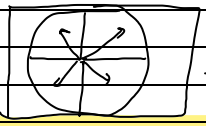
Date = 6/1/2021

↳ Previous class:



→ Near the center of circle have low freq
→ away from the center has high freq

→ filter / transformation function:

↳ Low pass filter

$$H(u,v) = \begin{cases} 1 & D(u,v) \le D_0 \\ 0 & D(u,v) > D_0 \end{cases}$$

* D → distance
↳ Radius

Calculation of D:

$$D(u,v) = \sqrt{\left(u - \frac{M}{2}\right)^2 + \left(v - \frac{N}{2}\right)^2}$$

High pass filter:

$$H(u,v) = \begin{cases} 1 & D(u,v) \ge D_0 \\ 0 & D(u,v) < D_0 \end{cases}$$

① → How to apply filter:

↳ In spatial domain (Already we know)
↳ In frequency domain

In frequency Domain:

↳ We need Magnitude and Phase etc

Magnitude:

$$M = \sqrt{Re^2 + Img^2} \qquad \text{Phase} = \tan^{-1}\left(\frac{Real}{Img}\right)^2$$

In Diagram:

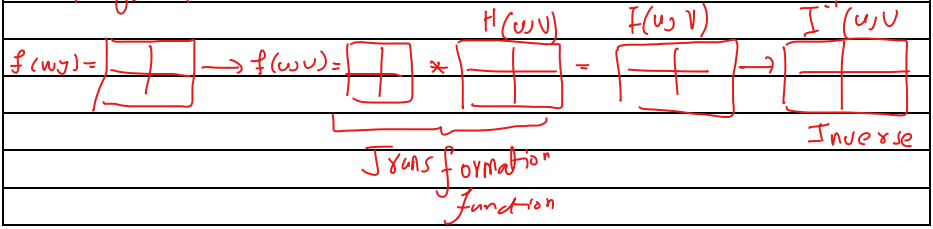


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Image Restoration:

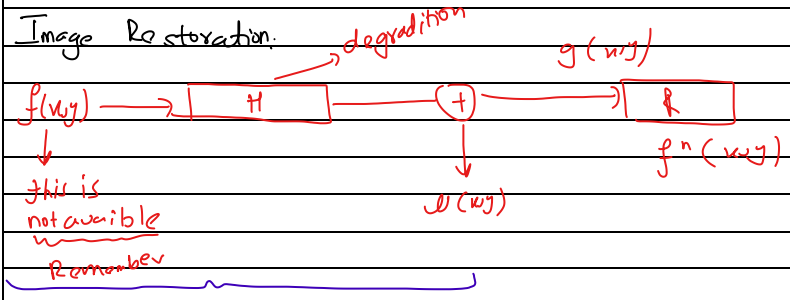
↳ Image Restoration is the process of removing noise (Additive / Multiplicative) from the Image.

Q- what is the difference between Image enhancement and Image Restoration??

↳ Image Restoration is different from the Image enhancement in sense that it is more objective process while Image enhancement is is subjective process.

For example = MRI → is a subjective process because human eye are judge the Image and Give feedback. While objective process first model the noise from the Image. Image noise for example Gaussian Noise

Image Restoration.



During taking Picture.

H = Degradation function.
↳ multiplicative blur
↳ motion blur

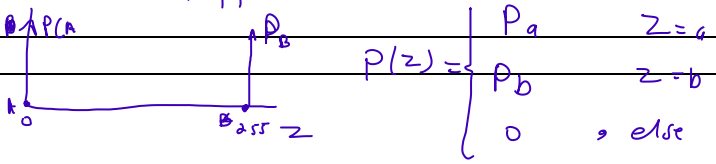
η = Additive Noise

R = Restoration function

↳ we want to choose R such that $\hat{f}(x,y)$ is very close to $f(x,y)$

Noise Models:

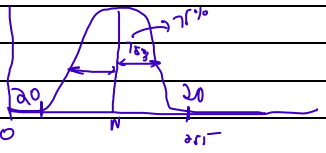
↳ Salt and Pepper noise:



8/12/21

↳ Gaussian Model (Noise)

↳



Density function

$$P(z) = \begin{cases} \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(z-\mu)^2}{2\sigma^2}} & z \geq 0 \\ 0 & z < 0 \end{cases}$$

$$\mu = \frac{1}{M \times N} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} f(i,j)$$

→ (1) → How we given noise is which type?

↳ How to model the noise

↳ first

↳ (i) You have detector (Mobile camera)

(ii) Detector specification and mechanism are available

(iii) If only Image is available

↳ (i) look for Smooth Area of Image and extract a patch

(ii) Draw of Histogram of Image

(iii) Calculate μ and σ

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Image Restoration:

→ Start with classical filter:

① Static filter:

↳ i) Static filters are fixed size (3×3) etc
↳ mean(3,3) filter

ii) Static filters have same behaviour irrespective of the Image
↳ Characteristics
↳ Noise, Non-Noise Pixel)

$f(x,y) =$

3	3	3
3	255	3
3	3	3

$prob(x,y) = 1/9$

↳ patch of Image

iii) Static filter are well suited when the prob of Noise
$P_{noise} < 0.20$ (20%)

② Dynamic / Adaption filters

↳ i) filter size is changing according to the Image Characteristics
ii) Same difference behaviours for (Noise, Non-Noise pexel)
iii) $P_{noise} > 0.20$ well suited

① Static filter:
i) Mean filter

$$g(x,y) = \frac{1}{m \times n} \sum_{(s,t) \in S_{xy}} f(x,y)$$

$S(x,y) =$

3	3	3
3	255	3
3	3	3

N →, M ↓

② Geometric Mean filters:

$$g(x,y) = \left[\prod_{(s,t) \in S_{xy}} \frac{1}{f(s,t)} \right]^{1/mxn}$$

$$\text{mean} = \frac{3 \times 8 + 255}{9} = 31$$

$$\text{G.mean} = \frac{(3^8 \times 255)^{1/9}}{} = 4.9 \approx 5$$

↳ Drawback what happen if Image contains '0'

In mean choose more Information as compared to the A Mean

↳ black object will dilate in G. mean

③ Harmonic Mean:

$$g(x,y) = \frac{mxn}{\sum_{(s,t) \in S_{xy}} \frac{1}{f(s,t)}}$$

→ may be wrong corrected it from side.

④ Contra-Harmonic filters:

$$g(x,y) = \sum_{(s,t) \in S_{xy}} \frac{f(s,t)^{Q+1}}{f(s,t)^{Q}}$$

↳ Q ⇒ be any number (+ve, -ve)

Calculation of Q

If noise is salt:
↳ Q will be negative
If noise is pepper:
↳ Q will be +ve

$$f(1,1) = \frac{3^{-2+1} + 3^{-2+1} + \cdots + 3^{-2+1} + 255}{3^{-2} + 3^{-2} + \cdots + 3^{-2} + 255^{-2}}$$

$$f(1,1) = \frac{8 \times 3^{-1} + 255^{-1}}{8 \times 3^{-2} + 255^{-2}} = 3.004 \approx 3$$

What if choose wrong value of Q???

↳ median filter

↳ for Impulse filter

If we Apply median filter again and again then Image will Increase sharpness.

→ Max filter:

→ Min filter:

→ Midpoint filter from slide:

→ Alpha-Trimmed Mean filter:

$f(x,y) \leftarrow f(r,s) \Rightarrow$ a pixel in Image

3	3	3	3	255	3	3	3	3	3

$\alpha = d/2$ $\alpha = d/2$

$d = mn - 1$ $0 \leq \alpha \leq d/2$

$0 \leq \alpha \leq 4$

If $d = 0$:

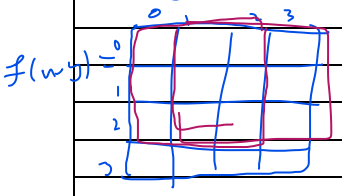
↳ then behave like mean filter.

Short form $\Rightarrow$ ATM

↳ The behaviour of ATM is the Combination of mean filter and median filter.

↳ $\frac{1}{q-4} \sum f(s,t)$ $d = 2\alpha = 4$

Rough Work



→ for

[0,0] + [0,1] + [0,2]

[1,0] + [1,1] + [1,2] →

[2,0] → [2,1] + [2,2]

↓

[0,1] + [0,2] + [0,3]

[1,1] + [1,2] + [1,3]

[2,1] → [2,2] → [2,3]