



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: March 2022

Module Number: EE7204 Module Name: Computer Vision and Image Processing

[Three Hours]

[Answer all questions, each question carries 10 marks]

All notations have their usual meanings.

- Q1 a) i) What is image enhancement?
ii) List two main image enhancement methods. [2 Marks]
- b) Basic relationships between pixels include neighbourhood, adjacency, connectivity, paths, region and boundary.

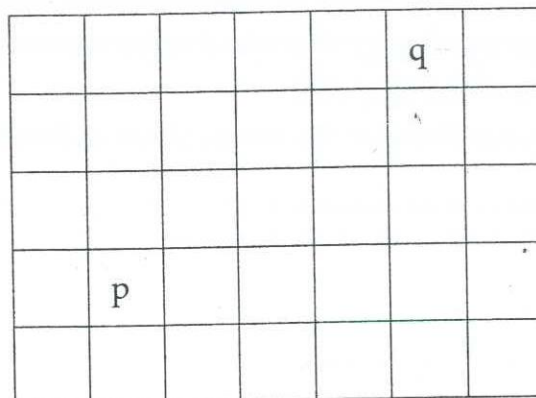


Figure Q1 (b)

- i) Consider the pixel p which is at $(2,4)$ as shown in Figure Q1 (b). Write the coordinates of $N_4(p)$ and $N_D(p)$. The size of neighborhood is 3×3 .
- ii) Consider the pixel q which is at $(6,1)$ as shown in Figure Q1 (b). Calculate the Euclidian distance and Chessboard distance between pixels p and q . [4 Marks]
- c) Images represented in the RGB colour model consist of three component images – one for each primary colour.
- i) Calculate the total number of colours in a 24-bit RGB model.
- ii) Convert the RGB value $(0, 255, 0)$ to CMY. Assume each pixel is represented using 8 bits. [2 Marks]
- d) Briefly describe following terms in the context of Digital Image Processing.
- i) Sampling
- ii) Quantization [2 Marks]

- Q2 a) i) Mention one similarity and one difference between Histogram equalization and Contrast stretching.
- ii) Equalize the histogram of the gray image shown in Figure Q2 (a). You should show the design of the mapping, mapping for each gray level and the final equalized matrix. The gray levels given in the image are from 0 to 7.

5	5	5	5	5
4	5	6	5	4
4	6	6	6	4
4	5	6	5	4
5	5	5	5	5

Figure Q2 (a)

[4 Marks]

- b) i) Averaging spatial filter helps in smoothing the image. However, it will have blurring effect. Briefly describe 2 ways we can change the averaging filter to avoid this blurring effect.
- ii) Apply 3×3 median filter for the image given in Figure Q2 (b).

0	2	1	1
1	2	3	3
0	1	0	1
1	2	1	4

Figure Q2 (b)

[3 Marks]

- (c) Describe the functionality of Butterworth Low-pass Filter (BLPF).

[2 Marks]

- (d) How many frequency components you will get if you convert the grayscale image in Figure Q2 (d) to frequency domain? The intensity values are shown in the Figure.

0	40	80	120	160	200	230	255	230	200	160	120	80	40	0
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Figure Q2 (d)

[1 Marks]

- Q3 a) i) Describe the information obtained by applying first derivative and second derivative operators on an image in edge detection.
- ii) Why it is important to smooth an image before applying first derivative and second derivative operators?
- [3 Marks]
- b) i) Write a pseudo code to find the global threshold to segment small objects in an image.
- ii) Can we use basic global threshold algorithm for any image to segment objects? Briefly justify your answer.
- [3 Marks]
- c) Segment the image in Figure Q3 (c) using the region growing technique. Use the shaded pixel as the seed and use intensity difference between pixels ≥ 8 as the condition. Use 8 connected neighbors when applying the predicate.

20	25	24	30	27	23	12	22
24	22	33	32	7	34	19	15
22	34	31	12	8	33	18	15
35	6	15	14	9	32	31	29
23	32	17	15	29	8	34	28
22	6	11	35	8	7	32	22
21	23	39	13	9	7	30	20
19	24	31	16	9	6	31	18

Figure Q3 (c)

[2 Marks]

- d) Consider the structuring element on Figure Q4 (d.1). Note that the origin is marked by a "x". Apply the morphological closing operation on Figure Q4 (d.2) using the structuring element Figure Q4 (d.1). You should show the intermediate steps.

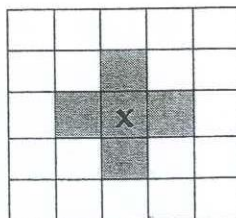


Figure Q4 (d.1)

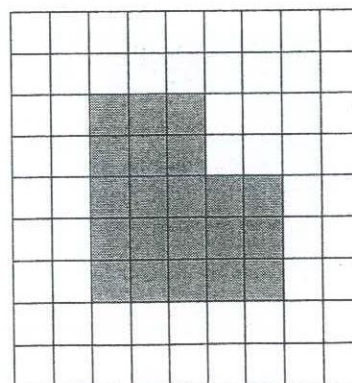


Figure Q4 (d.2)

[2 Marks]

- Q4 a) i) Describe one application and one challenge in computer vision.
 ii) Briefly explain how machine learning can be incorporated with traditional computer vision. [3 Marks]
- b) Describe the following steps in Image Mosaicing Model.
 i) Image registration
 ii) Image warping [2 Marks]
- c) i) Describe the main idea behind Harris Corner Detector.
 ii) Briefly explain why Harris Corner Detector is often used in stereo matching and image database retrieval. [3 Marks]
- d) Briefly describe two advantages of Scale Invariant Feature Transform (SIFT). [2 Marks]

- Q5 a) List two applications of Video Image Processing. [1 Marks]
- b) Why is optical flow not always the same as motion field? Discuss with an appropriate example. [2 Marks]
- c) What are binocular and monocular cues? Briefly discuss them by giving examples. [2 Marks]
- d) Using an appropriate diagram, explain how cameras perform depth estimation in stereo vision. [3 Marks]
- e) Figure Q5 (e.1) and Figure Q5 (e.2) represent two images. Calculate the Sum of Squared Difference (SSD) window cost between the given two shaded windows.

46	46	46	46
46	46	44	44
57	47	47	57
56	56	46	46

Figure Q5 (e.1)

46	46	46	46
48	46	44	42
47	47	47	47
58	46	46	58

Figure Q5 (e.2)

[2 Marks]