UNIT - V

↳ **Color Processing:**

The physics of colour

Human color perception

representing colour

model for image colour

Surface color from image colour

↳ **Range image processing:**

active range sensor

Range data segmentation

Range image registration and model acquisition

Object recognisation.

The physics of colours:

It describe that how matter and light intract to eachother and produce colour each other. that we see.

There are some key principles.

1. **Light as Electromagnetic wave:**

→ Visible light is the small portion of electromagnetic spectrum. It consist of wave with various wave length. Red light has longer wavelength and voilet has Shorter.

2. Absorption and reflection:

→ When light fall on any object then that object absorbed some light ~~and reflect some~~. transmitte and reflect other light. For example A red Apple appreears red because ~~the~~ it reflect red light and absorb the rest light.

3. Additive colour mixing:

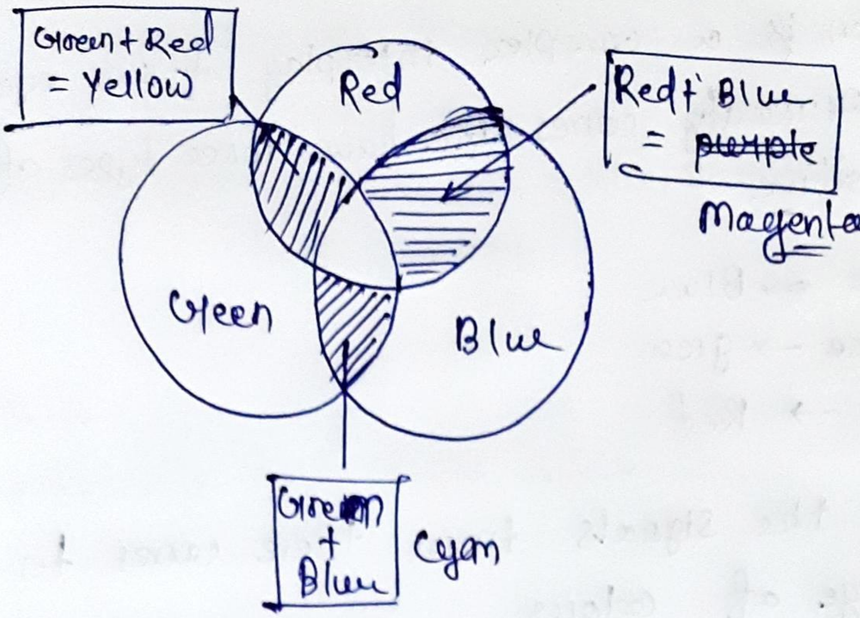
→ In additive colour mixing colour are created by combing different wave length of light. In this system red green and blue are primary colour mixing them in various proportion can create a wide range of colour. This is how computer screen and TVs can produces colour.

4. Subtractive colour mixing:

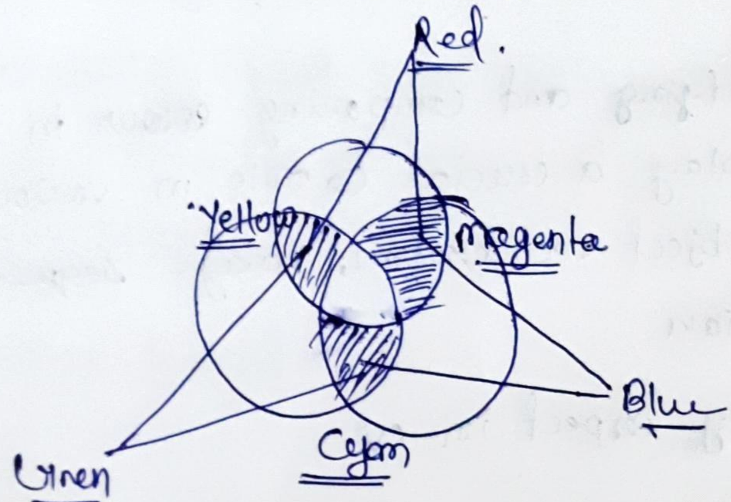
→ In subtractive colour mixing, colour are created by mixing pigment or dyes. Here the primary color are cyan magenta, yellow. When these colour combine they subtract certain wavelength of light. Resulting in the perception of specific colour like - Red, ~~Yellow~~ green, Blue

~~5. Colour Temp.~~

→ Diagram for Additive colour mixing:



→ Diagram for subtractive colour



5. Colour Temperature:

Higher temperatur → cressospond to → Blue light

Lower temperature → crosspond to → Raddish light.

Human colour perception:

- Human colour perception is a complex interplay of our eyes
- Photoreciptor cell primarily cones. We have three types of cones that are sensitive
  - (i) Short cone → Blue
  - (ii) medium cone → green
  - (iii) long cone → Red

Our brain processes the signals from these cones to recieve a wide range of colour.

Colour matching:

→ The process of quantifying and comparing colour in the image or vedio. It play a crucial role in various application. Such as object recognisation, image segmentation and color correction

→ There are some key aspect in CV

(i) color-space
(ii) color - Histogram
(iii) Color-Based object recognization
(iv) Colour-segmentation
(v) Colour-correction

(i) colour-space:

The representation of color in the color-space

Common color-space - RGB (Red, ~~Blue~~, Green, Blue)

~~Color Histogram~~ - HSV (Hue, Saturation, Value).

LAB

YUV

These colour-space provide different way to express and manipulate the colour information

(ii) colour-Histogram:

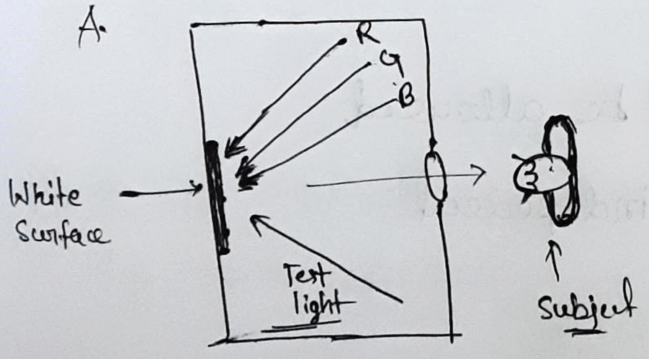
→ It is a statical representation of colour distribution in the image.

→ It quantify ~~that~~ how many pixels in the image having specific colour value within the defined colour space

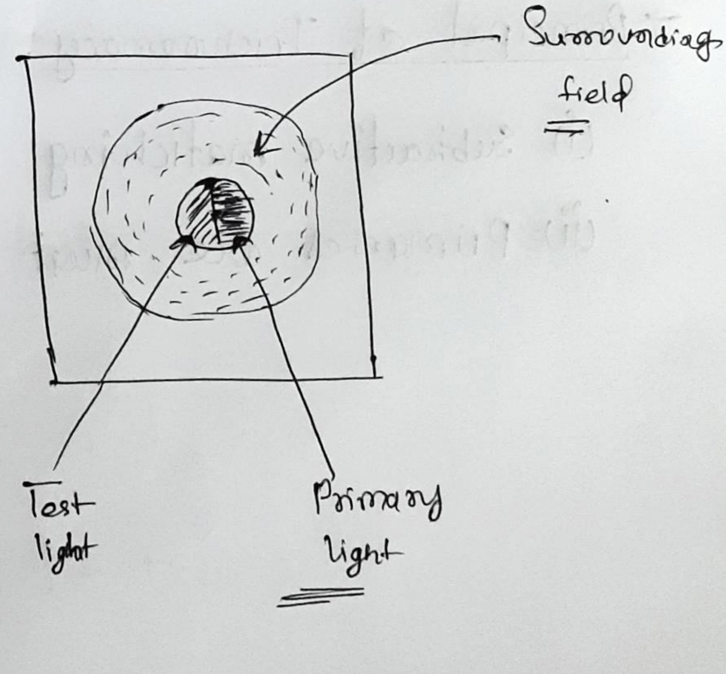
(iii) Color-Based.

Colour matching experiments:

A.



(B)



Trichromacy:

Trichromatic colour theory:

↳ Three number of colour are sufficient to make any numbers of colours.

Principle of trichromacy:

(i) Subtractive matching must be allowed

(ii) primaries must be independent: It means no mixture of two primary match to third.

~~(iii)~~

→ According to Trichromacy theory Human Eye can ~~p~~ percieve three primary colour ~~and~~ (Red, Green, Blue) There are three color transducer in the human eye. and we can sees a wide range of colour throug this three ~~p~~ color transducer.

~~From~~

Trichromatic vision is the most common vision in the human.

→ Principal of Trichromacy:

(i) Subtractive matiching must be allowed.

(ii) Primaries are must be indepedent

Grassman's Law :

↳ Grassman's law state that colour matching appears to be linears.

(i) Suppose we have two test light with same weight of primaries then both the light match to each other or appear same.

$$A = u_1 P_1 + u_2 P_2 + u_3 P_3$$

$$B = u_1 P_1 + u_2 P_2 + u_3 P_3$$

Then

$$A = B.$$

(ii) If There are two test light of different weight are mixed to each othere. Then its result colour ~~are~~ will be mixture the matches

$$A = u_1 P_1 + u_2 P_2 + u_3 P_3$$

$$B = V_1 P_1 + V_2 P_2 + V_3 P_3$$

Then

$$(A + B) = (u_1 + V_1) P + (u_2 + V_2) P_2 + (u_3 + V_3) P_3.$$

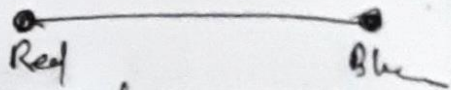
(iii) If we scaled the test light then matches get scaled by same amount

$$A = u_1 P_1 + u_2 P_2 + u_3 P_3$$

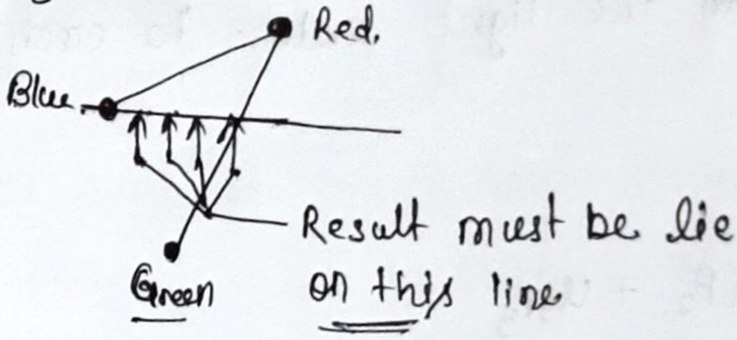
$$KA = (Ku_1) P_1 + (Ku_2) P_2 + (K u_3) P_3.$$

Linear - Colour - Space:

→ Mixing of two light produce colour that also lie along straight line on the colour space

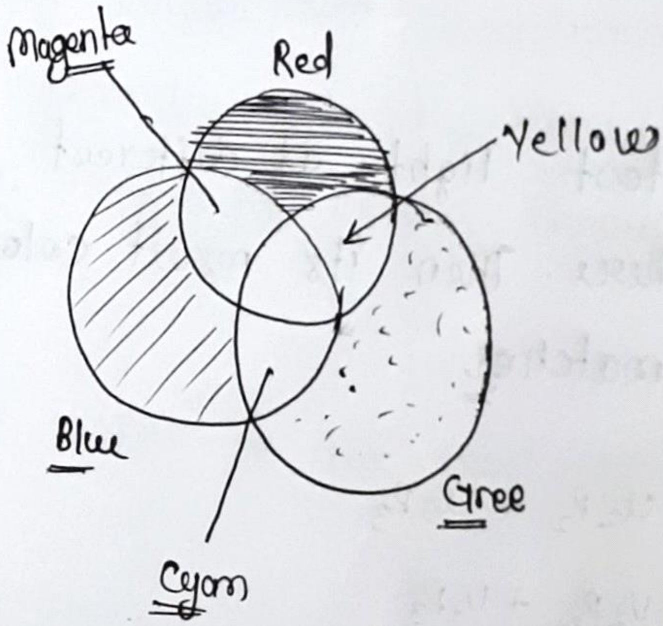


→ Mixing of three light produce colour that lie within the triangle they defined in the colour space.

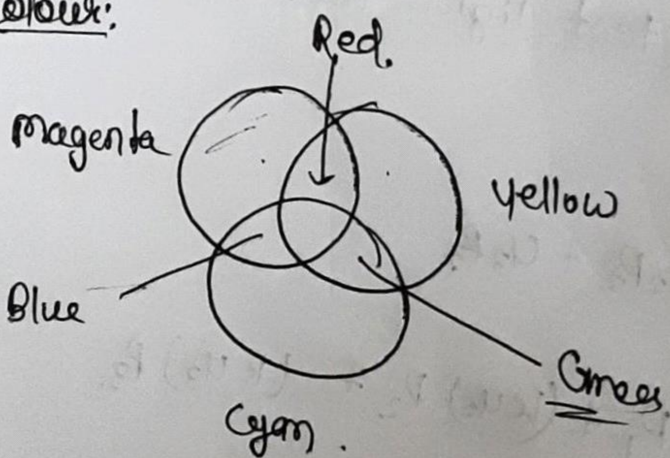


Additive and subtractive colour:

Additive colour



Subtractive colour:



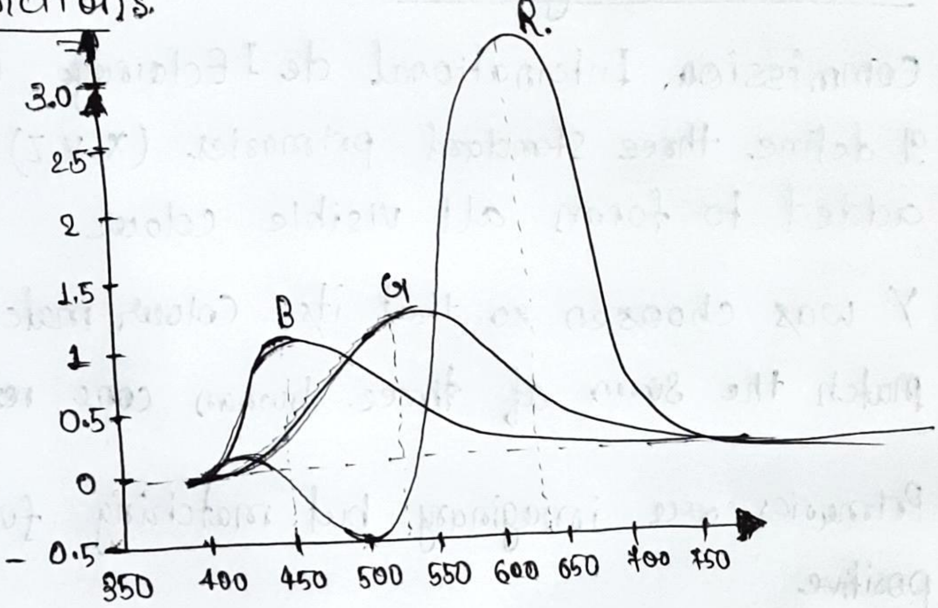
Linear colour-space :

(i) RGB Colour-space :

Red = 645 nm
Green = 525 nm
Blue = 444 nm

These all are primaries monochromatic light

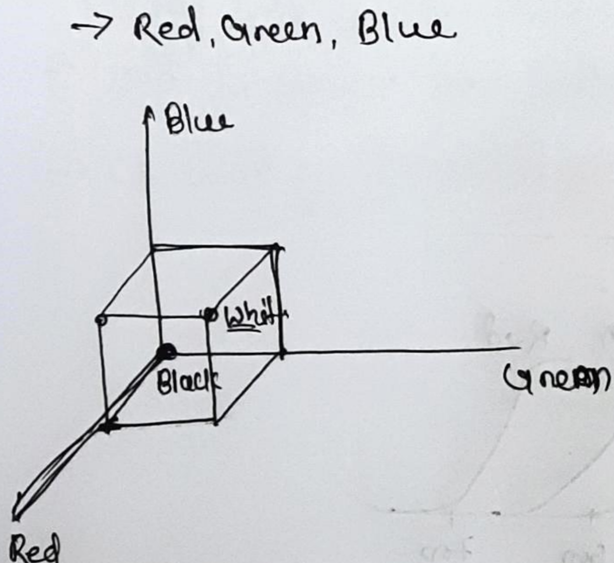
RGB matching functions.



RGB Model :

→ Additive model

→ Red, Green, Blue

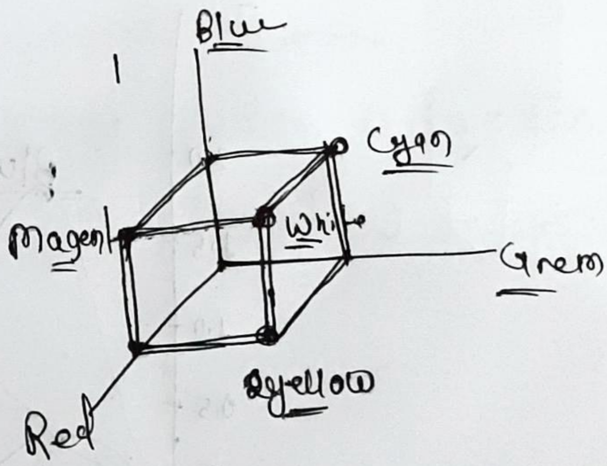


→ Appropiate for image display

CMY Model

→ Subtractive model

→ Cyan magenta, yellow.



→ Appropriat for paper printing

White + Blue = yellow

W + Red = Cyan

W + Green = Magent

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

CIE Chromaticity Model:

→ Commission International de l'Eclairage (Est = 1931)

→ It define three standard primaries (X, Y, Z) that can be added to form all visible colour

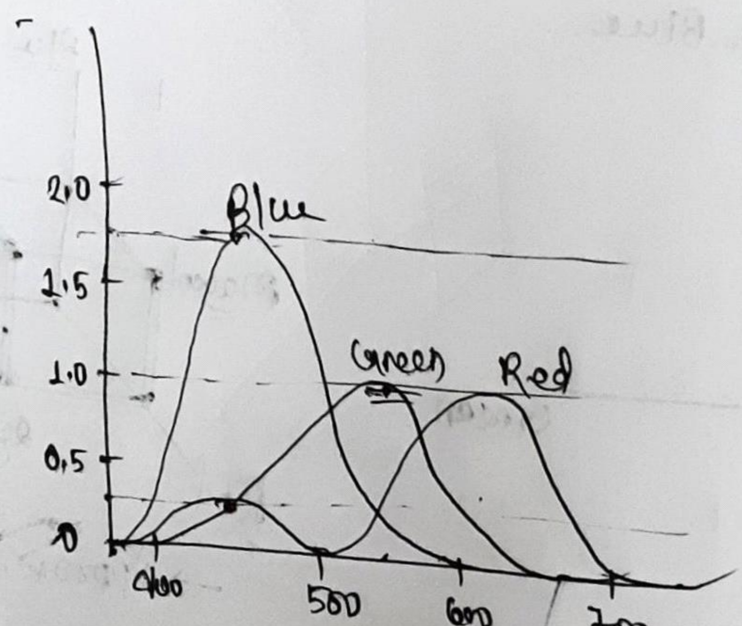
→ Y was choosen so that its colour matching function match the sum of three human cone responses

→ Primaries are imaginary but matching function are everywh positive

→ 2D-Visualization

$$x = X/(X+Y+Z)$$
$$y = Y/(X+Y+Z)$$

CIE matching function:



YIQ · Model:

→

→ YIQ All three value wed by colour TVs.

→ Y = Luminance which is use in black and white TVs

YCbCr Model:

$$\begin{bmatrix} 256 & 502 & 98 \\ 148 & 290 & 438 \\ 438 & 366 & 71 \end{bmatrix}$$

$$\begin{bmatrix} 0.256 & 0.502 & 0.098 \\ 0.148 & 0.290 & 0.438 \\ 0.438 & 0.366 & 0.71 \end{bmatrix}$$

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.256 & 0.502 & 0.098 \\ -0.148 & -0.290 & 0.438 \\ 0.438 & -0.366 & -0.071 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} 0 \\ 128 \\ 128 \end{bmatrix}$$

→ Having better composion properties

→ Used in image and video compression scheme

→ Cb and Cr translated to bring range 0 to 240.

(RGB) → 0 to 255.

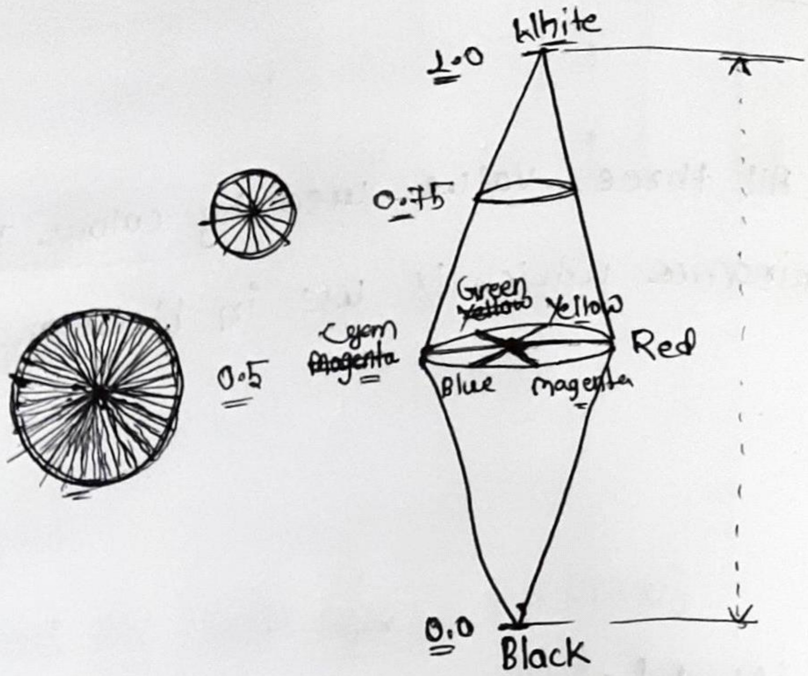
HSV-Colour Model:

→ Hue, saturation value

→ Hue is encoded angle 0 to 2π

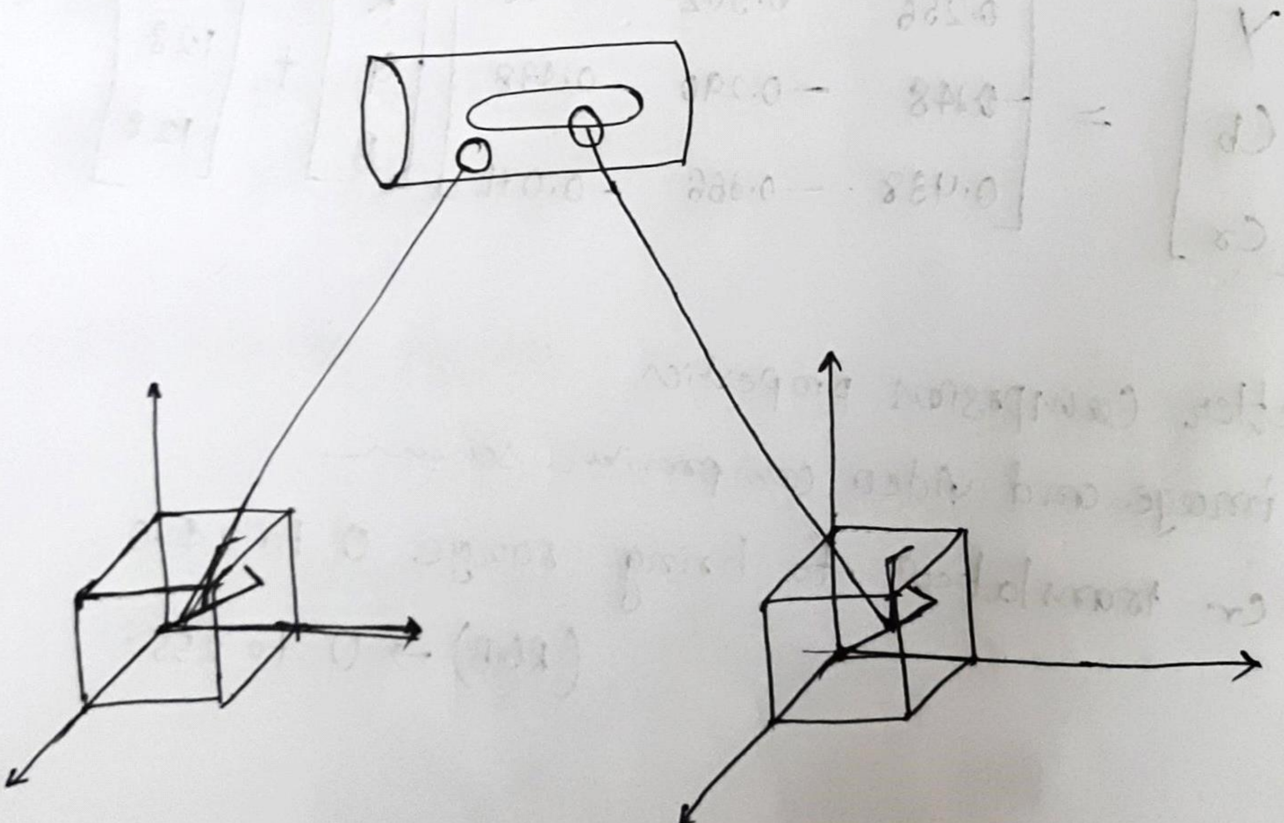
→ Saturation is encoded distance to virticle axis (0 to 1)

→ Intensity is ~~height~~ light along the virticle axis. (0 to 1)



Specularities:

→ Specularities can have strong effect on an objects appreance.



→ Linear cluster produce by specularities on the plastic Object

The Eye : A Camera :