Colour image Processing

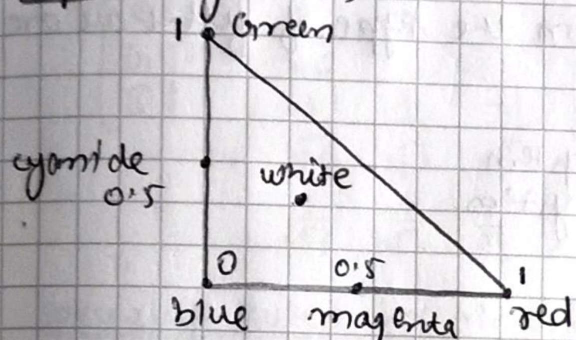
The most common quantities for human colour perception include:

4(A) Hue → is the property by which colourful colors (red, blue, etc) differ from colourless colours (white, grey, black)

4(B) Saturation → how clear the color is. If we go for single wavelength light (like lases), it generally has a good saturation.
→ The narrower the spread, the purer the colour.
→ Opposite of a pure colour is a pastel colour.

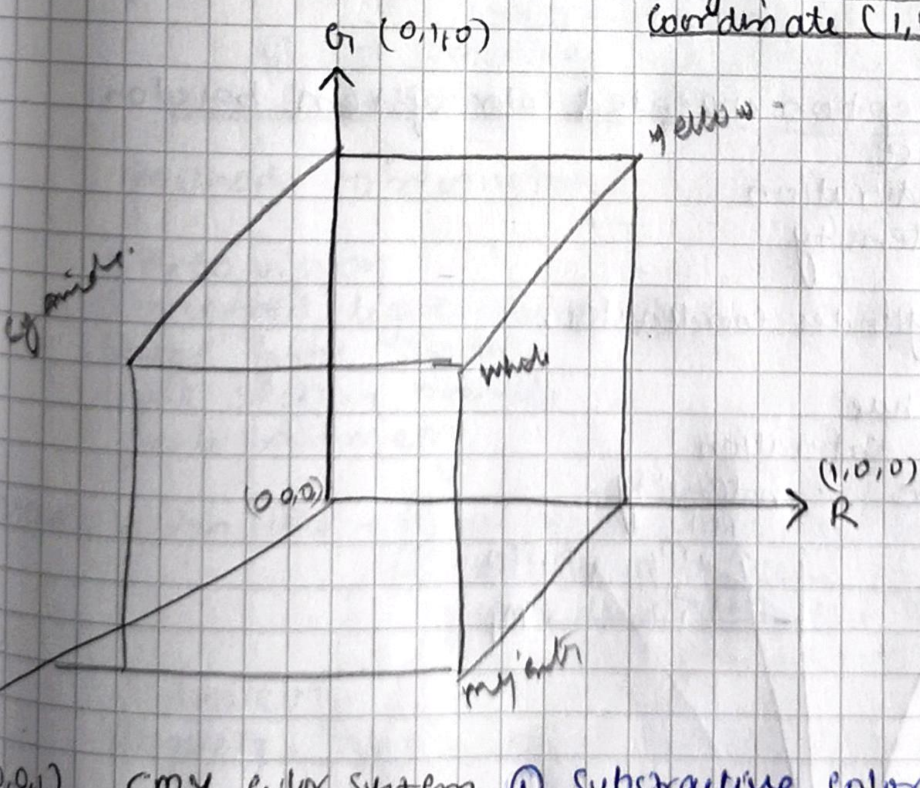
4(C) Intensity → a subjective measure of light energy.

* we assume that we have a trichromatic color model (color consists of 3 primary colors)



The color models we generally have
- Physical technical (RGB)
- Perception based (HSI)

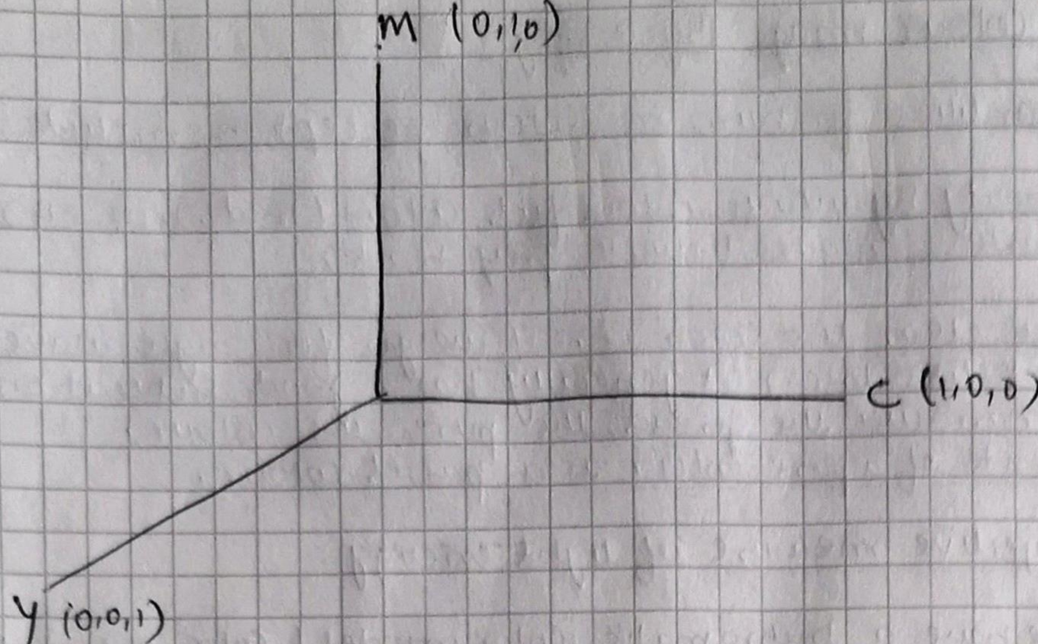
RGB color system: ① All colors are represented as points inside a cartesian color space.
② Additive color model:
origin (0,0,0) → black
coordinate (1,1,1) → white



256x256x256
Resolution.

CMY color system ① Substractive color system with primary colour.
- cyanide
→ magenta
→ yellow

② Unit cube:
black → 1,1,1
white → 0,0,0



* this usage of color system is based on the type of filter we are using in our images.

if RGB Colour filter → RGB system
CMY " " → CMY system.

(4) <u>RGB → CMY</u>

$$\begin{bmatrix} C \\ m \\ Y \end{bmatrix} = \begin{bmatrix} W \\ W \\ W \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

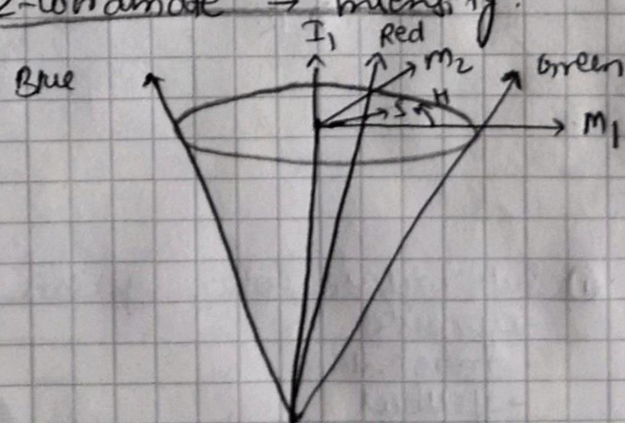
CMY → RGB

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} S \\ S \\ S \end{bmatrix} - \begin{bmatrix} C \\ m \\ Y \end{bmatrix} \qquad \begin{bmatrix} S \\ S \\ S \end{bmatrix} = \begin{bmatrix} W \\ W \\ W \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

<u>HSI Colour System</u> → (1) <u>Perception oriented color system, based on:</u>
hue
saturation
intensity.

(2) <u>Represented in cylinder coordinates.</u>

<u>angle</u> → hue
<u>radius</u> → saturation
<u>z-coordinate</u> → intensity.



$$\begin{bmatrix} m_1 \\ m_2 \\ I_1 \end{bmatrix} = \begin{bmatrix} \frac{2}{\sqrt{6}} & \frac{-1}{\sqrt{6}} & \frac{-1}{\sqrt{6}} \\ 0 & \frac{1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \\ \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{3}} \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

→ In cylinder coordinates:

$$H = \arctan\left(\frac{m_1}{m_2}\right) \qquad S = \sqrt{m_1^2 + m_2^2} \qquad I = I_1\sqrt{3}$$

→ from HSI to RGB

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} \frac{2}{\sqrt{6}} & 0 & \frac{1}{\sqrt{3}} \\ \frac{-1}{\sqrt{6}} & \frac{1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \\ \frac{-1}{\sqrt{6}} & \frac{-1}{\sqrt{2}} & \frac{1}{\sqrt{3}} \end{bmatrix} \cdot \begin{bmatrix} m_1 \\ m_2 \\ I_1 \end{bmatrix}$$

when we use CFs, we lose information because the surrounding pixels are also interpolated into the result. We can solve this by having higher resolution of our images crisp.

specially suited for removing grey areas using thresholds in color image processing.

YIQ-color system ① Origin → TV technology

→ 3d image processing ① most of the imaging methods ~~project the~~ 3D world information on a 2D image plane.
② But sometimes, we need (eg. depth information) to correctly reconstruct the scene.

methods to reconstruct 3d-information.

Stereo vision
Structured light illumination
Shape from shading
Light section methods
Photogrammetry

Stereo vision idea → ① we see the 3d-scene from 2 perspective (different)
② we get at our images, ~~dapo~~ ~~different~~ same world point at 2 different locations

$$\text{Distance}(m) = \frac{\text{base width}(m) \cdot \text{focal length}(pel)}{\text{disparity}(pel)}$$

Scale information is needed, provided by base width.