YIQ COLOR MODEL

- Used for TV broadcasting and video encoding by NTSC. • In this model, Color image is represented by 3 components, YIQ: (Y) and (I , Q)
- The Y-channel contains intensity information (luminance), I and Q channels carry color information (chrominance).
- Designed to separate chrominance and luminance. • Color television set will take these 3 channels Y,I and Q and map the information back to R,G,B levels for display on the screen. • The human visual system is more sensitive to changes in intensity than to changes in hue or saturation.
- Image defined in YIQ model can be expressed as

$$I_{YIQ} = (g_Y, g_I, g_Q)$$

where $g_Y^{(x,y)}$ -> intensity at pixel (x,y)

$g_I(x,y)$ and $g_Q(x,y)$-> color information of pixel (x,y) 1

- Conversion from RGB to YIQ is given by

$$\begin{bmatrix} g_Y(x,y) \\ g_I(x,y) \\ g_Q(x,y) \end{bmatrix} = \begin{bmatrix} 0.30 & 0.59 & 0.11 \\ 0.60 & -0.27 & -0.32 \\ 0.21 & -0.52 & 0.31 \end{bmatrix} \begin{bmatrix} f_R(x,y) \\ f_G(x,y) \\ f_B(x,y) \end{bmatrix}$$

- **Find the YIQ coordinate of a color at (0.2, 1, 0.5) in RGB space.**

$$\begin{bmatrix} g_Y(x,y) \\ g_I(x,y) \\ g_Q(x,y) \end{bmatrix} = \begin{bmatrix} 0.30 & 0.59 & 0.11 \\ 0.60 & -0.27 & -0.32 \\ 0.21 & -0.52 & 0.31 \end{bmatrix} \begin{bmatrix} f_R(x,y) \\ f_G(x,y) \\ f_B(x,y) \end{bmatrix}$$

$$\begin{bmatrix} g_Y(x,y) \\ g_I(x,y) \\ g_Q(x,y) \end{bmatrix} = \begin{bmatrix} 0.30 & 0.59 & 0.11 \\ 0.60 & -0.27 & -0.32 \\ 0.21 & -0.52 & 0.31 \end{bmatrix} \begin{bmatrix} 0.2 \\ 1 \\ 0.5 \end{bmatrix}$$

$$\begin{bmatrix} g_Y(x,y) \\ g_I(x,y) \\ g_Q(x,y) \end{bmatrix} = \begin{bmatrix} 0.30*0.2+0.59*1+0.11*0.5 \\ 0.60*0.2-0.27*1-0.32*0.5 \\ 0.21*0.2-0.52*1+0.31*0.5 \end{bmatrix} = \begin{bmatrix} 0.705 \\ -0.31 \\ -0.323 \end{bmatrix}$$

YUV COLOR MODEL

- Color image is represented by 3 components: luminance (Y) and chrominance (U , V)
- Used in video encoding and transmission by NTSC. • Images having only Y signal components without any U and V components are grey-scale images varying from black to white.
- Image defined in YUV model can be expressed as

$I_{YUV} = (h_Y, h_U, h_V)$

where $h_Y^{(x,y)}$ -> intensity at pixel (x,y)

$h_U(x,y)$ and $h_V(x,y)$ -> color

information of pixel (x,y)

- Good representation of images for compression.
- RGB to YUV conversion

$$\begin{pmatrix} Y \\ U \\ V \end{pmatrix} = \begin{pmatrix} 0.299 & 0.587 & 0.114 \\ -0.147 & -0.289 & 0.436 \\ 0.615 & -0.515 & -0.100 \end{pmatrix} \cdot \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

HSI COLOR MODEL

- This model describes every color with 3 components:

  Hue

  Saturation

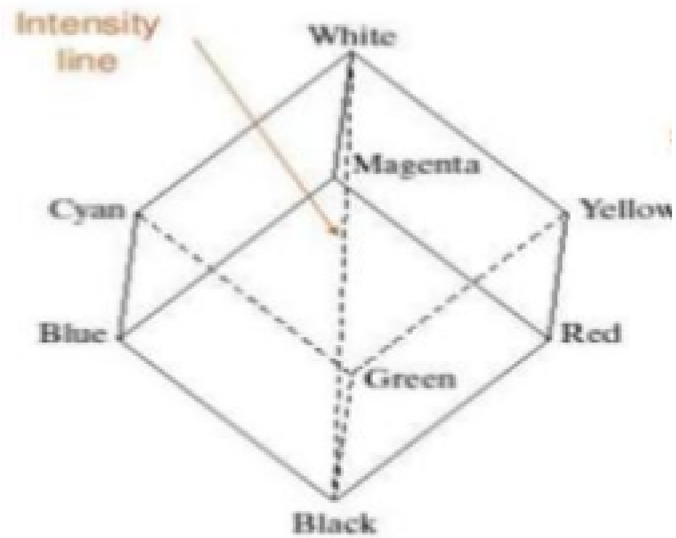
  Intensity

A color image I_{HSI} in the HSI model can be expressed as

$$I_{HSI}=(\phi_H, \phi_S, \phi_I)$$

$\varphi_H(, x\ y)$, the hue of the pixel located at (x, y);
$\varphi_S(, x\ y)$, the saturation of the pixel located at (x, y);
$\varphi_I(, x\ y)$, the intensity of the pixel located at (x, y).

- Now the intensity component of any color can be determined by passing a plane perpendicular to the intensity axis and containing the color point
- The intersection of the plane with the intensity axis gives .us the intensity component of the color.



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- In the hexagonal shape given in fig (a) each primary colors are separated by 120^0. Secondary colors are 60^0 from primaries, which means that angle between secondary's is also 120^0.

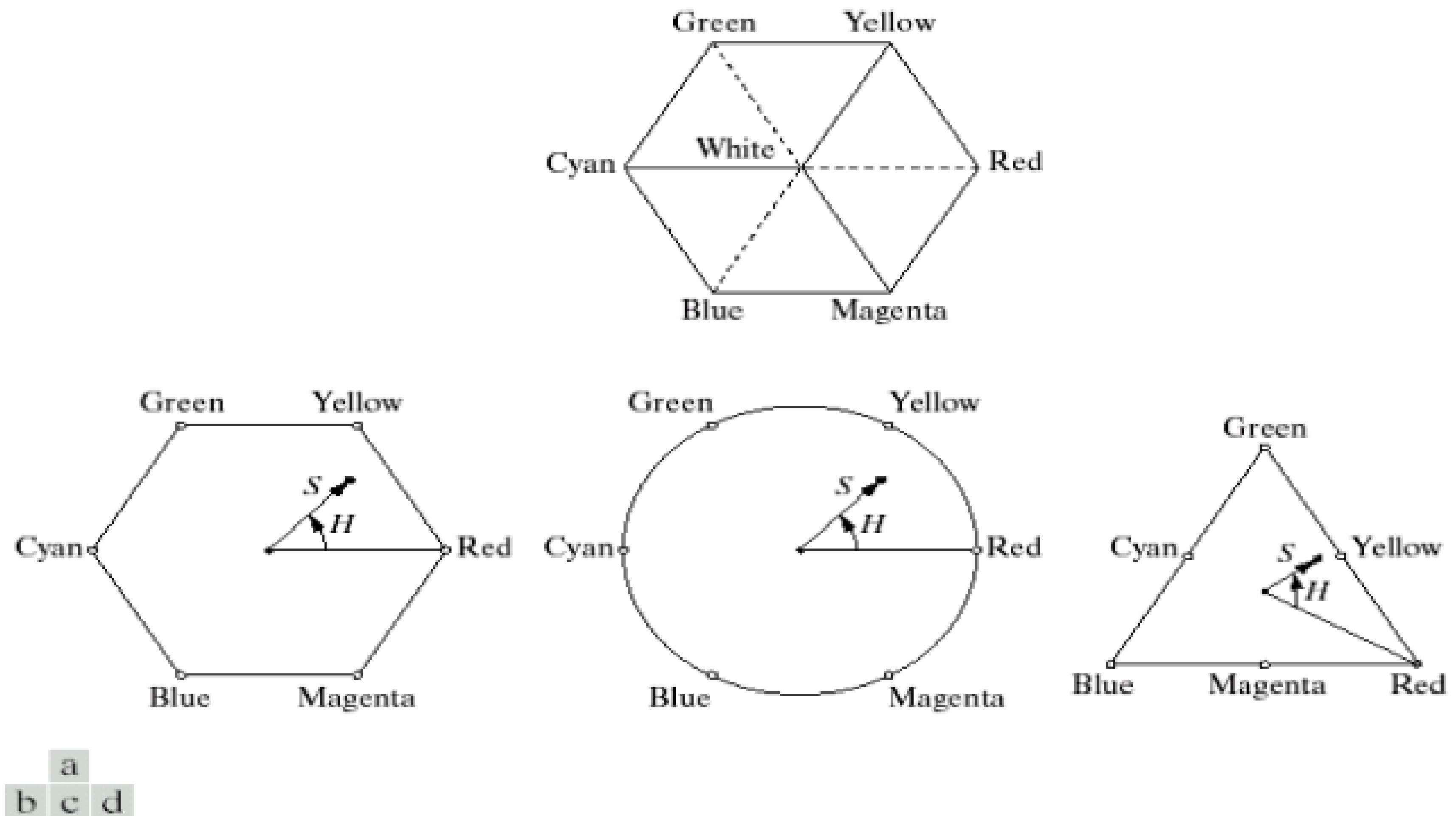

FIGURE 6.13 Hue and saturation in the HSI color model. The dot is an arbitrary color point. The angle from the red axis gives the hue, and the length of the vector is the saturation. The intensity of all colors in any of these planes is given by the position of the plane on the vertical intensity axis.

- Hue of a point is determined by an angle from some reference point usually with red axis and it increases counter clock wise from here.

- Saturation is the distance from the origin to the point.

CONVERSION FROM RGB TO HSI

- Given an image in RGB color format, H component of each RGB pixel is obtained by using the eq

$$H = \begin{cases} \theta & \text{if } B \leq G \\ 360 - \theta & \text{if } B > G \end{cases}$$

with

$$\theta = \cos^{-1}\left\{ \frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2 + (R-B)(G-B)]^{1/2}} \right\}$$

- Saturation is given by.

$$S = 1 - \frac{3 \min(R,G,B)}{(R+G+B)}$$

- Intensity is given by

$$I = \frac{R+G+B}{3}.$$

CONVERSION FROM HSI TO RGB

- RG sector ($0° \le H < 120°$); when H is in this sector, RGB components are given by the equation -

$$B = I(1-S)$$

$$R = I\left[1 + \frac{S\cos H}{\cos(60° - H)}\right]$$

$$G = 3I - (R+B)$$

- GB sector ($120° \le H < 240°$); when H is in this sector, we first subtract 120° from it.

$$H = H - 120°$$

Then RGB components are

$$R = I(1-S)$$

$$G = I\left[1 + \frac{S\cos H}{\cos(60° - H)}\right]$$

$$B = 3I - (R+G)$$

- BR sector ($240^\circ \le H \le 360^\circ$); when H is in this range we subtract 240° from it.

$$H = H - 240^\circ$$

Then RGB components are:-

$$G = I(1-S)$$

$$B = I\left[1 + \frac{S\cos H}{\cos(60^\circ - H)}\right]$$

$$R = 3I - (G+B)$$