UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: March 2021

Module Number: EE7207 **Module Name: Computer Vision and Image Processing**

[Three Hours]

[Answer **all questions**, each question carries 10 marks.
Attach Page 7 to your answer script]

(Q1)

(a) Give two real world examples of using power low (Gamma) transformation.

[1 mark]

(b) List and briefly describe the two (2) main steps when generating digital image from sensor data.

[2 marks]

(c) Briefly explain the difference between active display and passive display. Give example colour models used in each display type.

[2 marks]

(d) Figure Q1.1 is a low contrast image. Give an image processing technique that can be used to get better contrast.

[1 mark]

(e) Assume that an Engineer has been given X-ray images of a turbine blades. He has to find damaged blades. State and describe the best approach that he can use to find damaged blades?

[1 mark]

(f) Write pseudocode or MATLAB/Python code to remove salt and pepper noise using average filter from an image. Consider neighborhood size as 3x3 and image is in grayscale.

[2 marks]

(g) A mobile phone manufacturing company has announced a new mobile phone called **X100**. In the specification sheet, they have mentioned that X100 display can simulate 16 million colours. Describe how they were able to simulate 16 million colours using your knowledge on displays.

[1 mark]

(Q2)

(a) State the information that can be obtained by applying the first derivative operators on an image.

[1 mark]

(b) What are the factors that the Scale Invariant Feature Transform (SIFT) is robust? Briefly explain how the SIFT achieves its scale invariant feature.

[2 marks]

(c) Laplacian of Gaussian (LOG) is little costly for SIFT algorithm. State and briefly explain the alternative operation used in SIFT.

[2 marks]

(d) When an image is processed in frequency domain, there is an annoying effect in images and video appears as rippling artifact near sharp edges.

(i) State the name of this effect.

[0.5 mark]

(ii) Explain the reason for this effect and provide a solution for removing this effect?

[1 mark]

(e) When some programmer applied an average filter to remove salt and pepper noise, then he notices a blur effect in the image.

(i) What is the best alternative filter that he can use to remove the same noise without bothering about the blur effect?

[0.5 mark]

(ii) Briefly explain how the filter that you mentioned in (e)(i) does not cause a blurring effect?

[1.0 marks]

(f) Equalize the histogram of the image shown in Figure Q2.1. There are 8 possible gray levels from 0 to 7. Use Figure A2.1 grid to draw resultant image and showcase the steps in answer sheet.

[2 marks]

(Q3)

(a) Morphological operations are mostly used after image segmentation. What is the reason for that?

[1 mark]

(b) Describe the operations of morphological erosion and dilation.

[2 marks]

(c) Image segmentation is a very important stage in image processing. State two (2) discontinuity-based image Segmentation approaches.

[1 mark]

(d) One of the segmentation methods is thresholding. Improved version of thresholding is known as Basic Global thresholding. State the steps of Basic Global thresholding algorithm.

[2 marks]

(e) Consider structuring element in Figure Q3.2. Note that origin is marked by an "X" (use 0 to represent black, 1 to represent white and, empty cells to be considered as 0).

(i) Apply the morphological operation "opening" on Figure Q3.3 using structuring element Figure Q3.2. Use Figure A3.1 to answer and showcase steps in answer sheet.

[2 marks]

(ii) Apply the morphological operation "closing" on Figure Q3.3 using structuring element Figure Q3.2. Use Figure A3.2 to answer and showcase steps in answer sheet.

[2 marks]

(Q4)

(a) What is the main disadvantage of second order derivative operators? State how the Laplacian of Gaussian (LOG) operator overcomes that.

[2 marks]

(b) State and briefly explain any three (3) steps in image-mosaicing.

[2 marks]

(c) When image processing is done in the frequency domain, what is the purpose of applying logarithmic transformation to magnitude image obtained by Discrete Fourier Transform (DFT)?

[1 mark]

(d) If the Fourier transform of image f(x,y) is represented by F(u,v), then what is the property obtained by F(0,0)?

[1 mark]

(e) Find the HSV (Hue, Saturation, Value) values when the RGB (Red, Green, Blue) value (240,240,0) is converted to HSV. Assume Hue range 0 to 360, Saturation and Value range 0 to 255 (Hint: Value of the red colour is 255).

[1 mark]

(f) State the operation that can be used to convert the image given in Figure Q4.1 to image in Figure Q4.2.

[1 mark]

(g) In a power plant boiler; the temperature is constantly monitored using an infrared (IR) camera. Describe how you are going to highlight high temperature areas.

[2 marks]

(Q5)

(a) List two (2) examples that optical flow and motion filed are not coinciding.

[1 mark]

(b) State two (2) monocular cues used by human vision system. Give an example for each cue.

[2 marks]

(c) When doing image processing; optical flow and motion field are familiar terms.

(i) State one (1) factor which affects the optical flow and one (1) optical flow calculation algorithm?

[1 mark]

(ii) Provide an example for each of the cases where one case (Case I) is having the optical flow field same as the motion field and the other case (Case II) having zero motion field and non-zero optical field.

[1 mark]

(d) When using a surveillance camera, background is relatively constant. What simple technique can be used to detect motion in this scenario?

[1 mark]

(e) You are given two (2) stereo cameras (L and R). They are setup according to Figure Q5.1 with parallel optical axis. Figure Q5.2 represents the two images taken by the camera. Further f=0.5, b=100

(i) Derive the equation to find the depth (z) using disparity, focal length and baseline Figure Q5.1. (Hint: $d(disparity) = xl - xr$).

[1.5 marks]

(ii) Using SSD (Sum of Squared Difference), find the disparity. Hence find the distance to the object from camera. Assume all distance are in same.

[2.5 marks]

Figure Q1.1: Low contrast image

6	5	4	4	5
5	4	4	4	4
4	4	2	2	4
4	4	2	2	4
5	4	4	4	4

Figure Q2.1: Image with 6×6 dimension and 0-7 gray levels

0	60	120	180	120	60	0	60	120	180	120	60	0
0	60	120	180	120	60	0	60	120	180	120	60	0
0	60	120	180	120	60	0	60	120	180	120	60	0

Figure Q3.1: Gray scale image before DFT

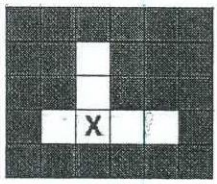


Figure Q3.2: Structuring element

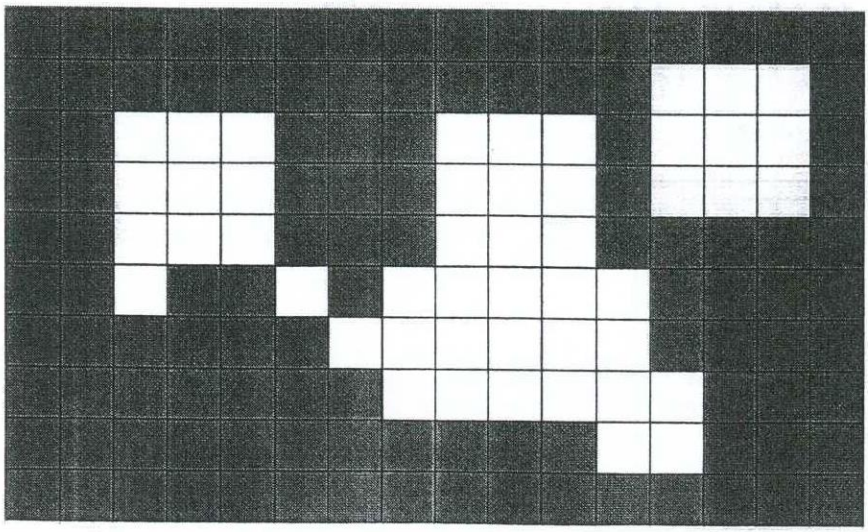


Figure Q3.3: Image to apply morphological operations

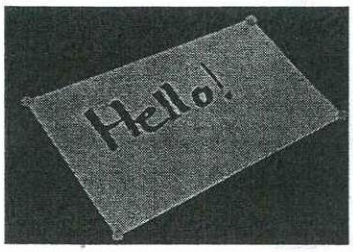


Figure Q4.1: Input image

Figure Q4.2: Output image

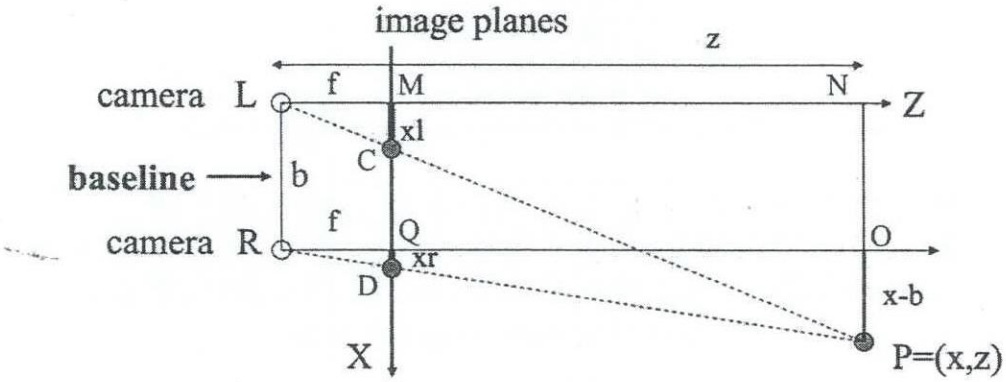
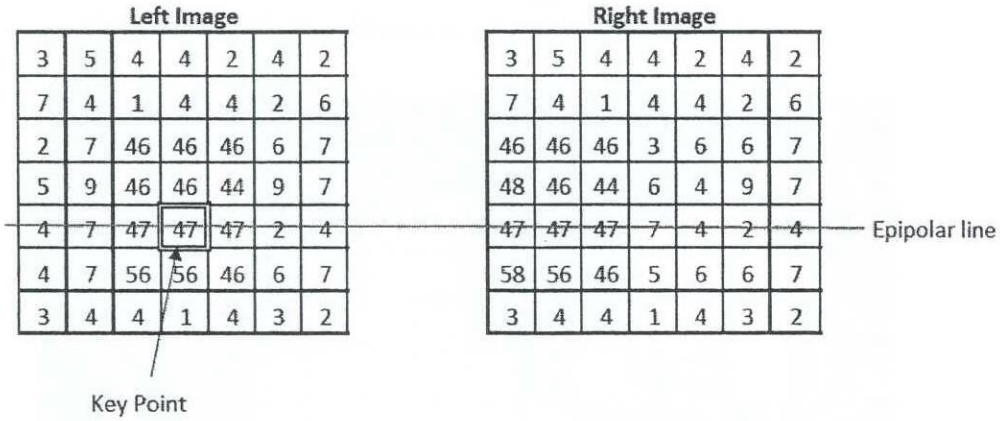


Figure Q5.1: Simple stereo camera setup



3	5	4	4	2	4	2
7	4	1	4	4	2	6
2	7	46	46	46	6	7
5	9	46	46	44	9	7
4	7	47	47	47	2	4
4	7	56	56	46	6	7
3	4	4	1	4	3	2

3	5	4	4	2	4	2
7	4	1	4	4	2	6
46	46	46	3	6	6	7
48	46	44	6	4	9	7
47	47	47	7	4	2	4
58	56	46	5	6	6	7
3	4	4	1	4	3	2

Figure Q5.2: Two images taken from Figure Q5.1 setup, left image represent image taken from camera L and right image represent image taken from camera R

Index No: _____

TO BE ATTACHED WITH THE ANSWER SCRIPT

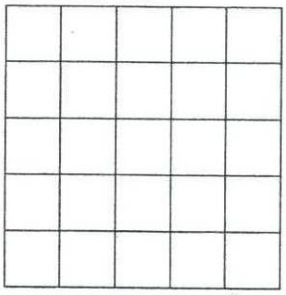


Figure A2.1: Answer for (Q2) (a)

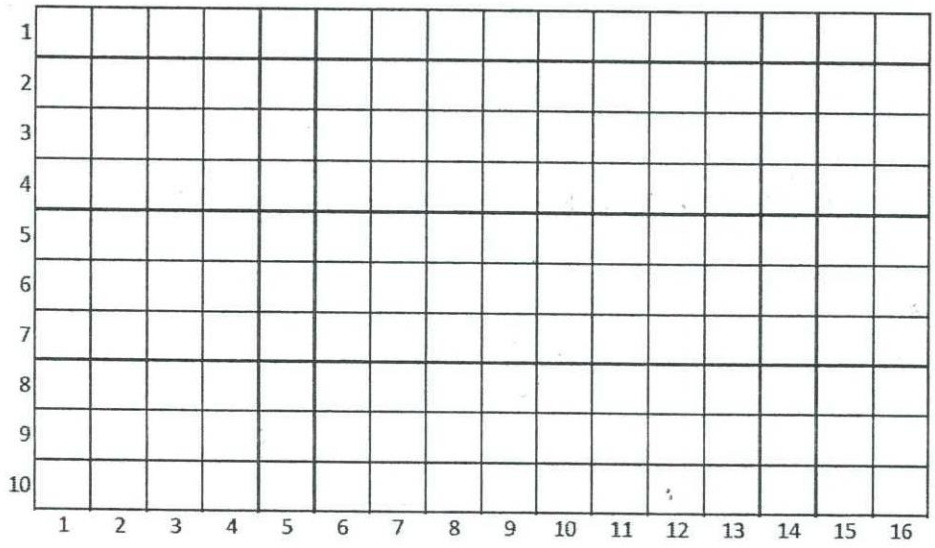


Figure A3.1: Answer for (Q3) (c)(i)

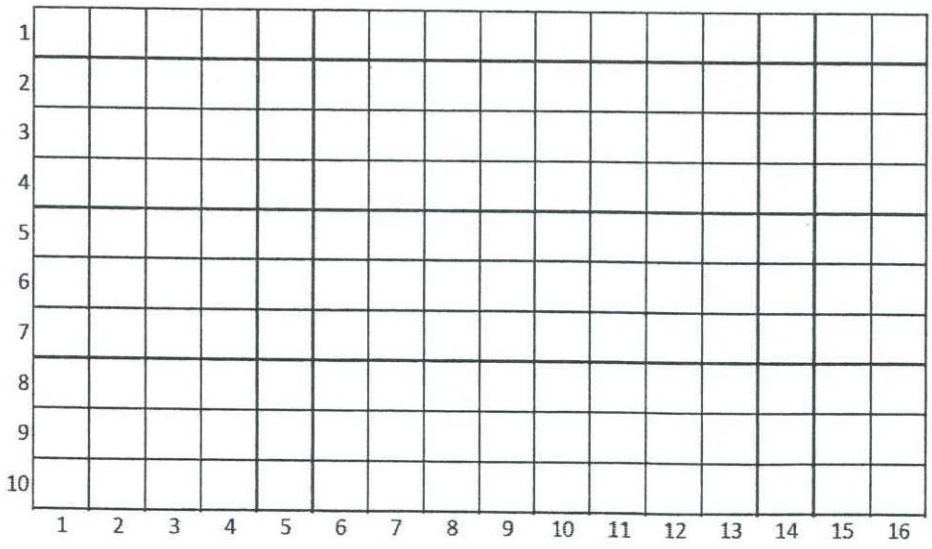


Figure A3.2: Answer for (Q3) (c)(ii)