YCbCr

Y: 強度、亮度
Cb: 藍色、色度
Cr: 紅色、色度

YIQ

Y: 亮度
I: 橙 ←→ 青
Q: 紫 — 黃綠

P[2] P[1] P[0]
R G B

0.299 0.587 0.114

HSI

$$r = \frac{R}{R+G+B}$$

$$g = \frac{G}{R+G+B}, \quad r+g+b=1$$

$$b = \frac{B}{R+G+B}$$

$$R = 3Ir$$
$$G = 3Ig$$
$$B = 3Ib$$
$$I = \frac{1}{3}(R+G+B)$$

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

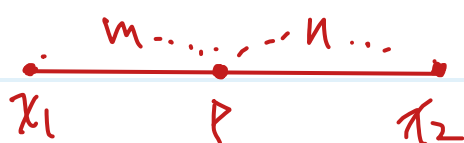$$H = \cos^{-1}\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{\frac{1}{2}}}\right\}$$

Zero-Order

$$\begin{bmatrix} 6 & 7 \\ 5 & 6 \end{bmatrix} \xrightarrow{x2} \begin{bmatrix} 6 & 6 & 7 & 7 \\ 6 & 6 & 7 & 7 \\ 5 & 5 & 6 & 6 \\ 5 & 5 & 6 & 6 \end{bmatrix}$$

First-Order

$$\begin{bmatrix} 6 & 7 \\ 5 & 6 \end{bmatrix} \xrightarrow{x3} \begin{bmatrix} 6 & 6.33 & 6.66 & 7 \\ 5.66 & 5.99 & 6.33 & 6.66 \\ 5.33 & 5.66 & 5.99 & 6.33 \\ 5 & 5.33 & 5.66 & 6 \end{bmatrix}$$
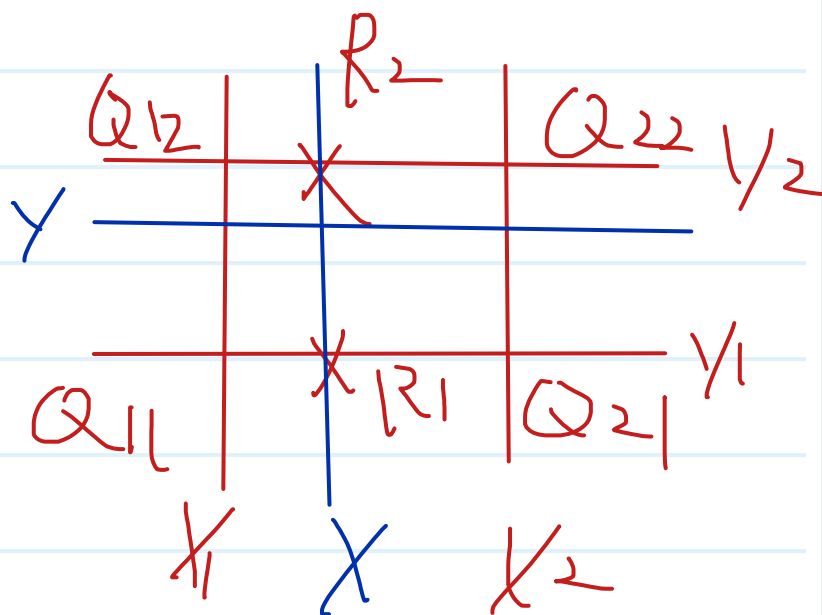
Bilinear Interpolation

$$\overline{X_1 P} : \overline{P X_2} = m : n$$

$$\frac{X_1 - P}{P - X_2} = \frac{m}{n}$$

$$m P - X_2 m = n X_1 - n P$$

$$(m+n) P = n X_1 + m X_2$$
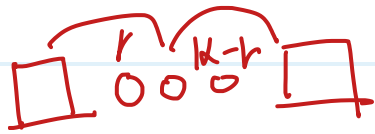
$$P = \frac{n X_1 + m X_2}{m + n}$$

$$R_1 = \frac{X_2 - X}{X_2 - X_1} Q_{11} + \frac{X - X_1}{X_2 - X_1} Q_{21}$$

$$R_2 = \frac{X_2 - X}{X_2 - X_1} Q_{12} + \frac{X - X_1}{X_2 - X_1} Q_{22}$$

$$P = \frac{Y_2 - Y}{Y_2 - Y_1} R_1 + \frac{Y - Y_1}{Y_2 - Y_1} R_2$$

First _ Order

$$r = X \bmod k$$

$$\frac{P\left[n/k\right] \times (k-r) + P\left[\frac{n}{k}+1\right] \times r}{k}$$

Bilinear Interpolation

$$Value[0] = Q_{11}(X_1, Y_1)$$

$$Value[1] = Q_{12}(X_1, Y_2)$$

$$Value[2] = Q_{21}(X_2, Y_1)$$

$$Value[3] = Q_{22}(X_2, Y_2)$$

$$Q_{11} * ((x_1+1) - sx) * ((y_1+1) - sy)$$

$$Q_{12} * ((x_1+1) - sx) * (sy - y_1)$$

$$Q_{21} * (sx - x_1) * ((y_1+1) - sy)$$

$$Q_{22} * (sx - x_1) * (sy - y_1)$$

Histogram Stretch

$$\text{Stretch}(r(x,y)) = \left[\frac{r(x,y) - r(x,y)_{min}}{r(x,y)_{max} - r(x,y)_{min}}\right] \times (S_{max} - S_{min}) + S_{min}$$

Histogram Shrink

$$\text{Shrink}(r(x,y)) = \left[\frac{S_{max} - S_{min}}{r(x,y)_{max} - r(x,y)_{min}}\right] \times (r(x,y) - r(x,y)_{min}) + S_{min}$$

Histogram Slide

$$\text{Slide}(r(x,y)) = r(x,y) + \Delta r$$

Histogram Equalization

$$Pr(r|\alpha) = \frac{h|\alpha}{n}$$

$$S_k = T(r|\alpha) = \sum_{i=0}^{k} Pr(r_i) = \sum_{i=0}^{k} \frac{h_i}{n}$$

$$\text{gray-level}$$

Box-Muller

$$P(X) = \frac{1}{\sqrt{2\pi}} e^{\frac{-x^2}{2}}, \quad P(Y) = \frac{1}{\sqrt{2\pi}} e^{\frac{-y^2}{2}}$$

$$P(X,Y) = \frac{1}{2\pi} e^{\frac{-x^2+y^2}{2}}$$

$$\begin{cases} X = R\cos\theta \\ Y = R\sin\theta \end{cases}$$

$$\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \frac{1}{2\pi} e^{\frac{-x^2+y^2}{2}} dx\, dy$$

$$= \int_0^{2\pi} \int_0^{\infty} \frac{1}{2\pi} e^{-\frac{R^2}{2}} R\, dR\, d\theta = 1$$

$$P_R(R \leq r) = 1 - e^{\frac{-r^2}{2}}$$

$$Z = 1 - e^{-\frac{r^2}{2}}$$

$$e^{-\frac{r^2}{2}} = 1 - Z$$

$$-\frac{r^2}{2} = \ln(1-Z)$$

$$r = \sqrt{-2\ln(1-Z)}$$