UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: August 2018

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

[Three Hours]

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

Q1 a) Draw a diagram to show the formation of the **epipolar line** with two cameras fixed in a horizontal plane. Mark the distance between the two cameras as **b**.

[2 Marks]

b) Describe two types of solving the stereo correspondence problem.

[2 Marks]

c) What are the monocular cues used by the human vision system?

[1 Mark]

d) What are the differences between optical flow and the motion field?

[2 Marks]

e) What are the differences between Horn–Schunck and Lucas–Kanade optical flow calculation methods?

[2 Marks]

f) Draw the optical flow of a video captured from a camera fixed on the center of the dashboard of a car. Assume that the car is moving forward and camera is focused to the road.

[1 Mark]

Q2 a) What are the factors that the Scale Invariant Feature Transform (SIFT) are robust?

[1 Mark]

b) Describe how Laplacian of Gaussian filter is used for detecting key points in Scale Invariant Feature Transform (SIFT).

[2 Marks]

c) Describe the process of getting local image descriptors at key points in Scale Invariant Feature Transform (SIFT).

[2 Marks]

d) Describe how the contrast stretching is done on a greyscale image, by using a piecewise-linear transformation function.

[2 Marks]

e) Describe how image processing techniques are applied to image compression.

[2 Marks]

f) Draw a 3x3 mask for the Laplacian operator with horizontal, vertical and diagonal directions.

[1 Mark]

Q3 a) Describe the two morphological operations erosion and dilation.

[2 Marks]

b) Consider the structuring element on Figure Q3.1. Note that the origin is marked by a "X".

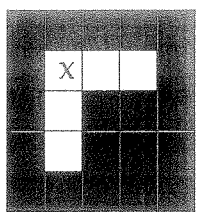

Figure Q3.1

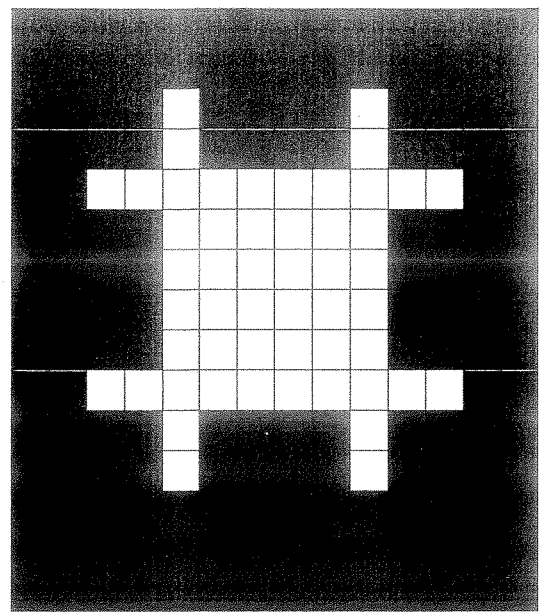

Figure Q3.2

i) Apply the morphological operation "Opening" on Figure Q3.2 using the structuring element in Figure Q3.1.

ii) Apply the morphological operation "Closing" on Figure Q3.2 using the structuring element in Figure Q3.1.

[4 Marks]

c) Describe how the image segmentation is done, based on the discontinuity of image intensity.

[2 Marks]

d) Describe how to apply global thresholding to small objects, where the number of pixels of the object is very low compared to the background.

[2 Marks]

Q4 a) Describe the Two-Dimensional discrete Fourier transform, by using the equation below.

$$F(u,v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) e^{-j2\pi\left(\frac{ux}{M}+\frac{vy}{N}\right)}$$

[2 Marks]

b) What is the reason for multiplying the input image function f(x,y) by $(-1)^{x+y}$, before applying the Two-Dimensional discrete Fourier transform?

[2 Marks]

c) 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)?

[2 Marks]

d) Two-Dimensional discrete Fourier transform can be obtained as a sequence of one dimensional Fourier transforms. Describe this sequence and its advantage.

[2 Marks]

e) Draw the grayscale image corresponding to the frequency transforms given in Figure Q4.(i) and Figure Q4.(ii). Assume that the images are multiplied with $(-1)^{x+y}$, before applying the transformation.

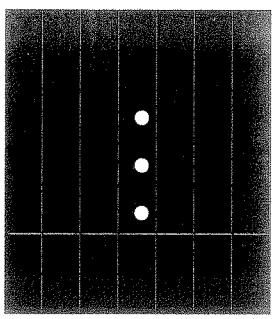

Figure Q4.(i)

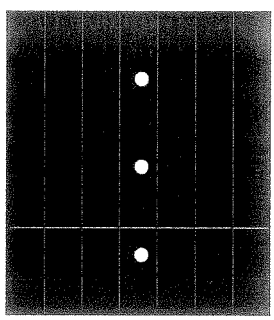

Figure Q4.(ii)

[2 Marks]

Q5 a) Draw the transformation function for the Power-Law Transformation $s = cr^{\gamma}$. Assume $r \leq 1$ and clearly state any other assumptions.

[1 Mark]

b) List two hardware devices which are manufactured using the Power-Law Transformation?

[1 Mark]

c) Write a program to equalize an image with 8 gray levels. Consider the size of the image as 10x8.

[4 Marks]

d) What is the reason for using the CMYK color model in printers than the RGB color model?

[2 Marks]

e) Describe the advantage of using HSI color model in image processing algorithms.

[2 Marks]