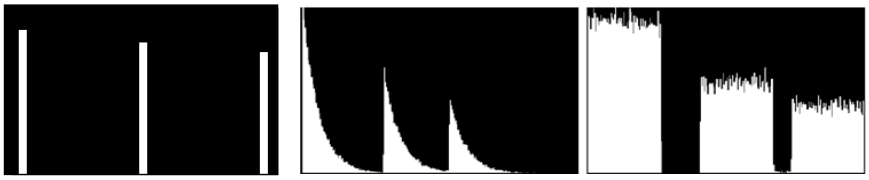
Benha University **Faculty of Engineering (at Shoubra)** **Electrical Engineering Department** **Master (**Computer Systems Engineering**)** **Subject: Image Processing - CES 605**		**Fall Semester** **Final Exam** **Date:** Saturday 05/01/2019 **Duration:** 3 hours **№ of Questions:** 4 in 4 pages **Total Marks:** 60
Attempt **all** the following questions:		

Question 1: Complete the following sentences: (16 Marks)

1. For **symmetric** filters, there is no difference between correlation and convolution**.**
2. Ideal edge is a **step function** in some direction**.**
3. Second derivative of I(x) has a **zero crossing** at edge**.**
4. **Negative** images are useful for enhancing white or grey detail embedded in dark regions of an image**.**
5. The Laplacian of Gaussian (or Mexican hat) filter uses the Gaussian for **noise removal** and the Laplacian for **edge detection.**
6. Single value thresholding only works for **bimodal** histograms**.**
7. The type of mean filters that works well for salt noise, but fails for pepper noise is **Harmonic mean.**
8. In Alpha-Trimmed Mean Filter, given a set of 8 points, trimming by 25% would compute the mean of the remaining **4** points**.**
9. The **opening** of image f by structuring element s, is simply an erosion followed by a dilation**.**
10. Dilation **enlarge** objects while Erosion **shrinks** objects**.**
11. Signatures are invariant to **location**, but will depend on **rotation** and **scaling.**
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 Contraharmonic Mean, negative values of Q eliminate **salt** noise**.**
14. In morphological processing, any on pixel in the structuring element covers an on pixel in the image in **Hit.**
15. In morphological processing, there are two basic morphological operations which are **erosion** and **dilation.**
16. The type of noise which arises due to electrical or electromagnetic interference is called **periodic noise** noise**.**

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Question 2: Choose the best answer: (8 Marks)

1. In spatial domain, which of the following operation is done on the pixels in sharpening the image?
   a. **Integration** c. Average
   b. Median d. Differentiation
2. Pixels are digital numbers that are composed of …….
   a. **bits** c. dots
   b. colors d. intensity levels
3. Negative of the image having intensity values [0,L-1] is expressed by
   a. s = L-1 **c. s = L-1-r**
   b. s = 1-r d. s = L-r
4. Smallest value of gamma will produce
   a. contrast c. **brighter image**
   b. darker image d. black and white image
5. Which one is not process of image processing
   a. high level c. **last level;**
   b. low level d. mid level
6. Smallest possible neighbourhood in an image must be of size
   a. 3x3 **c. 1x1**
   b. 2x2 d. 4x4
7. Smoothing spatial filters are useful for
   a. image enhancement **c. highlight gross details**
   b. image restoration d. highlight fine details
8. Which is first fundamental step in image processing?
   a. filtration **c. image acquisition**
   b. image enhancement d. image restoration
9. Which one is not area of digital image processing
   a. law enforcement c. lithography
   b. medicine **d. voice calling**
10. In ……. image we notice that the components of histogram are concentrated on the low side on intensity scale.
    a. bright c. all of the mentioned
    b. colourful **d. dark**
11. Histogram is the technique processed in
    a. intensity domain c. frequency domain
    b. undefined domain **d. spatial domain**
12. For edge detection we use
    a. first derivative c. third derivative
    b. second derivative **d. Both A and B**

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13. 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
14. First derivative of I(x) has a ……..at the edge.
    a. none of them
    b. valley
    c. zero crossing
    d. peak
15. 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
16. 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 3: (15 Marks)

a. **(4 marks)** What linear transformation will change an image f(x,y) with gray levels ranging from 5 through 20 to an image g(x,y) with gray levels ranging from 10 through 40?

Solution:

$f_{min} = 5$ $f_{max} = 20$

$g_{min} = 10$ $g_{max} = 40$

$ma + b = n$

$5a + b = 10$ (1)

$20a + b = 40$ (2)

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

$a = 2$

$b = 0$

Transformation function:

$2a = n$

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

L = 8
L-1 = 7
P (0) = 2 / 18
P (1) = 9 / 18
P (2) = 4 / 18
P (3) = 0
P (4) = 0
P (5) = 0
P (6) = 1 / 18
P (7) = 2 / 18

S (0) = 7 * P (0) = 7 (2/18) = 0.7 ≈ 1
S (1) = 7 * (P (0) + P(1)) = 7 (11/18) = 4.2 ≈ 4
S (2) = 7 * (P (0) + P(1) + P(2)) = 7 (15/18) = 5.8 ≈ 6
S (3) = 7 * (15/18) = 5.8 ≈ 6
S (4) = 7 * (15/18) = 5.8 ≈ 6
S (5) = 7 * (15/18) = 5.8 ≈ 6
S (6) = 7 * (16/18) = 6.2 ≈ 6
S (7) = 7 * (18/18) = 7

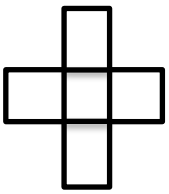
P (0) = 0
P (1) = 2 / 18
P (2) = 0
P (3) = 0
P (4) = 9 / 18
P (5) = 0
P (6) = 5 /18
P (7) = 2 / 18

The equalized image:

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

c. **(6 marks)** A 4x4 image is given by

100	110	160	120
80	90	100	100
90	90	50	120
40	100	19	150



Filter the image using a **Midpoint** filter (padding with zeros), use the filter mask given.

Solution:

55	80	80	80
50	95	105	60
45	75	69.5	75
50	50	75	75

Question 4: **(21 Marks)**

a. **(3 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. **(3 marks)** Explain the differences between regular and adaptive thresholding. State when each type should be used.

Solution:

For regular (global) thresholding you find threshold value or values for the entire image. In adaptive thresholding the image id divided into part, usually square, and threshold levels are found for each separate part. Global thresholding is useful when you want the image is similar in most parts. Adaptive thresholding is very useful when the image is changing in intensity, e.g., because of a light source from the right side. Then the threshold values should be quite different on the left and right side of the image**.**

c. **(3 marks)** When objects are represented, the representation should be invariant to three things. Describe these three things.

Solution:

1. Scale invariant

The same representation should work if the object is smaller or larger. Different scales shouldn't matter.

2. Rotation invariant

The same representation should work if the object is rotated. This is the most difficult invariance to handle since we have square pixels. A chain code which we say is rotation invariant is actually only invariant to rotation in even degrees (90º for 4-conneectivity and 45º for 8-connectivity)

3. Translation invariant

The same representation should work if the object is shifted around the image. The representation should not be dependent on the spatial position.

d. **(3 marks)** What is meant by "Representation".
State 4 approaches for the representation process.
Describe one of these approaches.

Solution:

The objective is to represent and describe the resulting aggregate of segmented pixels in a form suitable for further computer processing after segmenting an image into region.

Two choices for representing a region:

External characteristics: its boundary.

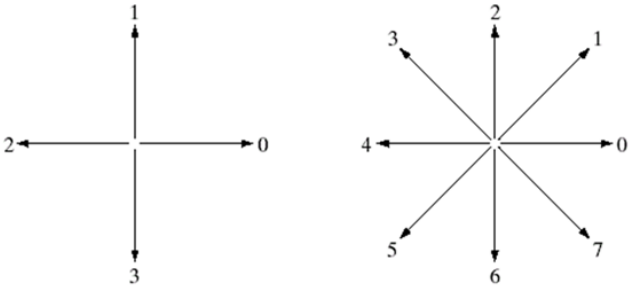
Internal characteristics: the pixels comprising the region.

approaches for the representation process:

1. Chain code

   To represent a boundary by a connected sequence of straight line segments of specified length and direction.

   The direction of each segment is coded by using a numbering scheme such as the ones shown below.



2. Polygonal approximation
3. Signature
4. Boundary Segments
5. Skeletons

e. **(3 marks)** Define "Texture".
Explain briefly the two types of texture.

Solution:

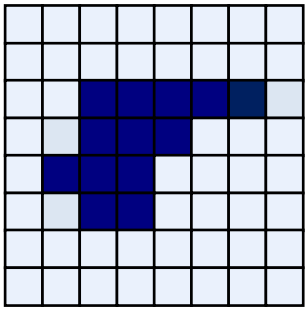
- Texture is usually defined as the smoothness or roughness of a surface.
- There are two types of texture:
  Random texture cannot be exactly described by words or equations; it must be described statistically. The surface of a pile of dirt or rocks of many sizes would be random.

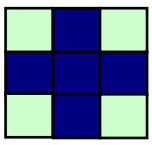
  Regular texture can be described by words or equations or repeating pattern primitives. Clothes are frequently made with regularly repeating patterns.
  Random texture is analyzed by statistical methods.
  Regular texture is analyzed by structural or spectral (Fourier) methods.

f. **(3 marks)** Explain the "relational descriptors".
Rewriting rules that capture the basic repetitive pattern.
It applies to both boundaries and regions.
Example: the staircase structure has been extracted from an image and we want to describe it.
We employ two primitive elements and a set of rules.

$$(1)\ S \rightarrow aA,$$
$$(2)\ A \rightarrow bS, \text{ and}$$
$$(3)\ A \rightarrow b,$$

g. **(3 marks)** Apply the opening operation on the image shown below:





Structuring Element

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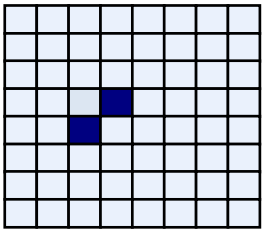
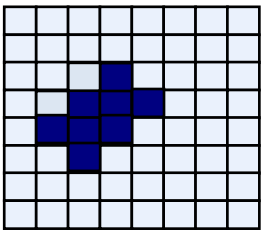
Erosion operation: $f \ominus s$



Dilation operation: $f \oplus s$



Good Luck
Dr. Shady Yehia Elmashad