2022

COMPUTER SCIENCE

Paper : CSME-301

(Image Processing and Pattern Recognition)

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

enhance

Answer *question nos.* 1 and 2, and *any four* from the rest.

1. Answer *any five* questions : 2×5

(a) Can histogram equalization always provide a better result? State your reasons.

(b) For median filters, what is the difference between a large kernel size and a small one? Which one outperforms the other?

(c) What type of operation can be applied to accomplish edge detection in images and why?

(d) What are the advantages of m-adjacency over 8-adjacency?

(e) How does the Weber Ratio affect the brightness of an image?

(f) Consider the continuous function, $f(t) = \sin(2\pi t)$. What would the sampled function look like if $f(t)$ is sampled at the Nyquist rate with samples taken at $t = 0,\ \Delta T,\ 2\Delta T, \ldots$?

(g) Give the formula for calculating D4 (city block distance) and D8 distance (chess board distance).

(h) How does correlation differ from convolution? Show with an example.

2. Answer *any five* questions : 4×5

(a) 'Histogram matching' is a useful contrast manipulation technique that transforms an image's histogram to match one of another image. Describe clearly how you achieve it.

(b) Given an image with impulse noise, Alice applies MINMAX after MAXMIN while Bob adopts MAXMIN after MINMAX. Would they get the same results ? Why or why not ?

(c) Consider the two image subsets, S1 and S2, shown in the following figure. For V = {1}, determine these two subsets are—

1. 4-adjacent
2. 8-adjacent
3. m-adjacent

	S_1				S_2				
0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	1	1	0	0	0
0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

(d) Discuss using examples the log and power-law transformation used for spatial image enhancement.

(e) 'Cluster seeking algorithms can be applied to unsupervised learning'. Justify.

(f) What is adaptive filtering? Explain the purpose of adaptive median filtering and its advantages over conventional median filtering.

(g) What is the motivation of sharpening filters? Critically comment on the following statement: "Second derivative enhances fine detail much better than the first derivative".

3. (a) Convert the following 3-bit RGB image to CMY model :

1,2,5	4,1,5	5,4,2	2,1,4
3,6,5	4,1,3	6,6,1	5,4,1
2,1,4	3,1,4	4,2,3	1,4,3
3,2,1	3,1,3	1,1,2	2,3,1

(b) Explain different noise models used. Mention its application in different types of noises. 5+5

4. (a) Write an algorithm for histogram specification.

(b) Plot the histogram of the following 8×8 image :

0	5	7	7	5	8	7	8
7	2	6	2	6	5	6	8
6	9	7	7	0	7	2	7
6	6	1	7	6	7	7	5
9	6	0	7	8	2	6	7
2	8	8	2	7	6	7	8
7	3	2	6	1	7	5	8
9	9	5	6	7	7	7	7

(c) Perform the histogram equalization of the image. Output the resultant image and its corresponding histogram. 3+2+5

5. Write the application of sharpening filters. Consider the following image segment. Perform the following transformation on the shaded pixels: (i) image negative, (ii) Log, (iii) Gamma correction, (iv) contrast stretching in [0, 8] (v) segmentation using mean intensity threshold : 5+5

15	6	21	22
17	15	6	19
14	3	11	12
19	14	19	16

6. (a) Cluster the dataset {(0, 0), (0, 1), (5, 4), (5, 5), (4, 5), (1, 0)} by (i) Applying the Maximin Distance Algorithm, and (ii) the k-means algorithm.

(b) How can gradient operators be used for Edge Detection? (3+3)+4

7. (a) Perform shear (vertical) and shear (horizontal) transformation on the following matrix and show them :

5	4	6	3
2	3	1	3
2	4	5	1
1	3	4	2

(b) Given two pattern classes, each containing five three-dimensional distinct patterns. Assume that all patterns are well distributed. It is desired to construct a polynomial decision function which can separate the two classes, regardless of the geometrical arrangement of the patterns, as long as they are well distributed. What is the minimum number of coefficients required?

(c) Assume that the following pattern classes have normal probability density functions :
w_1 : {(0, 0), (2, 0), (2, 2), (0, 2)} and w_2 : {(4, 4), (6, 4), (6, 6), (4, 6)}. Assuming $p(w_1) = p(w_2) = 0.5$, obtain the equation of the Bayes decision boundary between these two classes. 2+4+4

g

$$p(z) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{\overline{z-z}^2}{2\sigma}}$$

R

$$p(z) = \begin{cases} \frac{2}{b}(z-a)e^{-(z-a)^2}, & \text{if } z \geq a \\ 0, & \text{if } z < a \end{cases}$$