The LNM Institute of Information Technology

ECE and CCE

ECE4141: Introduction to Image Processing

Mid Term

Time: 90 minutes	**Date:** 26/09/2019	**Max. Marks: 30**

Instructions: *1) Start each answer on a fresh page of your answer book and highlight your answer number.*
*2) Check that your Question paper has **6 Questions**.*

Q1. **[1x2=2]**

a) The smaller cutoff frequency of a Low Pass Filter results in _increase_ blurring effect. (increase/decrease)

b) Process that increases the dynamic range of Gray levels in an image is called ___contrast stretching ______.

Q2. For the following 3 x 3 image (Fig.1), apply contra harmonic mean filter with Q = 1 **[4]**

8	5	3
5	3	2
2	0	4

Fig.1

Ans:

5.8	5.2	3.6
5.5	4.8	3.7
3.8	3.6	3.2

6	5	4
6	5	4
4	4	3

Q3. **[2 x 2 =4]**

a) What happens to histogram if the least significant bit of every pixel is set to 0?

Ans: For a gray image, when we set the lower-order bits to zero, the gray values of many of the pixels will decrease slightly. For example, the binary equivalent of 162 is 10100010. If we set the last 4 bit planes to zero, the number will become 160. However, the values of those pixels will not change which have already zeros at the respective positions. The frequencies of 128, 128+64, 128+64+32, etc. will increase. The histogram may slightly shift to the left.

b) How does 1st order derivative differ from 2nd order derivative in image sharpening?

Ans:

- The 1st-order derivative is nonzero along the entire ramp, while the 2nd-order derivative is nonzero only at the onset and end of the ramp.

- The response at and around the point is much stronger for the 2nd- than for the 1st-order derivative

Q4. Write the steps to perform unsharp masking. Show that subtracting the Laplacian from an image is proportional to unsharp masking. **[3+5=8]**

1st part:

Steps

- Blur $f_b(x,y)$
- Subtract from original image (unsharp mask)

$$mask = f(x,y) - f_b(x,y)$$

- add resulting mask to original image

$$f_{sharp}(x,y) = f(x,y) + mask$$

$$\boxed{f_{sharp}(x,y) = 2f(x,y) - f_b(x,y)}$$

2nd part:

Consider the following equation:

$$\begin{aligned} f(x,y) - \nabla^2 f(x,y) &= f(x,y) - [f(x+1,y) + f(x-1,y) + f(x,y+1) \\ &\quad + f(x,y-1) - 4f(x,y)] \\ &= 6f(x,y) - [f(x+1,y) + f(x-1,y) + f(x,y+1) \\ &\quad + f(x,y-1) + f(x,y)] \\ &= 5\,\{1.2f(x,y) - \\ &\quad \frac{1}{5}[f(x+1,y) + f(x-1,y) + f(x,y+1) \\ &\quad + f(x,y-1) + f(x,y)]\} \\ &= 5\,[1.2f(x,y) - \overline{f}(x,y)] \end{aligned}$$

where $\overline{f}(x,y)$ denotes the average of $f(x,y)$ in a predefined neighborhood that is centered at (x,y) and includes the center pixel and its four immediate neighbors. Treating the constants in the last line of the above equation as proportionality factors, we may write

$$f(x,y) - \nabla^2 f(x,y) \sim f(x,y) - \overline{f}(x,y).$$

The right side of this equation is recognized as the definition of unsharp masking

Thus, it has been demonstrated that subtracting the Laplacian from an image is proportional to unsharp masking.

Q5. Enlist the applications of KL transform. Write the steps to explain how compression can be achieved using KL Transform. **[2+3=5]**

Applications:

1. Compression
2. KL Transform establishes a new coordinate system whose origin is at the center of the object. And the axis of this new coordinate system will be parallel to the direction of the eigen vectors.

- This transform operates in an image of n x n image.
- Create vector x for the object.
- Find mean of the vector. $\mu_x = E\{x\}$
- Find the covariance of the vector. $C_x = E\{(x - \mu_x)(x - \mu_x)^T\}$
- Find the eigen values and eigen vectors from the covariance matrix.
- Eigen vectors should be arranged in such a way that eigen values are arranged in decending order.
- A →1st row : Eigen vector of highest eigen value and other rows so on..
- Y=A(x $- \mu_x$)

Mention about inverse KLT

By removing some of the weak coefficients after performing the forward transform, the image can be reconstructed back approximately to the original form by using inverse transform to it. The removal of the coefficients results in compression of the image.

Q6. Suppose that the gray scale is of range [0, 9] for the image given below (Fig. 2). **[5+2=7]**

0	**5**	**7**	**7**	**5**
7	**2**	**6**	**2**	**6**
6	**9**	**7**	**7**	**0**
6	**6**	**1**	**7**	**6**
9	**6**	**0**	**7**	**8**

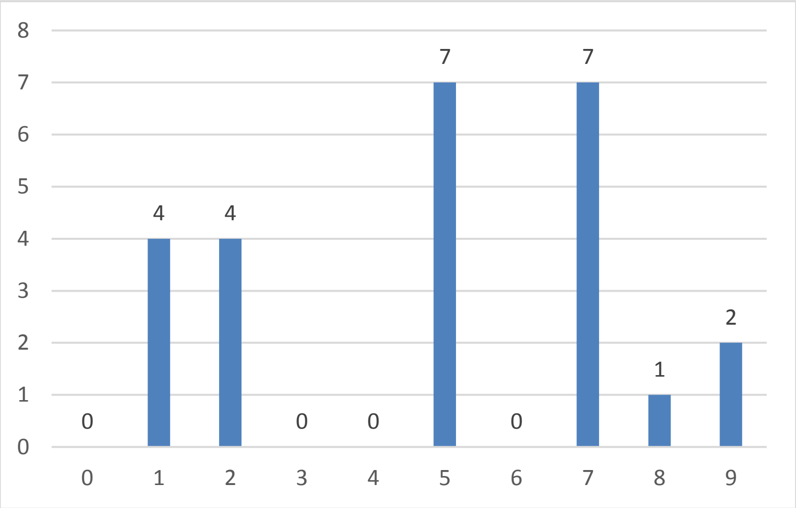
Fig. 2

i) Perform histogram equalization of the above image. Show the resultant image and its corresponding histogram.

ii) What will happen if we apply histogram equalization to the above result (part i).

Ans:

i/p	o/p
0	1
1	1
2	2
3	2
4	2
5	2
6	5
7	7
8	8
9	9



If we apply histogram equalization to the above result, we will obtain the same result as input.
