CSE 428 Image Processing

SPRING 2025

Quiz 3

Marks: 15

ANSWER ALL THE QUESTIONS

Time: 25 mins

Name -
ID -
Section -

Q1. What is the purpose of the Discrete Fourier Transform (DFT) in signal and image processing? [2]
Q2. How can the DFT be used to filter the frequency domain? [1]
Q3. Explain how noise can be removed from an image using the DFT. [1]

Q4.

A 2×2 grayscale image is given as:

$$I = \begin{bmatrix} 12 & 18 \\ 24 & 36 \end{bmatrix}$$

a. Generate 2D DFT. [4]
b. Remove the Min value from the DFT and regenerate the actual image. [4]
c. What type of filter is used in this case? State an application of this. [3]
a. What is DC component? [1]

4Q

$$I = \begin{bmatrix} 12 & 18 \\ 24 & 36 \end{bmatrix}$$

$$F(u,v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y)\, e^{-j2\pi\left(\frac{ux}{M} + \frac{vy}{N}\right)}$$

$$F(0,0) = f(0,0)e^{-j2\pi(0)} + f(0,1)e^{-j2\pi(0)} + f(1,0)e^{-j2\pi(0)} + f(1,1)e^{-j2\pi(0)}$$

$$12 + 18 + 36 + 24 = 90$$

$$F(0,1) = f(0,0)e^{-j2\pi(0)} + f(0,1)e^{-j2\pi\left(0+\frac{1}{2}\right)} + f(1,0)e^{-j2\pi(0+0}$$

$$+ f(1,1)e^{-j2\pi\left(0+\frac{1}{2}\right)}$$

$$= 12 + 18e^{-j\pi} + 24 + 36e^{-j\pi}$$

$$= 36 + 54e^{-j\pi} = \underline{-18}$$

$$F(1,0) = f(0,0)e^{-j2\pi(0+0)} + f(0,1)e^{-j2\pi(0+0)}$$

$$+ f(1,0)e^{-j2\pi\left(\frac{1}{2}+0\right)} + f(1,1)e^{-j2\pi\left(\frac{1}{2}\right)}$$

$$12 + 18 + 24e^{-j\pi} + 36e^{-j\pi}$$

$$30 - 60$$

$$\underline{-30}$$

$$F(1,1) = f(0,0)e^{-j2\pi(0)} + f(0,1)e^{-j2\pi\left(\frac{1}{2}\right)} + f(1,0)e^{-j2\pi\left(\frac{1}{2}\right)} + f(1,1)e^{-j2\pi\left(\frac{1}{2}+\frac{1}{2}\right)}$$

$$= 12 + 18e^{-j\pi} + 24e^{-j\pi} + 36e^{-j2\pi}$$

$$= 6$$

$$\therefore DFT = \begin{bmatrix} 90 & -18 \\ -30 & 6 \end{bmatrix}$$

Remove min $= \begin{bmatrix} 90 & -18 \\ 0 & 6 \end{bmatrix}$

∴ Regenerate with inverse formula

$$f(x,y) = \frac{1}{M \times N} \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} F(u,v) e^{-j2\pi\left(\frac{ux}{M} + \frac{vy}{N}\right)}$$

$$F(0,0) = \frac{1}{4}(90 - 18 + 0 + 6) = 19.5$$

$F(0,1) = \frac{1}{4}(90 + 18 - 6) = 25.5$

$F(1,0) =$ ~~$\frac{1}{4}(90 - 100 - 6)$~~ 16.5

$F(1,1) = 28.5$

$$\begin{bmatrix} 19.5 & 25.5 \\ \text{~~26.5~~ } 16.5 & 28.5 \end{bmatrix}$$

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Quiz 4

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A	B	C	D	E	F	G	H	I	J	K	L	M	N
Layer	Input Volume			Hyperparameters				Output Volume			Memory (KB)	Learnable parameters (K)	FLOPs (M)
	Hin	Win	Cin	Filters	Size	Stride	Pad	Hout	Wout	Cout			
conv1	542	542	3	30	11	4	2	135	135	30	2136	11	198
pool1	135	135	30		3	2	0	67	67	30	527	0	0
conv2	67	67	30	72	5	1	2	67	67	72	1263	54	242
pool2	67	67	72		3	2	0	33	33	72	306	0	0
conv3	33	33	72	64	3	1	2	35	35	64	306	41	51
conv4	35	35	64	48	3	1	2	37	37	48	257	28	38
conv5	37	37	48	48	3	1	2	39	39	48	285	21	32
pool3	39	39	48		3	2	0	19	19	48	68	0	0
flatten	19	19	48										
fc1			17328	2256									
fc2			1222	1222									
fc3 (output)			1222	3									
Total											0	0	0