Benha University
First Term (January 2017) Final Exam
Class: Post Graduates (MSc.)
Subject: Digital Image processing& Pattern Recognition
Course code :CS613

Faculty of Computers & Informatics
Date: 24/5/2017
Time: 3 Hours
Examiner: Assoc. Prof. Mazen Selim

Answer the following questions:

Question (1) ***please make a table of two columns, one for the question no. and the other for your selection*** ***(10 Marks)***

1) *The shape numbers measure of shape ----------*
   a. correlation *b. Compactness* *c. Convolution* *d. filtering*
2) *The kernel [-1 2 -1] is meant to approximate ---------- order derivative*
   a. a Low pass filter *b. second* *c. first* *d. Median filter*
3) *In the time domain, the convolution multiplication becomes_____ operation*
   a) Linear *b) Nonlinear* *c) a sum* *d) Bicubic*
4) *Digitizing image intensity amplitude is called_____*
   a) Enhancement *b) Sampling* *c) Dynamic range* *d) Quantization.*
5) *Filter that performs opposite to band rejected filter is called filter.*
   a) Harmonic *b) bandpass* *c) LPF followed by HPF* *d) Bicubic* *e) None of the above*
6) *Fourier transform is a _____ transform*
   a) Linear *b) Nonlinear* *c) Bilinear* *d) Bicubic* *e) None of the above*
7) *(T/F)The dynamic range of an image can be compressed by replacing each pixel value with its logarithm*
8) *The Rayleigh density can be used to approximate _____*
   a) Ideal histograms *b) Non-Ideal histograms* *c) Gaussian histograms* *d) Skewed histograms*
9) *(T/F) noise reduction can be accomplished by blurring with a linear filter and also by a nonlinear filter*
10) *Entropy represents the _____amount of data required to represent an image.*
    a) maximum *b) average* *c) minimum* *d) all of the above*

Question (2) ***(10 Marks)***

a. *Give a short note about HSV coloring model, show the relation between the HSVand RGB coloring model?*

The hue component H in all three color spaces is an angular measurement, analogous to position around a color wheel. A hue value of 0°corresponds to red, 120° corresponds to green, and 240° corresponds to blue. The saturation component in all three color spaces describes color intensity. A saturation value of 0 (in the middle of a hexagon) means that there is no color (gray). A saturation value at the maximum (at the outer edge of a hexagon) means that the colorfulness value is at maximum for the color defined by the hue. HSV model is called a single hexagon model. The top of the hexagon corresponds to maximum intensity V=1. The maximum saturation is available for maximum intensity. The bottom converges to one point that corresponds the color black.

RGB to HSV/HSI/HSL conversion

$$R' = R/255;\ G' = G/255;\ B' = B/255$$

$$C_{max} = \max(R', G', B');\ C_{min} = \min(R', G', B');\ \Delta = C_{max} - C_{min};$$

$$H = \begin{cases} 0, & \Delta = 0 \\ 60\left(\frac{G'-B'}{\Delta} mod 6\right), & C_{max} = R' \\ 60\left(\frac{B'-R'}{\Delta} + 2\right), & C_{max} = G' \\ 60\left(\frac{R'-G'}{\Delta} + 4\right), & C_{max} = B' \end{cases}$$

b. *Apply histogram specification on the following image. Let the input and output gray levels be in the range of [0, 7]. Assume that the expected grayscale specification is {0: 5%, 1: 5%, 2: 10%, 3: 10%, 4: 25%, 5: 5%, 6: 25%, 7: 15%}. Show the output image.*

Answer: From the input image,

x	p_x	$\int_0^x p_x(u)du$
0	17/64	17/64 = 0.2656
1	18/64	35/64 = 0.5469
2	1/64	36/64 = 0.5625
3	3/64	39/64 = 0.6094
4	10/64	49/64 = 0.7656
5	11/64	60/64 = 0.9375
6	3/64	63/64 = 0.9844
7	1/64	64/64 = 1.0000

1	1	0	0	0	0	0	1
1	1	1	1	0	1	0	1
1	3	4	4	5	5	0	0
0	3	4	4	5	5	5	5
2	4	4	4	3	5	7	0
1	1	4	5	6	5	6	1
1	0	4	4	1	5	6	1
1	0	1	0	0	0	5	0

From the expected specification,

z	p_z	$\int_0^z p_z(u)du$
0	0.05	0.05
1	0.05	0.10
2	0.10	0.20
3	0.10	0.30
4	0.25	0.55
5	0.05	0.60
6	0.25	0.85
7	0.15	1.00

Question (3) ***(10 Marks)***

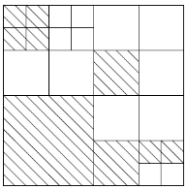
a) *Filter the image in figure (d) using an Order Statistics filter (after replicate padding) using the filter mask as in (a). The weighting vector of the order statistics filter is defined as*

$$\{w_i\} = \left\{0, \frac{1}{3}, \frac{1}{3}, \frac{1}{3}, 0\right\}$$

a

1	1	1	1	0	0	0	0	
1	1	1	1	0	0	0	0	
1	1	1	1	1	1	0	0	
1	1	1	1	1	1	0	0	
0	0	1	1	1	1	0	0	
0	0	1	1	1	1	0	0	
0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	

b



c

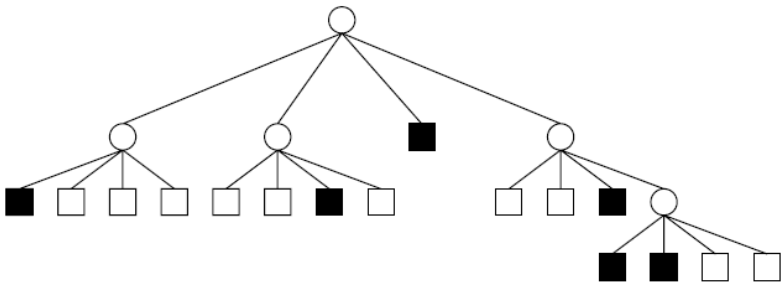
9	8	7	6
8	7	13	5
7	6	5	4
6	1	4	3

d

b) *using the run length to represent the image in Figure (b)*

1	4	4	
1	4	4	
1	6	2	
1	6	2	
0	2	4	2
0	2	4	2
0	8		
0	8		

c) *Find the quad tree representation of the image given in figure(c)*



Question (4) ***(10 Marks)***

a) *Consider a Bayes Classifer.Given two classifiers and three classes, assume that the confusion matrix of A[1……3],[1……..3],[1…….3], as given. Note that the element A[I,J, K] denotes the number of samples in class i to be assigned to class j by the first classifier and to class k by the second classifier. The total number of samples N is 400.Assume j1=j2=1.*

$$\underset{A[1,1\cdots3,1\cdots3],}{\begin{bmatrix}90 & 2 & 5\\ 1 & 5 & 5\\ 5 & 1 & 5\end{bmatrix}},\quad \underset{A[2,1\cdots3,1\cdots3],}{\begin{bmatrix}2 & 15 & 5\\ 5 & 90 & 5\\ 5 & 5 & 3\end{bmatrix}},\quad \underset{A[3,1\cdots3,1\cdots3]}{\begin{bmatrix}1 & 5 & 10\\ 5 & 10 & 5\\ 10 & 5 & 95\end{bmatrix}}$$

$$P(\omega_1|j_1j_2)=\frac{90}{90+2+1}=0.9677$$

$$P(\omega_2|j_1j_2)=\frac{2}{90+2+1}=0.0215$$

$$P(\omega_3|j_1j_2)=\frac{1}{90+2+1}=0.0108$$

$$P_{\text{comb\_min\_err}}=1-\frac{\sum_{j_1}\sum_{j_2}\max_i A[i,j_1,j_2]}{N}=1-0.8125=0.1875$$

The minimum errors of the first and second classifiers are, respectively,

$$P_{\text{min\_err}}(1)=1-\frac{\sum_{j_1}\sum_{j_2}A[j_1,j_1,j_2]}{N}=1-0.7675=0.2325$$

$$P_{\text{min\_err}}(2)=1-\frac{\sum_{j_2}\sum_{j_1}A[j_2,j_1,j_2]}{N}=1-0.79=0.21$$

Therefore, we obtain $P_{\text{comb\_min\_err}}\le P_{\text{min\_err}}(1)$ and $P_{\text{comb\_min\_err}}\le P_{\text{min\_err}}$

b) *Convolve the 4x4 image as in fig. (d) of question (3) with the Sobel kernel that detects horizontal edges. (Use even boundary extension)*

Question (5) ***(10 Marks)***

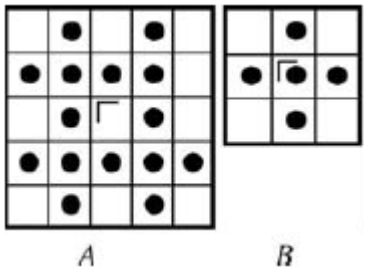
A 4×4, 4bits/pixel original image is given

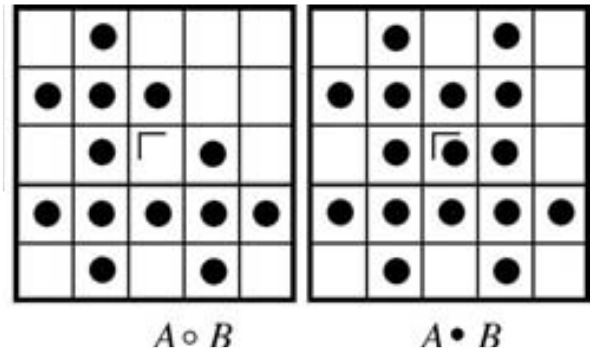
6	13	12	13
12	6	7	12
13	7	7	12
14	11	11	14

a. Apply full-scale contrast stretch to the image. Show your work and sketch the resulting image.
b. Compute the entropy of the image.
c. Compress the image using Huffman coding.
d. Compute the compression achieved and the effectiveness of the Huffman coding.

Question (6) ***(10 Marks)***

a) Find the openning and closing of A where the structure element is B





b) Extract the boundary of A

Boundary extraction of a set A is first eroding A by a structuring element B and then taking the set difference between A and its erosion. The structuring element must be isotropic; ideally, it is a circle, but in digital image processing, a 3X3 matrix of 1' s is often used. That is, the boundary of a set A is obtained by:

$$\partial A = A - (A \ominus B)$$

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