lec 3

Image pyramids
Frequency Domain

(1) Any univarite function Can be re-written as a Weighted Sum of Sines, Cosines of different frequencies

Amplitude ← (A) $\sin(\omega x + \theta)$

fourier transform Stores:

(2) (1) magnitude → how much signal at Particular Freq.
(2) Phase → Spatial information (indirectly)

Amplitude $= \pm\sqrt{R(\omega)^2 + I(\omega)^2}$ Phase $= \theta = \tan^{-1}\frac{I(\omega)}{R(\omega)}$

(3) In mathematical way, they are represented as real, Complex numbers

(4) (FFt) ⇒ Fast fourier transform = $N \log N$

(5) Fourier transform of $\boxed{\text{Convolution}}$ of two functions is the $\boxed{\text{product}}$ of their fourier transform

$$F[g*h] = F[g]\,F[h]$$

(6) Inverse Fourier transform of product of 2 Fourier transform is the Convolution of 2 invers Ft

$$F^{-1}[gh] = F^{-1}[g] * F^{-1}[h]$$

Convolution in spatial = Multiplication in Frequency

/ /

Properties of Fourier transform

7 ① linearity ② Symetric about origin
③ energy of Signal = energy of its Fourier transform

8 $\boxed{\text{Gaussian}}$ filter give (more smooth) image than $\boxed{\text{Box}}$ filter

9 lower resolution ⟶ Sampling
Subsampling by factor of 2 < row 1/2, Col 1/2 ⇒ الصورة الجديدة = 1/4 الصورة القديمة

⇓

Aliasing problem

مظاهره ① Wagon wheel ② checkboards disintegrate
③ Striped Shirts looks funny on Color TV

⇓

لذا

Nyquist sampling theorem

هاخذ Sample ضعف
أكبر Frequency

Sampling Frequency must be ≥ 2 X Fmax
Fmax ⟶ max frequency of input Signal

⇓

re Construct the original perfectly from Sampled Version

Anti-Alliasing ⟶ Solution: Sample more often
Get rid of all frequencies that are grater than half the new Sampling frequency

Scanned with CamScanner

Problems ال
مهم

Template Matching

① Correlation ② Zero mean Corellation ③ Sum Square diffrence
④ Normalized Cross Co-relation

① Correlation

Problem : response is Stronger in higher intensity

② Zero mean

Bright pixel above average / dark pixels below

Problem : ① response is Sensitive to gain / Contrast
② pixels in filter (near) have little effect
③ doesn't require pixels in image to be near or proportional to values in filter

③ Sum Square diffrence (SSD)

بس Fast problem: response is Sensitive to overall average intesity

④ Normalized Cross Corelation

كويس $\boxed{✓}$ invariant to mean and Scale of intensity and Contrast

Problem: Slow

Sampling

Image → Gaussian Filter → low pass filtered img $\xrightarrow{\text{Sample}}$ Low Res image

ALADIB

mexican hat

Laplacian filter ⟶ $\boxed{\text{2nd}}$ derivative of $\boxed{\text{Gaussian}}$

↓

2D edge detection ∇^2 ⟶ operator

how many 2d derevative filters ?

↳ 4 ⟶ 2 in x

↳ 2 in y

we can reconstruct original image from laplacian pyramid

Image Pyramids

pixels ⟶ $\boxed{\text{great}}$ spatial resolution

$\boxed{\text{poor}}$ access frequency

fourier transform ⟶ $\boxed{\text{Poor}}$ in spatial

$\boxed{\text{great}}$ in frequency

$\boxed{\text{Pyramids}}$ ⟶ Balance between spatial, frequency

applications

① Compression ② object detection (scale search features)

③ detection stable points

④ Registeration ⟶ Corase-to-fine

Denoising

Smoothing with larger standard deviation suppress noise تقلل
But also Blur image

Salt, Pepper noise (by) Gaussian Smoothing
حل → median filter → non linear
↓
Select median intensity
Not Convolution
Robousst to outliers

Non linear filters

① weighted median
pixels furthur from center count less

② Clipped mean
average, ignoring few bright, dark pixel

③ Bilateral filteral
weign by spatial distace, intensity difference