MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 518: DIGITAL IMAGE PROCESSING

DATE: **TIME: 2 HRS**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Explain the principle of operation of unsharp masking filters

(3 marks)

b) Distinguish between **dilation** and **erosion** as applied to morphological operations

(2 marks)

c) In a morphological operation the structural element (SE) is given by the matrix A and the image is given by the matrix B as shown

$$A = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

$$B = \begin{vmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{vmatrix}$$

Obtain the output image.

(4 marks)

d) (i) State any **two** characteristics of each of the following sharpening spatial filters

I. First order derivative

II. Second order derivative

(ii) From the definition of the laplacian operator in image processing,

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

Derive the expression of the basic Laplacian mask

(9 marks)

e) Apply Laplacian filter on the given image. Use zero padding of the edges

$$\begin{bmatrix} 8 & 5 & 4 \\ 0 & 6 & 2 \\ 1 & 3 & 7 \end{bmatrix}$$

(4 marks)

f) Perform the histogram equalization of the following image

$$f(x,y) = \begin{bmatrix} 1 & 2 & 1 & 1 & 1 \\ 2 & 5 & 3 & 5 & 2 \\ 2 & 5 & 5 & 5 & 2 \\ 2 & 5 & 3 & 5 & 2 \\ 1 & 1 & 1 & 2 & 1 \end{bmatrix}$$

(8 marks)

QUESTION TWO (20 MARKS)

a) Explain the use of image segmentation

(3 marks)

b) (i)For the image represented by the matrix given, apply region growing with seed point as 6 and threshold value as 3 to obtain the segmented image. Consider 8 way connectivity.

$$\begin{bmatrix} 5 & 6 & 6 & 7 & 6 & 7 & 6 & 6 \\ 6 & 7 & 6 & 7 & 5 & 5 & 4 & 7 \\ 6 & 6 & 4 & 4 & 3 & 2 & 5 & 6 \\ 5 & 4 & 5 & 4 & 2 & 3 & 4 & 6 \\ 0 & 3 & 2 & 3 & 3 & 2 & 4 & 7 \\ 0 & 0 & 0 & 0 & 2 & 2 & 5 & 6 \\ 1 & 1 & 0 & 1 & 0 & 3 & 4 & 4 \\ 1 & 0 & 1 & 0 & 2 & 3 & 5 & 4 \end{bmatrix}$$

(ii)Draw the quad tree structure for the splitting in b (i)

(10 marks)

c) (i)Outline the procedure for global thresholding to obtain threshold value T

(ii)The image shown have to be segmented using global thresholding. Obtain the threshold value T

$$\begin{matrix} 5 & 3 & 9 \\ 2 & 1 & 7 \\ 8 & 4 & 2 \end{matrix}$$

(7 marks)

QUESTION THREE (20 MARKS)

a) State **three** merits of image transform in image processing

(3 marks)

b) Compute 2 DFT of the gray scale image given by

$$f(m,n) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

(8 marks)

c) (i) Explain the need for Haar transform

(ii) Obtain the Haar transform for the signal

$$f(m,n) = \begin{bmatrix} 4 & -1 \\ 2 & 3 \end{bmatrix}_{2\times 2}$$

(9 marks)

QUESTION FOUR (20 MARKS)

a) Distinguish between image enhancement and image restoration

(2 marks)

b) Describe the following methods of estimation of degradation model

i. Observation

ii. Experimentation

(8 marks)

c) The output expression of the Wiener filter is given by

$$\hat{F}(u,v) = \left[\frac{H^*(u,v)S_f(u,v)}{S_f(u,v)|H(u,v)|^2 + S_\eta(u,v)}\right] G(u,v)$$

(i) Write down the meaning of each of the terms in the expression.

(ii) Explain the circumstances under which the Wiener filter is equal to the inverse filter. Hence write down the expression of the Inverse filter.

(iii) Explain the advantage of Wiener filter over an inverse filter

(10 marks)

QUESTION FIVE (20 Marks)

a) Distinguish between histogram equalization and histogram specification. Explain the application of each. (4 marks)

b) Perform histogram equalization on the following on the following $\mathbf{8 \times 8}$ image. The grey level distribution of the image is shown in Table 1.

Gray level(r_k)	0	1	2	3	4	5	6	7
No. of pixels(p_k)	9	8	11	4	10	15	4	3

(10 marks)

c) An image is represented by a matrix A given by

$$\begin{matrix} 4 & 3 & 5 & 2 \\ 3 & 6 & 4 & 6 \\ 2 & 2 & 6 & 5 \\ 7 & 6 & 4 & 1 \end{matrix}$$

Denoting the input pixels by r and the output pixels by s obtain the resultant image through contrast stretching such that $r_1 = 3, s_1 = 2$ and $r_2 = 5, s_2 = 6$

(6 marks)