

FORMULAE

RGB to HSI Conversion:

First, we convert RGB color space image to HSI space beginning with normalizing RGB values:

$$r = \frac{R}{R+G+B}, g = \frac{G}{R+G+B}, b = \frac{B}{R+G+B}.$$

Each normalized H, S and I components are then obtained by,

$$h = \cos^{-1} \left\{ \frac{0.5 \cdot [(r-g) + (r-b)]}{\left[(r-g)^2 + (r-b)(g-b) \right]^{1/2}} \right\} \quad h \in [0, \pi] \text{ for } b \leq g$$

$$h = 2\pi - \cos^{-1} \left\{ \frac{0.5 \cdot [(r-g) + (r-b)]}{\left[(r-g)^2 + (r-b)(g-b) \right]^{1/2}} \right\} \quad h \in [\pi, 2\pi] \text{ for } b > g$$

$$s = 1 - 3 \cdot \min(r, g, b); \quad s \in [0, 1]$$

$$i = (R + G + B) / (3 \cdot 255); \quad i \in [0, 1].$$

For convenience, h, s and i values are converted in the ranges of [0,360], [0,100], [0, 255], respectively , by:

$$H = h \times 180 / \pi; \quad S = s \times 100 \text{ and } I = i \times 255.$$

HSI to RGB Conversion:

$$h = H \cdot \pi / 180; \quad s = S / 100; \quad i = I / 255$$

$$x = i \cdot (1 - s)$$

$$y = i \cdot \left[1 + \frac{s \cdot \cos(h)}{\cos(\pi/3 - h)} \right]$$

$$z = 3i - (x + y);$$

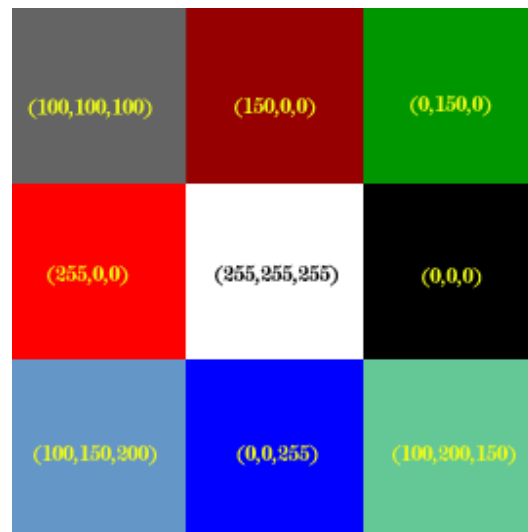
when $h < 2\pi/3$, $b = x$; $r = y$ and $g = z$.

when $2\pi/3 \leq h < 4\pi/3$, $h = h - 2\pi/3$, and $r = x$; $g = y$ and $b = z$.

when $4\pi/3 \leq h < 2\pi$, $h = h - 4\pi/3$, and $g = x$; $b = y$ and $r = z$.

The result r, g and b are normalized values, which are in the ranges of [0,1], therefore, they should be multiplied by 255 for displaying.

Example: An image is shown here:



With RGB values as:

$$\begin{pmatrix} (100,100,100) & (150,0,0) & (0,150,0) \\ (255,0,0) & (255,255,255) & (0,0,0) \\ (100,150,200) & (0,0,255) & (100,200,150) \end{pmatrix}$$

RGB to HSI Conversion:

To compute HSI value of pixel (100,150,200)

1. Normalize:

$$r = \frac{R}{R+G+B} = 0.222, g = \frac{G}{R+G+B} = 0.333, b = \frac{B}{R+G+B} = 0.444$$

2. Here $b > g$, so we compute H value by equation:

$$h = 2\pi - \cos^{-1} \left\{ \frac{0.5 \cdot [(r-g) + (r-b)]}{[(r-g)^2 + (r-b)(g-b)]^{1/2}} \right\} = 1.167\pi$$

Compute S value by:

$$s = 1 - 3 \cdot \min(r, g, b) = 0.333$$

3. Represent H,S,I values in the ranges of [0,360], [0,100] and [0, 255]:
- 4.

$$H = h \times 180 / \pi = 210$$

$$S = s \times 100 = 33.3$$

$$I = (R + G + B) / 3 = 150$$

HSI to RGB Conversion

5. $h = H \cdot \pi / 180 = 7\pi / 6$; $s = S / 100 = 0.333$; $i = I / 255 = 0.588$

6. When $2\pi/3 \leq h < 4\pi/3$, we use following formulae

$$h = h - 2\pi/3 = \pi/2,$$

$$r = x = i \cdot (1 - s) = 0.392$$

$$g = y = i \cdot \left[1 + \frac{s \cdot \cos(h)}{\cos(\pi/3 - h)} \right] = 0.588$$

$$b = z = 3i - (x + y)$$

7. To represent R,G,B values in the ranges of [0,255], [0,255] and [0, 255]:

8.

$$R = 255 \cdot r = 100$$

$$G = 255 \cdot g = 150$$

$$B = 255 \cdot b = 200$$