Color Spaces

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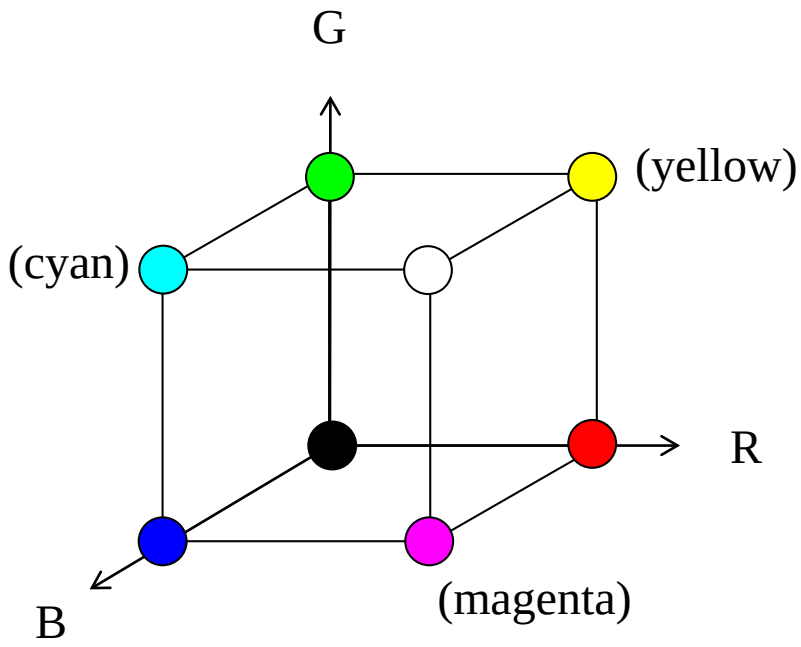
CS 418

Interactive Computer Graphics

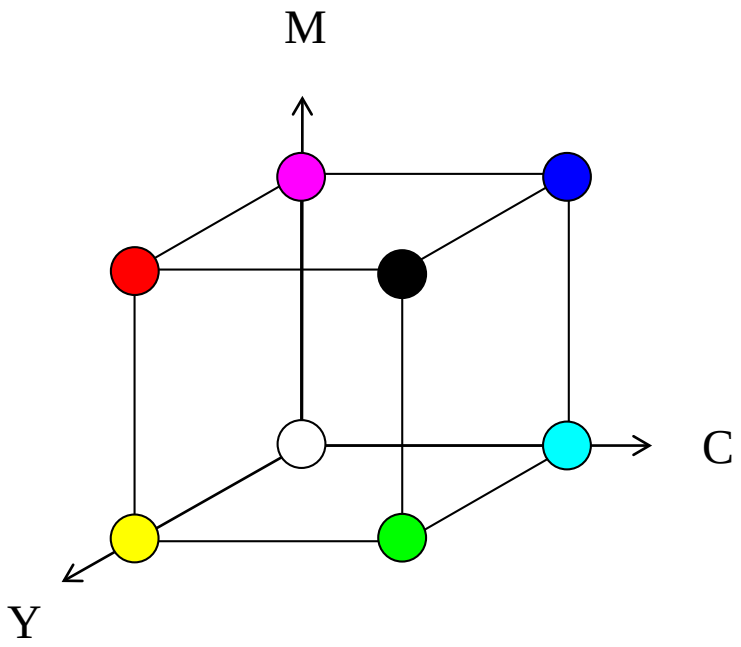
RGB Additive Color

- Red, Green, Blue
- Color model used in luminous displays (CRT, plasma, LCD)
- Designed to stimulate each kind of cone



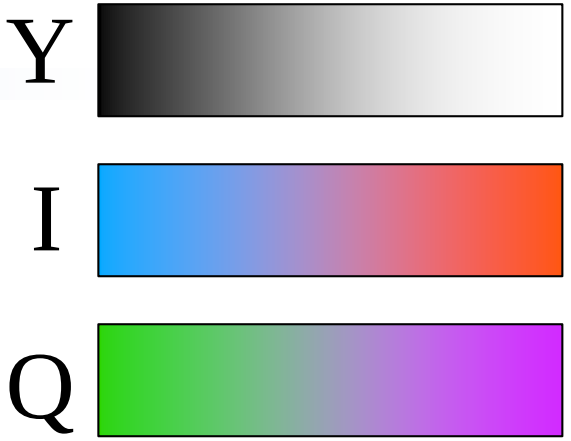
CMY Subtractive Color

- Cyan, Magenta, Yellow
- Color model used in pigments and reflective materials (ink,paint)



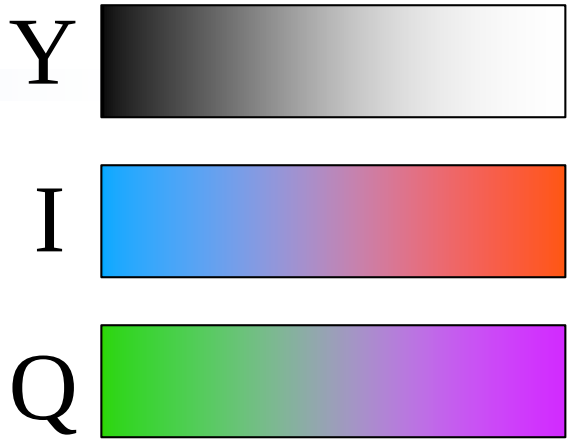
NTSC TV Colors

- YIQ
  - Yluminance = 59%G + 30%R + 11%B
  - Intermodulation (or In-Phase)
  - Quadrature
- Flesh tones in I given more bandwidth than Q, but not as much as luminance
- Luminance resolution of NTSC video is about 500 pixels
- Full-color resolution of NTSC video is about 160 pixels (limited by Q's carrier)



Example by Wikipedia user: (3ucky(3all

NTSC TV Colors



- YIQ
  - Yluminance = 59%G + 30%R + 11%B
  - Intermodulation (or In-Phase)
  - Quadrature

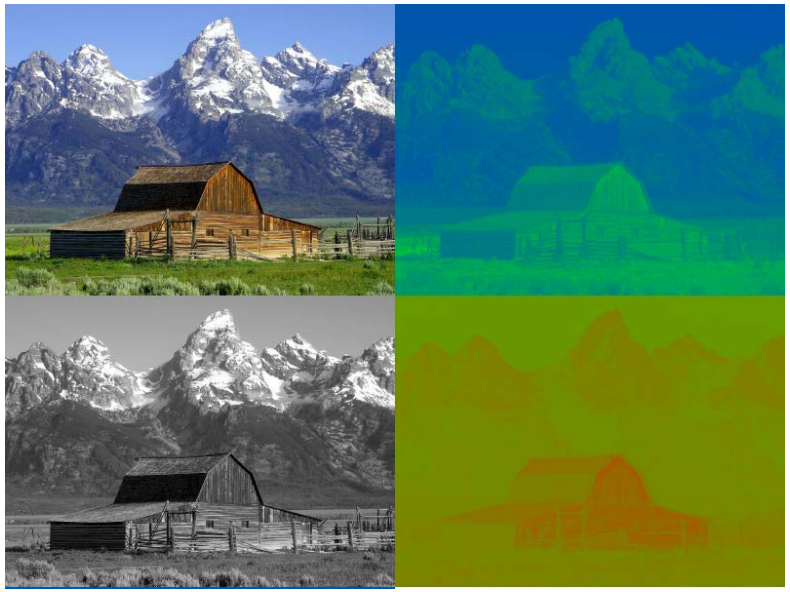
$$Y \in [0,1], \quad I \in [-0.5957, 0.5957], \quad Q \in [-0.5226, 0.5226]$$

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.595716 & -0.274453 & -0.321263 \\ 0.211456 & -0.522591 & 0.311135 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 & 0.9563 & 0.6210 \\ 1 & -0.2721 & -0.6474 \\ 1 & -1.1070 & +1.7046 \end{bmatrix} \begin{bmatrix} Y \\ I \\ Q \end{bmatrix}$$

Digital Video Colors

- YUV
  - yLuminance
  - U ≅ B – Y
  - V ≅ R – Y
- Aka YPbPr (analog) and YCbCr (digital)
- YUV422 transmits pixel pairs with individual luminance but shared chrominance

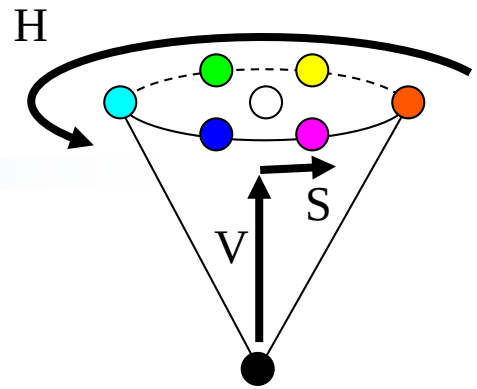


$$Y \in [0,1], \quad U \in [-0.436, 0.436], \quad V \in [-0.615, 0.615]$$

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.14713 & -0.28886 & 0.436 \\ 0.615 & -0.51499 & -0.10001 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1.13983 \\ 1 & -0.39465 & -0.58060 \\ 1 & 2.03211 & 0 \end{bmatrix} \begin{bmatrix} Y \\ U \\ V \end{bmatrix}$$

Selecting Colors



HSV = Hue, Saturation, Value

- 1978, Alvy Ray Smith
- Hue [0,360] is angle about color wheel

  0° = red, 60° = yellow, 120° = green,

  180° = cyan, 240° = blue, 300° = magenta
- Saturation [0,1] is distance from gray

  S = (maxRGB – minRGB)/maxRGB
- Value [0,1] is distance from black

  V = maxRGB

Δ = maxRGB – minRGB

maxRGB = R → H = (G – B)/Δ

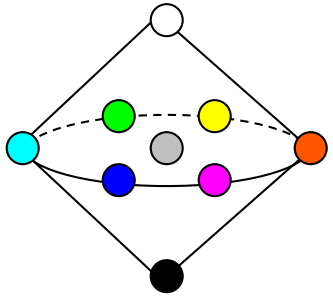
maxRGB = G → H = 2+(B – R)/Δ

maxRGB = B → H =4+ (R – G)/Δ

H = (60*H) mod 360

HLS = Hue, Saturation, Lightness

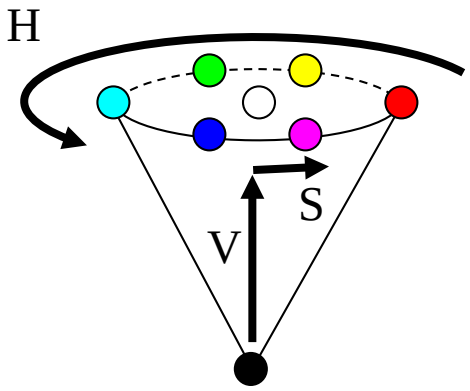
- Double cone, saturation in middle

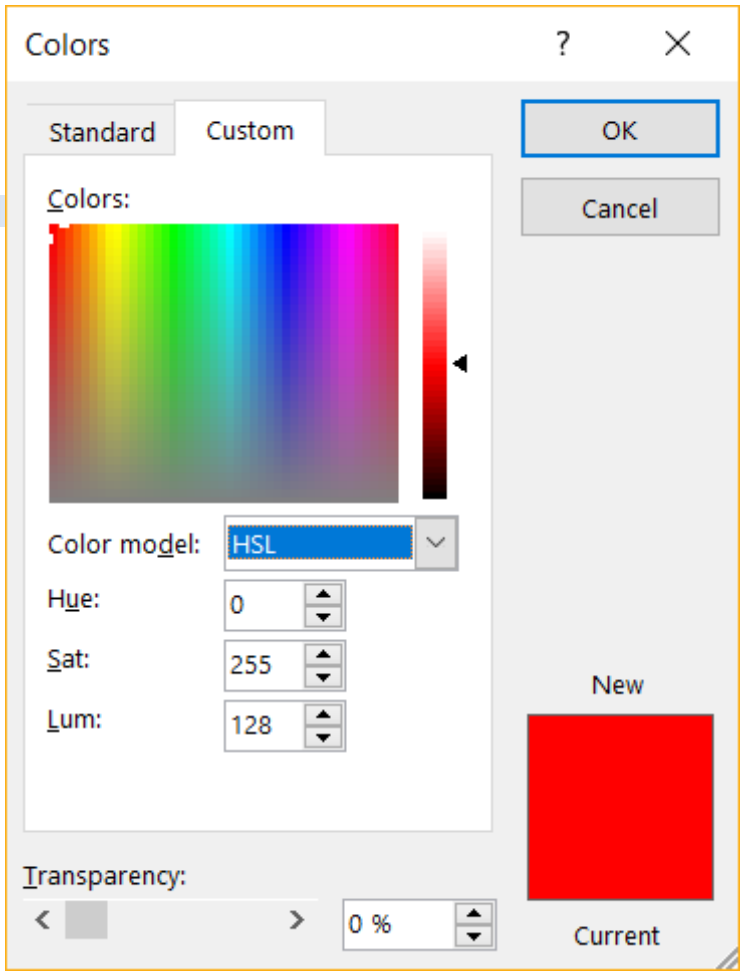


Selecting Colors

HSV – Hue, Saturation, Value

- Single cone, saturation at top





HLS = Hue, Saturation, Lightness

- Double cone, saturation in middle