. CMY and CMYK models are for colour printing. While HSI model calls man in describtion and Interpretation of colors.

RGB Model

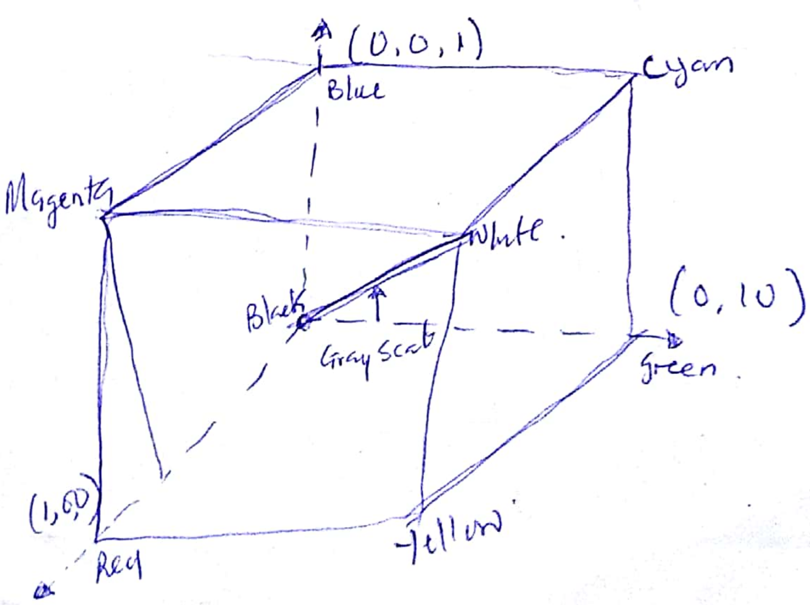

fig 1

2

This model is based on a Cartesian Cordinate system. Fig 1 above shows the RGB color model. The RGB values are at three corners while Cyan Magenta and yellow are at three other corners. Black is the origin and white is at corner farthest from the origin. In this model the gray scale (points of equal RGB values) extends from black to white along the line joining these two points. Different colors are represented in this model by different points inside the cube. and at defined by vectors from the origin. as shown in the figure above.

2 CMY and CMYK colour model

Most devices that deposit colored pigments on paper such as color printers and copier require CMY data input or perform an RGB to CMY conversion internally. The Convertion is perform using equation 1. This equation is based on the assumption that all

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

color values have been normalized to the range [0, 1].

The equation demostrates that the light reflected from a surface coated with pure cyan does not contain red i.e. $C = 1 - R$ in the equation. Similarly pure magenta does reflect green and pure yellow does not reflect blue.

The equation demostrate that RGB values can be obtained easily from a set of CMY values by substracting individual CMY values for 1

Theoretically as ~~demostrated~~ Illustrated in previous section primary pigments such as cyan magenta and yellow should produce black. In ~~But~~ in practice, combining these colors produces a muddy-look black. So in order to produce true black (which a predominant color in printing) a fourth color, black is added giving rise to the CMYK color model.

HSI Colour model: 3

HSI model is an ideal tool for developing image processing algorithms based on color descriptions that are natural and intuitive to humans. The HSI model decouples the intensity component from color carry information (hue and saturation) in a color image.

* In other words: we say that RGB is ideal for image color generation (as in image capture by a color camera or image display in a monitor screen) but it's use for color description is much more limited.

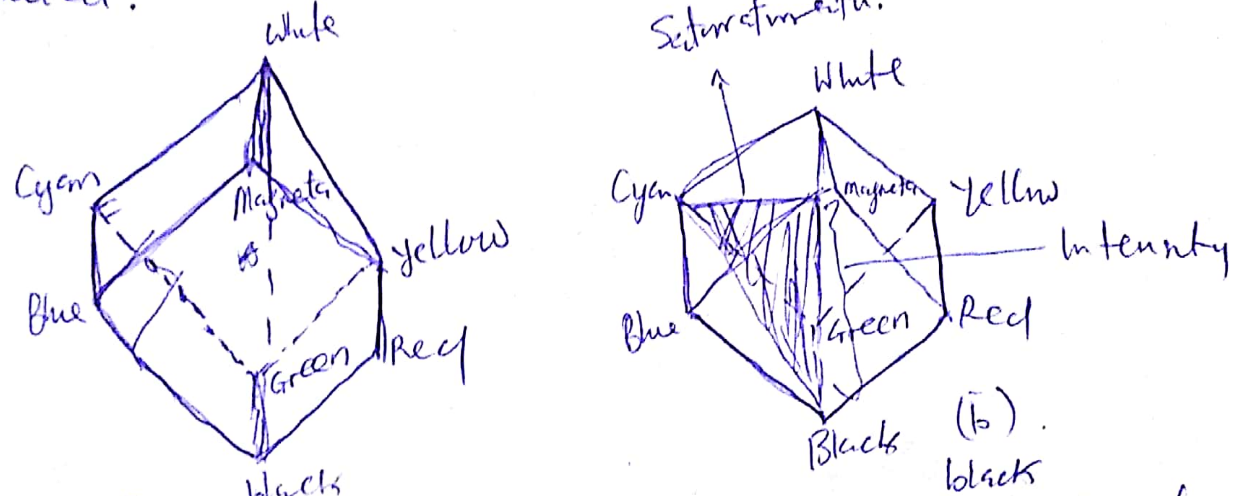

Fig 3 (a) (b).

The figure above shows an RGB color cube standing on a vertex (0 0 0) with white vertex (1,1,1) directly above it. In this arrangement as shown in the figure above the line joining black and white vertices is vertical. Thus if are to determine the intensity component of any color point. we have to draw a perpendicular plane to the intensity axis, containing the color point fig b. The intersection of the plane with the intensity axis gives us the intensity value in the range [0,1]. It is important to note that the saturation of points on the intensity axis is zero as evidenced by the fact that all points along the axes are gray.