Benha University **Faculty of Engineering (at Shoubra)** **Electrical Engineering Department** **Subject: Image Processing ECE 441C**		**Fall Semester** **Final Exam** **Date:** Wednesday 18/01/2017 **Duration:** 3 hours **№ of Questions:** 6 in 5 pages **Total Marks:** 100
Attempt **all** the following questions:		

Part I: Fundamentals

Question 1: Choose the best answer: (20 Marks)

1. …….. bring out detail that is obscured, or simply to highlight certain features of interest in an image.
   a. Image Restoration
   b. Image Enhancement
   c. Segmentation
   d. Object Recognition

2. By default, Matlab stores most data in arrays of class ……..
   a. uint8 b. uint16 **c. double** d. logical

3. Intensity levels in 8bit image are
   a. 255 **b. 256** c. 244 d. 245

4. Full color images have at least
   a. 2 components
   b. 4 components
   c. 3 components
   d. 255 components

5. Hue and saturation, both together produce
   a. brightness
   b. transitivity
   c. chromaticity
   d. reflectivity

6. Structuring elements runs over image's
   a. rows
   b. columns
   c. every element
   d. edges

7. Negative of the image having intensity values [0,L-1] is expressed by
   a. s = L-1
   b. s = 1-r
   c. s = L-1-r
   d. s = L-r

8. Smallest value of gamma will produce
   a. contrast
   b. darker image
   c. brighter image
   d. black and white image

9. Which one is not process of image processing
   a. high level
   b. low level
   c. last level
   d. mid level

10. Smallest possible neighbourhood in an image must be of size
    a. 3x3
    b. 2x2
    c. 1x1
    d. 4x4

11. Smoothing spatial filters are useful for
    a. image enhancement
    b. image restoration
    c. highlight gross details
    d. highlight fine details

12. Which is first fundamental step in image processing?
    a. filtration
    b. image enhancement
    c. image acquisition
    d. image restoration

13. To remove "salt-and-pepper" noise without blurring we use
    a. Max Filter
    b. Min Filter
    c. Median Filter
    d. Smoothing Filter

14. In ……. image we notice that the components of histogram are concentrated on the low side on intensity scale.

a. bright
b. colourful
c. all of the mentioned
d. dark

15. Histogram is the technique processed in
a. intensity domain
b. undefined domain
c. frequency domain
d. spatial domain

16. For edge detection we use
a. first derivative
b. second derivative
c. third derivative
d. Both A and B

17. Method in which images are input and attributes are output is called
a. low level processes
b. edge level processes
c. high level processes
d. mid level processes

18. First derivative of I(x) has a ……..at the edge.
a. none of them
b. valley
c. zero crossing
d. peak

19. The type of noise in which pixel values multiplied by random noise is……
a. **speckle noise.**
b. periodic noise
c. gaussian noise
d. none of them

20. The type of mean filters that achieves similar smoothing to the arithmetic mean, but tends to lose less image detail is ……..
a. **geometric mean**
b. contraharmonic mean
c. harmonic mean
d. none of them

Question 2: Complete the following sentences: (20 Marks)

1. **Exposure**, is the amount of light per unit area reaching a photographic film or electronic image sensor**.**
2. For **symmetric** filters, there is no difference between correlation and convolution**.**
3. Ideal edge is a **step function** in some direction**.**
4. Second derivative of I(x) has a **zero crossing** at edge**.**
5. The **histogram** shows the distribution of grey levels in an image**.**
6. **Negative** images are useful for enhancing white or grey detail embedded in dark regions of an image**.**
7. The Laplacian of Gaussian (or Mexican hat) filter uses the Gaussian for **noise removal** and the Laplacian for **edge detection**.
8. Single value thresholding only works for **bimodal** histograms**.**
9. The type of noise in which idealized form of white noise *added to* image, normally distributed is **Gaussian Noise**.
10. The type of mean filters that works well for salt noise, but fails for pepper noise is **Harmonic Mean**.
11. What to do at image boundaries?

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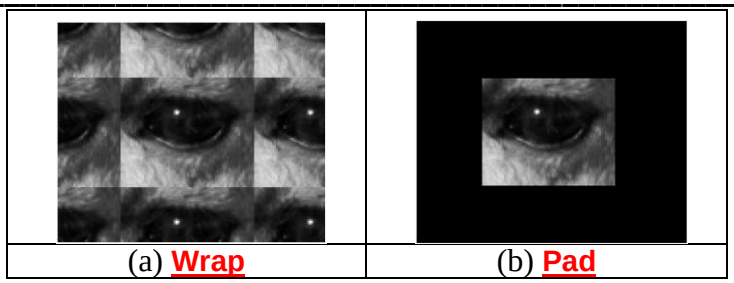
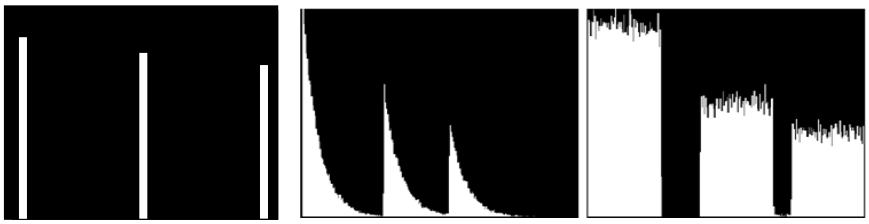


(a) **Wrap** (b) **Pad**

12. Figure (a) shows an image histogram. Decide the noise models added to it that produce the following histograms, figure (b) and figure (c).



(a) Original histogram (b) **Exponential** (c) **Uniform**

13. In Alpha-Trimmed Mean Filter, given a set of 8 points, trimming by 25% would compute the mean of the remaining **4** points.
14. In Contraharmonic Mean, negative values of Q eliminate **salt noise** noise.
15. In morphological processing, any on pixel in the structuring element covers an on pixel in the image in **Hit**.
16. In morphological processing, there are two basic morphological operations which are **erosion** and **dilation**.
17. Erosion **shrinks** objects while **Dilation** enlarges objects.
18. The **Closing** of image f by structuring element s, is simply a dilation followed by an erosion.
19. The total amount of energy that flows from the light source (measured in watts) is called **Radiance**.
20. **The point of equal energy** has equal amounts of each colour and is the CIE standard for pure white.

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Question 3: (15 Marks)

a. **(5 marks)** What linear transformation will change an image f(x,y) with gray levels ranging from 8 through 16 to an image g(x,y) with gray levels ranging from 10 through 50?

Solution:

$f_{min} = 8$ $f_{max} = 16$

$g_{min} = 10$ $g_{max} = 50$

$ma + b = n$

$8a + b = 10$ (1)

$16a + b = 50$ (2)

Solving equations (1)&(2), we get:

$a = 5$

$b = -30$

Transformation function:

$5m - 30 = n$

b. **(5 marks)** Consider the image shown below; compute the equalized image with eight possible gray levels. Show each step carefully. Draw the histograms of the original and equalized images.

1	2	1	1	2	5
0	1	0	1	0	1
1	6	7	7	1	2

Solution:

L = 8
L-1 = 7
P (0) = 3 / 18
P (1) = 8 / 18
P (2) = 3 / 18
P (3) = 0

P (4) = 0
P (5) = 1 / 18
P (6) = 1 / 18
P (7) = 2 / 18

S (0) = 7 * P (0) = 7 (3/18) = 1.1 ≈ 1
S (1) = 7 * (P (0) + P(1)) = 7 (11/18) = 4.2 ≈ 4
S (2) = 7 * (P (0) + P(1) + P(2)) = 7 (14/18) = 5.4 ≈ 5
S (3) = 7 * (14/18) = 5.4 ≈ 5
S (4) = 7 * (14/18) = 5.4 ≈ 5
S (5) = 7 * (15/18) = 5.8 ≈ 6
S (6) = 7 * (16/18) = 6.2 ≈ 6
S (7) = 7 * (18/18) = 7

P (0) = 0
P (1) = 3 / 18
P (2) = 0
P (3) = 0
P (4) = 8 / 18
P (5) = 3 / 18
P (6) = 2 /18
P (7) = 2 / 18

The equalized image:

4	5	4	4	5	6
1	4	1	4	1	4
4	6	7	7	4	5

c. **(5 marks)** Find the filtered image using zero padding of the original image.

0	9	10	0
7	1	6	1
10	15	2	6
11	3	8	0

Original (input) image

1/8

0	1	0
1	0	1
0	1	0

Linear filter

?	?	?	?
?	?	?	?
?	?	?	?
?	?	?	?

Filtered (output) image

Solution:

	0	0	0	0	
0	0	9	10	0	0
0	7	1	6	1	0
0	10	15	2	6	0
0	11	3	8	0	0
	0	0	0	0	

Original (input) image using zero padding

First Row:
1/8 [7+9] = 2
1/8 [1+10] = 1.3
1/8 [6+9] = 1.8
1/8 [1+10] = 1.3

2	1.3	1.8	1.3
1.3	4.6	1.7	1.5
4.1	2	4.3	0.3
1.6	4.2	0.6	1.7

Filtered image

Question 4: (20 Marks)

a. **(5 marks)** In a given application an averaging mask is applied to input images to reduce noise, and then a Laplacian mask is applied to enhance small details. Would the result be the same if the order of these operations were reversed?

Solution:
The result would be the same if the order of these operations were reversed since the averaging and the Laplacian are linear operations. The Laplacian is a linear operator because derivatives of any order are linear operations and the Laplacian is the second derivation.

b. **(5 marks)** Give a 3*3 mask for performing unsharp masking in a single pass through an image.

Solution:

$$f_{hb} = \begin{cases} Af(x,y) - \nabla^2 f(x,y) & \text{if the center coefficient of the Laplacian mask is negative} \\ Af(x,y) + \nabla^2 f(x,y) & \text{if the center coefficient of the Laplacian mask is positive.} \end{cases}$$

And its mask filter

−1	−1	−1
−1	$A + 8$	−1
−1	−1	−1

Using A=1, the mask will be

1	1	1
1	-7	1
1	1	1

For first equation and this mask for the second equation

-1	-1	-1
-1	9	-1
-1	-1	-1

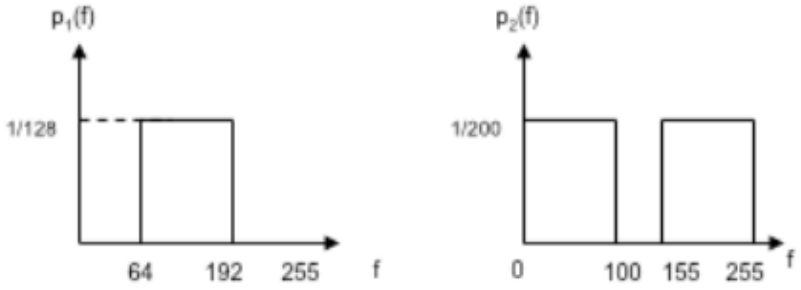
c. **(5 marks)** Explain why the discrete histogram equalization technique does not, in general, yield a flat histogram.

Solution:

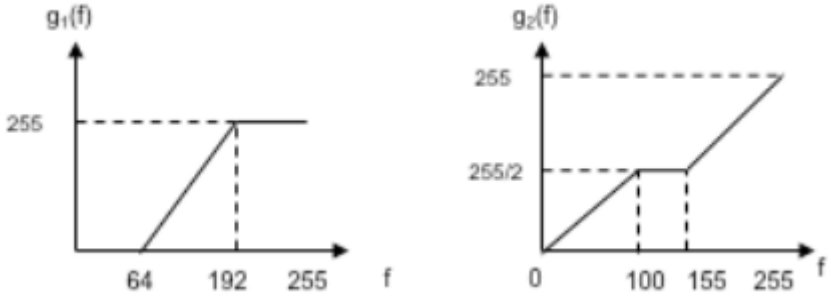
The distribution "flat" (flat histogram) which means the number of pixel in each intensity levels distributed equally, and in the discrete histogram equalization map each pixel in the

input image with intensity r_k into a corresponding pixel with level s_k in output image to spread the histogram of the input image so that the intensity levels of the equalized image span a wider range of the intensity scale.

d. **(5 marks)** The histograms of two images are illustrated below. Sketch a transformation function for each image that will make the image has a better contrast.

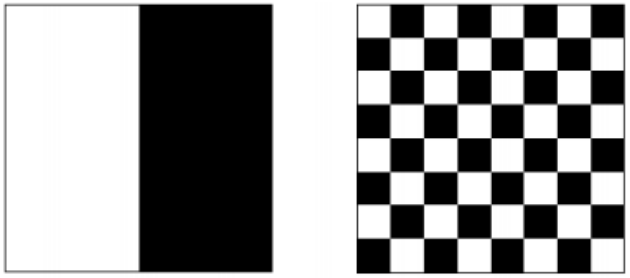


Solution:



Question 5: (15 Marks)

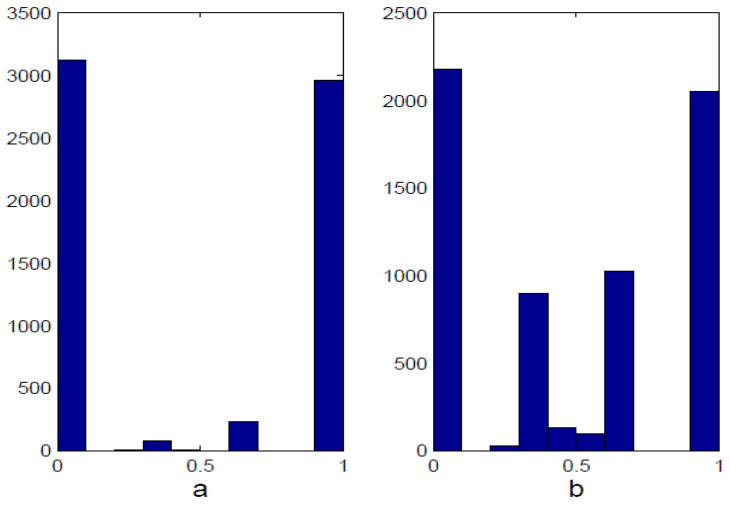
a. **(5 marks)** The two images shown below are different, but their histograms are identical. Both images have size 80 × 80, with black (0) and white (1) pixels.



Suppose that both images are blurred with a 3×3 smoothing mask. Would the resultant histograms still be the same? Draw the two histograms and explain your answer.

Solution:

The histograms will no longer be the same. They are plotted as follows



b. **(5 marks)** Given a color as R=10, G=20, and B=100, calculate its HSI model.

Solution:

$$H = \begin{cases} \theta & if\ B \le G \\ 360 - \theta & if\ B > G \end{cases}$$

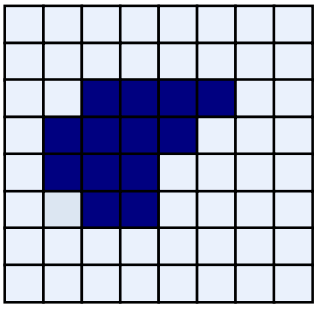
$$\theta = \cos^{-1}\left\{ \frac{\frac{1}{2}\left[(R-G)+(R-B)\right]}{\left[(R-G)^2+(R-B)(G-B)\right]^{\frac{1}{2}}} \right\}$$

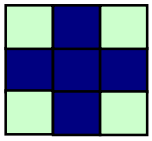
$$S = 1 - \frac{3}{(R+G+B)}\left[\min(R,G,B)\right]$$

$$I = \frac{1}{3}(R+G+B)$$

S = 0.77
I = 43.3
H= 234°

c. **(5 marks)** Apply the Erosion and Dilation operations on the image shown below:

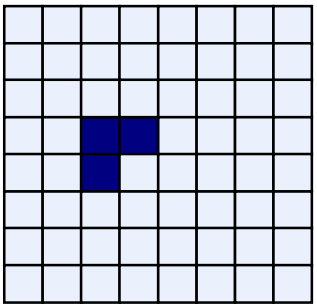




Structuring Element

Solution:

Erosion operation: $f \ominus s$



Dilation operation: $f \oplus s$

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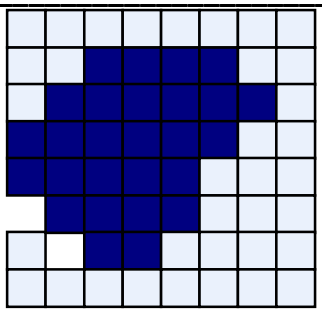

Part II: Research

Question 6: (10 Marks)

Define briefly each of the following:

a. Biometrics

Biometrics is the science and technology of measuring and analyzing biological data. Biometrics refers to technologies that measure and analyze human body characteristics, such as DNA, fingerprints, eye retinas and irises, voice patterns, facial patterns and hand measurements, for authentication purposes.

b. Fingerprint

A fingerprint is the feature pattern of one finger.
It is the pattern of ridges and valleys (also called furrows in the fingerprint literature) on the surface of a fingertip.
Each individual has unique fingerprints so the uniqueness of a fingerprint is exclusively determined by the local ridge characteristics and their relationships

c. Fingerprint Recognition

Fingerprint recognition is the process of comparing questioned and known fingerprint against another fingerprint to determine if the impressions are from the same finger or palm.

d. Fingerprint Verification

Fingerprint verification is to verify the authenticity of one person by his fingerprint.

e. Fingerprint Identification

Fingerprint identification is to specify one person's identity by his fingerprint(s).

Good Luck
Dr.Shady Yehia Elmashad