UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: October 2019

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

[Three Hours]

[Answer **all questions**, each question carries 10 marks]

Q1 a) Describe the process of sampling and Quantization when generating digital images from sensor data.

[2 Marks]

b) Determine the equation for the size of the digital image in bytes (S) for a color image with Red, Green and Blue channels. Assume there are M vertical samples and one row has N samples. Assume that one grey-level value is quantized into Q discrete quantities.

[2 Marks]

c) The n^{th} power transformation function is shown in Figure Q1.1. According to Figure Q1.1. what will be the value of L?

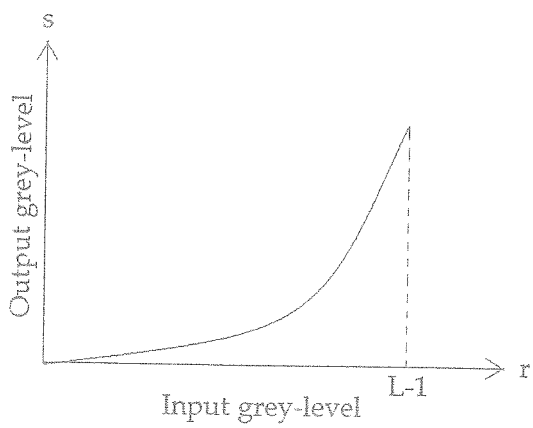

Figure Q1.1

[1 Mark]

d) What is Grey-level slicing under spatial domain methods?

[1 Mark]

e) Find the intensity value when the RGB (red, green,blue) value (200, 200, 200) is converted to HSI (hue, saturation, intensity). Assume the HSI values are represented from 0 to 240.

[2 Marks]

f) Mathematically prove how the straight line segment joining any two points of CIE Chromaticity diagram define all colour variations of the combination of these 2 colours.

[2 Marks]

Q2 a) What is the advantage of separability with Discrete Fourier Transform?

[1 Mark]

b) How many frequency components you will get if you convert the grayscale image in Figure Q2.1 to frequency domain. The intensity values are shown in the image.

0	40	80	120	160	200	230	255	230	200	160	120	80	40	0

Figure Q2.1

[1 Mark]

c) Assume you have to apply a edge detection operator to an image. Draw the filter function in the frequency domain if you want to pre-process the image before applying the edge detection operator.

[2 Marks]

d) What is the main difference between contrast stretching and histogram equalization?

[1 Mark]

e) Describe the process of intensity slicing, used in Pseudocolour Image Processing.

[2 Marks]

f) Equalize the histogram of the image shown in Figure Q2.2. There are 9 possible grey-levels from 0 to 8.

6	6	6	6	6	6	6	6	6
6	5	5	5	5	5	5	5	6
6	5	3	3	5	3	3	5	6
6	5	3	3	5	3	3	5	6
6	5	3	3	5	3	3	5	6
6	5	3	3	5	3	3	5	6
6	5	3	3	5	3	3	5	6
6	5	5	5	5	5	5	5	6
6	6	6	6	6	6	6	6	6

Figure Q2.2

[3 Marks]

Q3 a) Describe about the information obtain by applying first derivative and second derivative operators on an image?

[2 Marks]

b) Describe the functionality of Laplacian of Gaussian (LOG) operator.

[2 Marks]

c) Write a pseudocode or a program in mathlab to find the global threshold to segment small objects in an image.

[2 Marks]

d) Describe the process of Mosaicing used in a synthetic wide angle camera.

[2 Marks]

e) Assume the image shown in Figure Q3.1 is resized to Figure Q3.2. Figure Q3.1 is a 2x2 image and Figure Q3.2 is a 4x4 image. Resample the intensity of the pixel location at (2.5, 2.5) using bilinear interpolation. The (2.5, 2.5) location is marked by a "x" on Figure Q3.2.

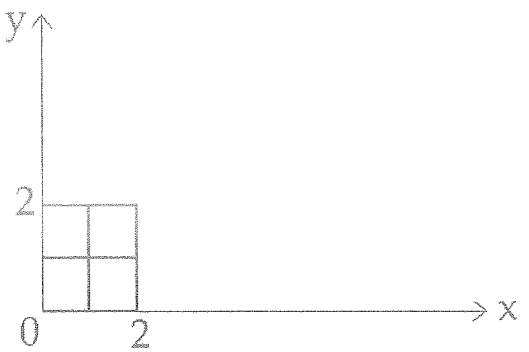

Figure Q3.1

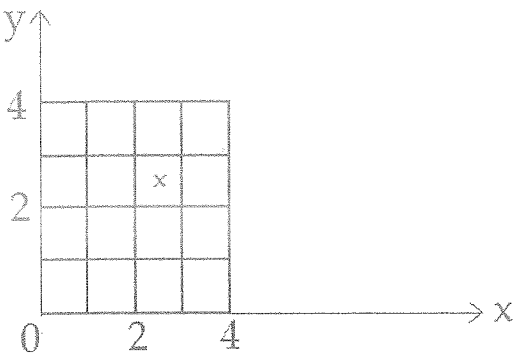

Figure Q3.2

[2 Marks]

Q4 a) Describe the purpose of two morphological operations "Opening" and "Closing".
[2 Marks]

b) Consider the structuring element on Figure Q4.1. Note that the origin is marked by a "x".

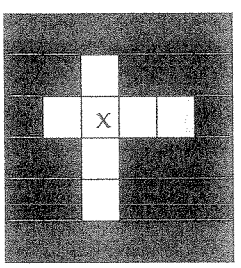

Figure Q4.1

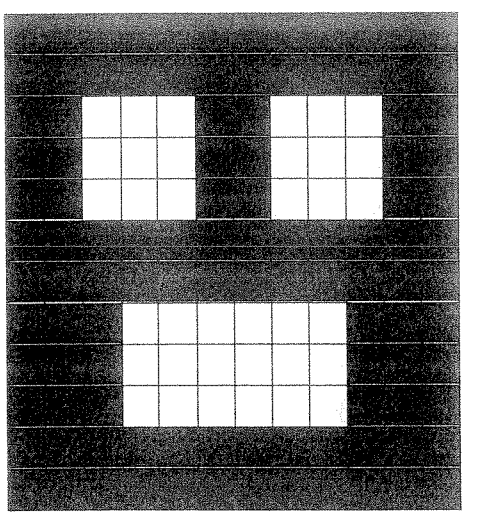

Figure Q4.2

i) Apply the morphological operation "dilation" on Figure Q4.2 using the structuring element Figure Q4.1.

ii) Apply the morphological operation "erosion" on the image you obtained in Q4 b (i) using the structuring element in Figure Q4.1.

[2 Marks]

c) What are the differences between the optical flow and the motion field?
[2 Marks]

d) "A" and "B" objects are placed 10m and 20m away from the camera as shown in the Figure Q4.3. Approximately draw the new positions of the objects "A" and "B" if the image is taken after moving the camera 5m towards the objects.

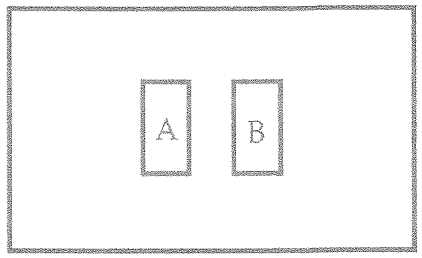

Figure Q4.3

[2 Marks]

e) Assume a object is attached to a string and rotates in constant angular velocity. A camera is fixed in the same height as the object. Draw the optical flow field of the video recorded at the camera in time t = 0, 1, 2, 3, 4.

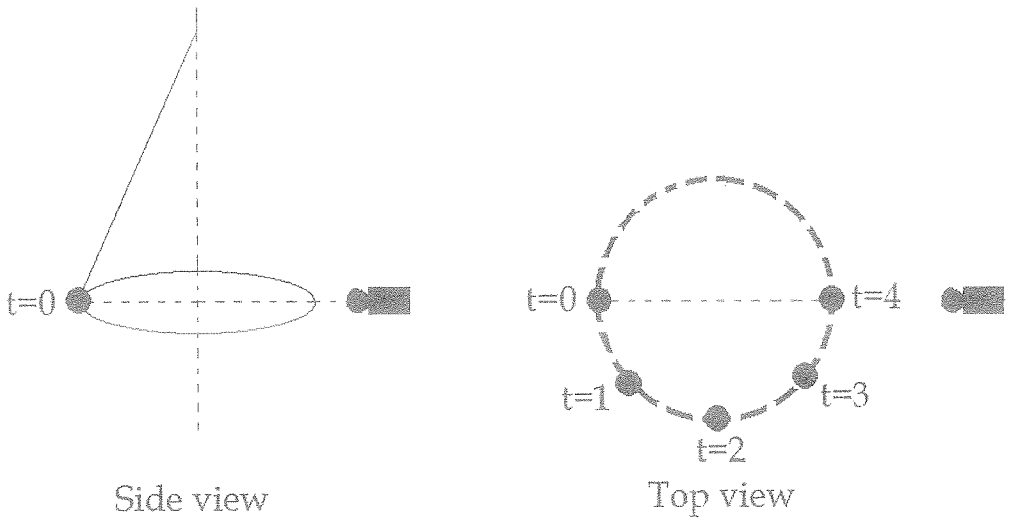

Figure Q4.4

[2 Marks]

Q5 a) Describe the monocular and binocular cues used by the human vision system to estimate the depth?

[2 Marks]

b) Describe the process of triangulation used in a stereo camera using a diagram?

[2 Marks]

c) List TWO advantages of Scale Invariant Feature Transform (SIFT).

[2 Marks]

d) How does the Scale Invariant Feature Transform (SIFT) algorithm find the same keypoint in different scales?

[2 Marks]

e) Describe how the SIFT descriptor is robust to illumination changers.

[2 Marks]