What is an Image?

Color Space :-

RGB

HSV

CIE XYZ Y → luminance (dominated by Green)

L*a*b* "Perceptually Uniform"

Image Filtering

Linear Filter (linearity, shift invariance) $\xrightarrow{\text{implement as}}$ convolution

Cross-correlation: $G[i,j] = \sum_{u=-k}^{k} \sum_{v=-k}^{k} H[u,v] F[i+u, j+v]$

$$G = H \otimes F$$

Convolution: (commutative, associative)

$$G[i,j] = \sum_{u=-k}^{k} \sum_{v=-k}^{k} H[u,v] \cdot F[i-u, j-v]$$

$$G = H * F$$

Gaussian filter (separable): $G_\sigma = \frac{1}{2\pi\sigma^2} e^{-\frac{(x^2+y^2)}{2\sigma^2}}$

Sharpen filter: $F + \alpha(F - \underbrace{F * H}_{\text{blur}})$

2 types of noise:
- Gaussian noise — Gaussian filter
- salt-and-pepper noise — Median filter

Thresholding, Padding, ~~

Sampling

Undersampling :

Aliasing : due to not sufficient undersampling, high frequency signal be mapped to low frequency signal.

Shannon's Sampling Theorem : $f_{sampling} \geq 2 \cdot f_{max}$

Fourier Transform / Fourier Series $f(x) \rightarrow f(w)$
$\rightarrow$ sum of sines

How to anti-aliasing? low-pass filter

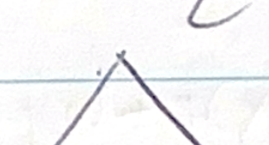
Up sampling :

Linear Interpolation :

$x_1 \quad x \quad x_2$ $\qquad \alpha = \frac{x - x_1}{x_2 - x_1}$

$f(x) = (1-\alpha) f(x_1) + \alpha f(x_2)$

in convolution way : $G_{interpolation}(x_i) = [\quad] \otimes G'$
G' is padded by $G_{original}$

$h(x)$  1D

$h(x,y)$ 2D