ARAVIND
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# Lecture 15
## Color Image Processing

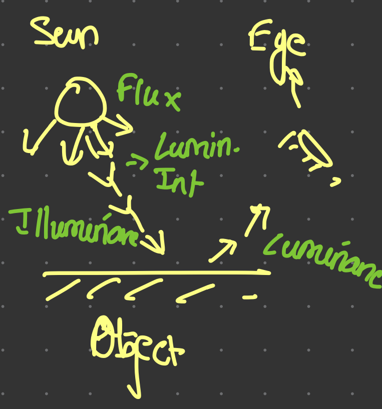
Color as a 1) Physical phenomenon [Spectrum]

Radiance: Total amount of energy flow [in Watts]

Luminance: Amount of energy an observer perceived from source [candela/m²]

Brightness: Subjective descriptor

Illuminance: [Lumens/m²]




2) Physiopsychological phenomenon

→ Human visual system [Rods & Cones]

S (blue)

M (green)

L (Red)

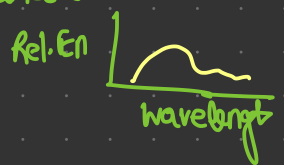
→ Based on wavelength of light they best respond to.

→ Respond to all but its relative concept

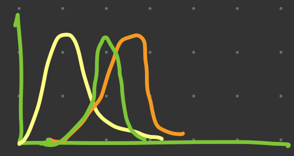
Illumination:

Relative energy & Wavelength

Reflectance:




Cone sensitivity curves



$$\underbrace{\text{Intensity} = 0.299 * \text{Red} + 0.587 * \text{Green} + 0.114 * \text{Blue}}_{\text{Weighted function of R, G, B value}}$$

→ Perception of color is entirely arbitrary creation of nervous system

→ Not contained/dependent on wavelengths

## Primary Colors

→ Additive Color scheme

↳ Other colors are obtained by adding R, G, B

↳ On combination can produce lighter colors offering good contrast

No. of colors one can differenciate based on number of primary color receptors

## Perceived colors:

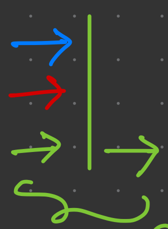
Determined by nature of light reflected from an object

$f(\text{Light}, \text{Object})$

## Subtractive Color Scheme:

→ Used in painting, printing

→ Starts with white, colored ink "subtracts" available color



↳ Example of subtractive scheme

Additive: Think of as lights

Subtractive: Think of as color pigments

Example: Magenta: Red + Blue    White - Green

Cyan: Blue + Green    White - Red

## Passive displays:

Absorb light

We use CMYK → Needed to produce deep dark

→ RGB are already dark

→ Layering is even darker

→ So less possiblity of lighter colors

→ CMYK are lighter, so covers most color range

## RGB color space:

$\rightarrow f(x,y) = \alpha_1 R + \alpha_2 G + \alpha_3 B$


→ Color Cube

→ Perceptually non-uniform [Take 2 colors and interpolate b/w them

## Yx y - Chromaticity Diagram

$\underbrace{\text{Luminance}}_{\text{brightness}}$ + $\underbrace{\text{two most distinctive}}_{\text{color}}$ chrominance components

Rim - represents all pure monochromatic colors

→ Helps to separate luminance and chromaticity

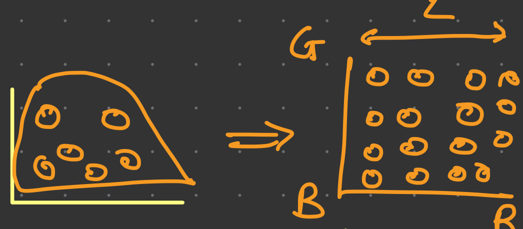
$$\underbrace{(x,y)}_{\text{Chromaticity coordinate}} = \left(\frac{X}{X+Y+Z}, \frac{Y}{X+Y+Z}\right)$$

$XYZ \leftarrow M \cdot RGB$

$Y \downarrow$ Relative luminance

↓ Exactly matches luminous intensity curves

## McAdam Ellipses:




→ ↑L for better resolution.

Region of chromaticity diagram that contains all colors which are indistinguishable from color at center of ellipse

→ Contour represents just noticeable diff of chromaticity

→ Not all same size.

↳ Can cover large range in green

→ Shouldn't use RGB for seeing small diff. So prefer CIE color space

→ Whitening transform to convert to square [normalisation essentially]

(CIE Lab color space)