Digital Image Processing
Spring Semester Exam.

Mansoura University
Faculty of Engineering

Biomedical Engineering Program - Level 300
Exam Date: 28-5-2017
Allowed Time: 2 Hours

Attempt all questions. Assume any missed data. Full mark is 50

Q.1) Correct the errors, if any, in each of the following statements: **[5 Marks]**

إذا كانت الجملة صحيحة يكتب رقم الجملة وعلامة (√) فقط أمامها، أما إذا كانت الجملة خطأ فتوضع علامة (x) أمام رقم الجملة، وتعاد كتابة الجملة كاملة بعد تصحيحها.

a. The complement of a grey-scale image is its photographic negative.
b. In point processing, a pixel's grey value is changed without any knowledge of its surrounds.
c. In maximum filter, the minimum value of the ordered pixel values is taken.
d. Gaussian noise can be cleaned by using frequency domain techniques.
e. The shifting property places the dc coefficient in the top right corner of the matrix.
f. Adaptive filters are a class of filters which change their characteristics according to the values of the grey-scales under the mask.
g. In a ramp edge, the grey values change slowly.
h. The human visual system is particularly attuned to two things: edges, and color.
i. Saturation is the amount by which the color has been diluted with white.
j. Color processing must be done using RGB color model.

Q.2) Give a short answer to each of the following questions: **[15 Marks]**

i. *"Recently, waves of terrorism attacks are beginning to spread from one place to another and thus a proper security approach needs to be adopted by the government"*. How can image processing helps in this situation?

ii. *"The result of applying a linear filter may be values outside the range (0-255)"*. Suggest two different methods to overcome this problem.

iii. *"Image restoration concerns the removal or reduction of degradations which have occurred during the acquisition of the image"*. Give a mathematical model of image degradation. Comment on the resulting model.

iv. *"An appropriate use for the Laplacian is to find the position of edges by locating zero crossings"*. Define the terms *'Laplacian'* and *'Zero crossing'*. State the main steps of *Marr-Hildreth* method.

Q.3.a) Use *MATLAB* to read the image *"liga.jpg"*. Transform it into grey-scale. Add *5% Gaussian noise* to the image. Attempt to remove noise using average filtering *(Size 3x3)*. Obtain the edges of the original color image using *RGB* color model. **[5 Marks]**

Q.3.b) Given a 5x5 image, *X*, and a Roberts edge detector, *H*

$$X = \begin{bmatrix} 115 & 110 & 105 & 105 & 350 \\ 105 & 100 & 100 & 100 & 355 \\ 100 & 140 & 120 & 100 & 350 \\ 110 & 130 & 145 & 115 & 345 \\ 120 & 130 & 130 & 125 & 345 \end{bmatrix} \quad \& \quad H = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Apply the given edge detector to the image? Modify values outside the range [0-255]. Then, apply a suitable threshold to transform the resulting image into a binary one. **[10 Marks]**

Q.4.a) ***Derive the parametric form of a straight line in an image.*** Use the Hough transform to detect the two strongest lines in the binary image shown below. **[10 Marks]**

y \ X	0	1	2	3	4	5	6
0	1	0	0	0	0	0	1
1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0
3	1	0	0	1	0	0	0
4	0	0	0	0	0	0	0
5	1	0	0	0	0	1	0
6	0	0	0	0	0	0	1

Q.4.b) Suppose a 4-bit grey-scale image has the following grey values distribution:

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
n_i	10	50	100	45	80	40	20	10	0	0	0	0	0	0	0	5

i. Sketch the histogram of this image. What do you expect about the appearance of this image?

ii. Use histogram stretching to improve the appearance of the image. Sketch the result.

Hint: Use the following stretching function: $j = \frac{14-2}{7-1}(i-1)+2, \quad 1 \le i \le 7$

iii. Repeat the solution using histogram equalization. Sketch the result. **[10 Marks]**

☺ ***Best wishes*** ☺

Assoc. Prof. Hossam El-Din Moustafa

Model Answer

Q.1)
a- ✓
b- ✓
c- ✗
d- ✗
e- ✗
f- ✓
g- ✓
h- ✓
i- ✓
j- ✗

Q.2) i- Image processing helps in this situation by using its applications in the law enforcement field as it can be used in fingerprint analysis application in the global important places for security and control entry and exit.

- we can also use it to the probability of sharpening and deblurring of speed camera images to recognize people.

ii- a) Clip value

$$y = \begin{cases} 0 & \text{if } x < 0 \\ x & \text{if } 0 \leq x \leq 255 \\ 255 & \text{if } x > 255 \end{cases}$$

- this result destroy the output of the filter.

b) scaling Transformation :-

$$y = 255 \frac{x - g_L}{g_H - g_L}$$

x = rang M قيمة الـ Pixel خارج

g_L أقل قيمة ناتجة من الفلتر

g_H أكبر قيمة " " "

Scanned by CamScanner

iii- In Spatial domain, the Convolution results some forms of degradations. $g(x,y) = x(x,y) * h(x,y)$

we must consider noise n.

$$g(x,y) = x(x,y) * h(x,y) + n(x,y)$$

Applying the Fourier transformation

$$Y(i,j) = X(i,j) \cdot H(i,j) + N(i,j)$$

If we know the values of H, N then

$$X(i,j) = \frac{Y(i,j) - N(i,j)}{H(i,j)}$$

Comment :- we have problem by dividing on spatial filter because if the spatial filter has small values close to zero then the noise may dominate the output.

V- * Laplacian :-

- May be obtained by considering the second derivatives in both directions (x, y) $\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$

mask $\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ used as H.p.f

* Zero Crossing :-

To be pixels whose values satisfy either of the following :-

1- The have negative grey values and are next to a pixel whose value is postive.

2- They have value of Zero and are between negative and postive-

steps of Marr hildreth method :-

1- Smooth the image with aguassian filter.

2- Convolve the result with alaplacian.

3- Find the Zero Crossings in the image

Q.3) a.
```
m = imread('liga.jpg');
y = rgb2grey(m);
n = imnoise(y,'gaussian',0,0.05);
f = fspecial('average',[3x3]);
x = filter2(f,n);
imshow(x)
e1 = edge(m(:,:,1));
e2 = edge(m(:,:,2));
e3 = edge(m(:,:,3));
T = e1|e2|e3;
figure, imshow(T);
```

b) By applying the mask over the image from left to right then step down and to left again and so on.

The result will be: $\begin{bmatrix} 15 & 10 & 5 \\ -35 & -20 & 0 \\ -30 & -5 & 5 \end{bmatrix}$

after modify the values out the range

- clip values $<0 \rightarrow 0$

$>255 \rightarrow 255$

the result = $\begin{bmatrix} 15 & 10 & 5 \\ 0 & 0 & 0 \\ 0 & 0 & 5 \end{bmatrix}$

we choose a threshold value $\rightarrow 128$

$>128 \rightarrow 1$

$<128 \rightarrow 0$

The result in binary: $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

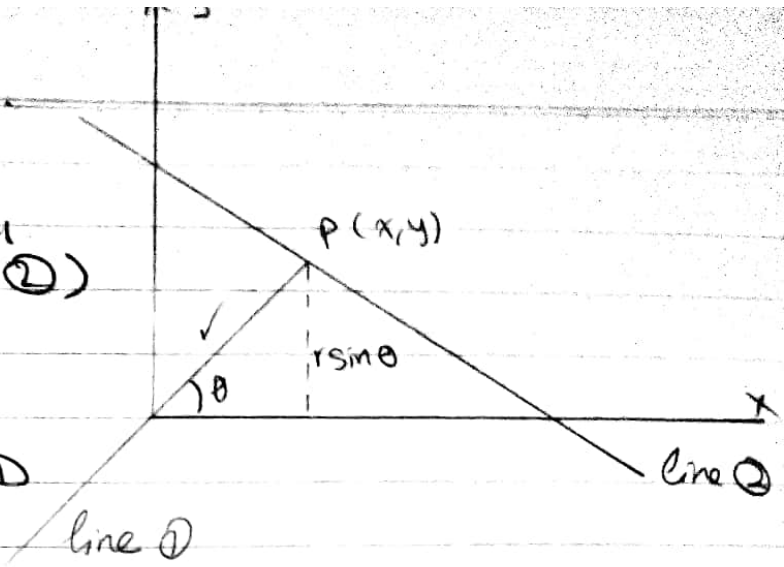
Q.4.a) line ① → slope = m

line ② → slope = m_1

$m m_1 = -1$ (line ① ⊥ line ②)

$m = \tan\theta = \frac{r\sin\theta}{r\cos\theta} = \frac{\sin\theta}{\cos\theta}$

$m_1 = \frac{-1}{m} = \frac{-1}{\tan\theta} = \frac{-\cos\theta}{\sin\theta} \rightarrow ①$



$m_1 = \frac{y-y_1}{x-x_1} = \frac{y-r\sin\theta}{x-r\cos\theta}$

from ①, ② ⇒ $\frac{-\cos\theta}{\sin\theta} = \frac{y-r\sin\theta}{x-r\cos\theta}$

$-x\cos\theta + r\cos^2\theta = y\sin\theta - r\sin^2\theta$

$r\cos^2\theta + r\sin^2\theta = y\sin\theta - x\cos\theta$

$r(\cos^2\theta + \sin^2\theta) = y\sin\theta - x\cos\theta$

$r = y\sin\theta - x\cos\theta \qquad (-90 \leq \theta \leq 90)$.

Q.4_a)

(x, y)	-90°	-45°	0	45°	90°
(0,0)	0	0	0	0	0
(0,1)	-1	-0.7	0	0.7	1
(0,3)	-3	-2.1	0	2.1	3
(0,5)	-5	-3.5	0	3.5	5
(1,1)	-1	-1.4	-1	0	1
(3,3)	-3	-4.2	-3	0	3
(5,5)	-5	-7.1	-5	0	5
(6,0)	0	-4.2	-6	-4.2	0
(6,0)	-6	-8.5	-6	0	6

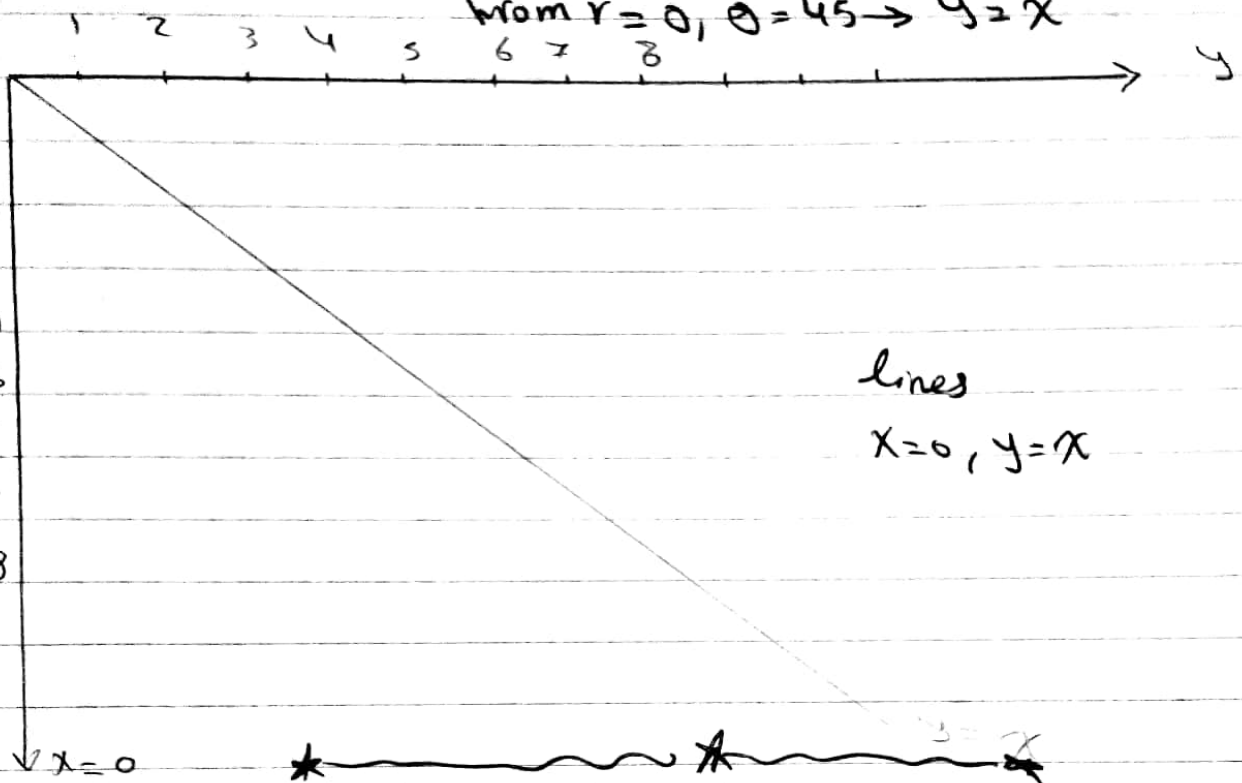
$r=0, \theta=0$

$r=0, \theta=45$

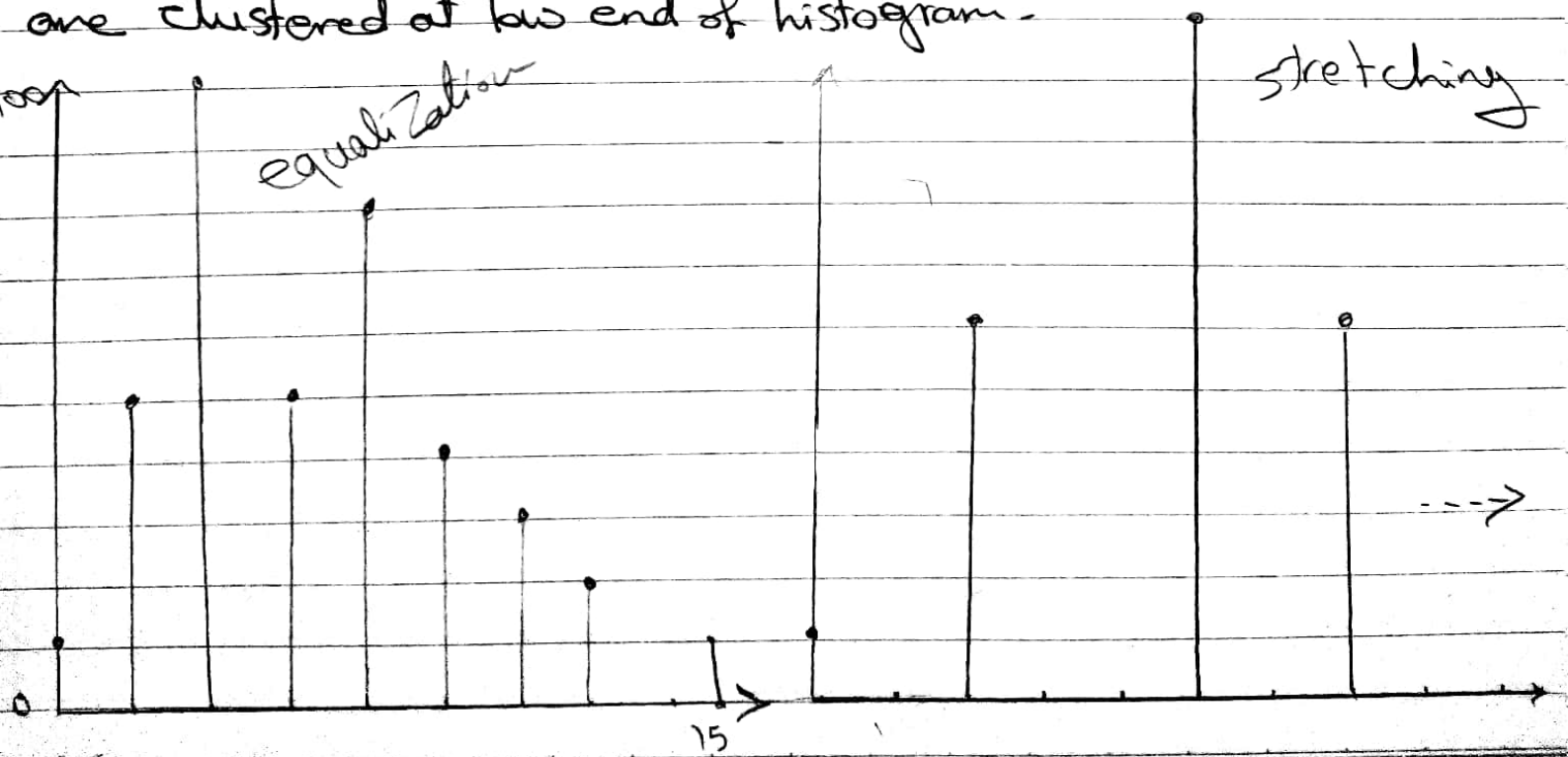
$r=y\sin\theta - x\cos\theta$

From $r=0, \theta=0 \rightarrow 0 = x$

From $r=0, \theta=45^\circ \rightarrow y = x$



i- it will be Bad Contrast image (dark image) because values are clustered at low end of histogram.



iii. $L = 16$, $\frac{L-1}{n} \sum n_i = \frac{1}{24} \sum n_i$, $n = \sum n_i = 360$

i	n_i	$\sum n_i$	$\frac{1}{24}\sum n_i / (\frac{L-1}{n})\sum n_i$	j
0	10	10	0.4	0
1	50	60	2.5	3
2	100	160	6.66	7
3	45	205	8.54	9
4	80	285	11.875	12
5	40	325	13.54	14
6	20	345	14,375	14
7	10	355	14,7	15
8	0	355	14,7	15
9	0	355	14,7	15
10	0	355	14,7	15
11	0	355	14,7	15
12	0	355	14,7	15
13	0	355	14,7	15
14	0	355	14,7	15
15	5	360	15	15