Digital Image Processing
Spring Semester Exam.

Mansoura University
Faculty of Engineering

Biomedical Engineering Program - Level 300
Exam Date: 13-5-2018
Allowed Time: 2 Hours

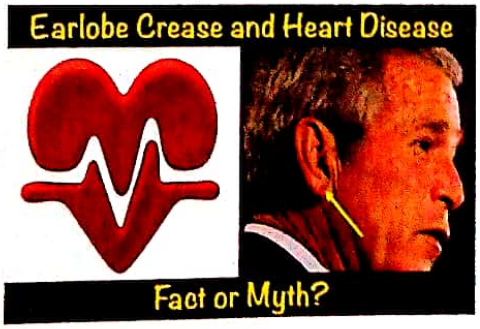
Attempt all questions. Assume any missed data. Full mark is 50

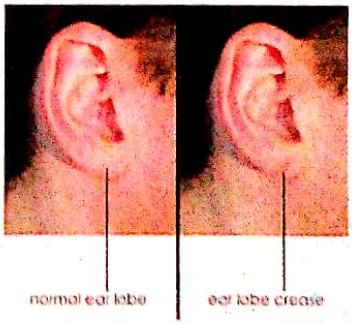
Q.1) Use neat sketches to compare between each of the following **[12 Marks]**

a. CCD camera and flat-bed scanner
b. The characteristics of a grey-scale image if we add 100 and the characteristics obtained if we multiply by 2.
c. Block diagram of unsharp masking and block diagram of transform processing using discrete Fourier transform.
d. Color image processing using RGB components and color image processing using intensity component.

Q.2) Give a short answer to each of the following questions: **[12 Marks]**

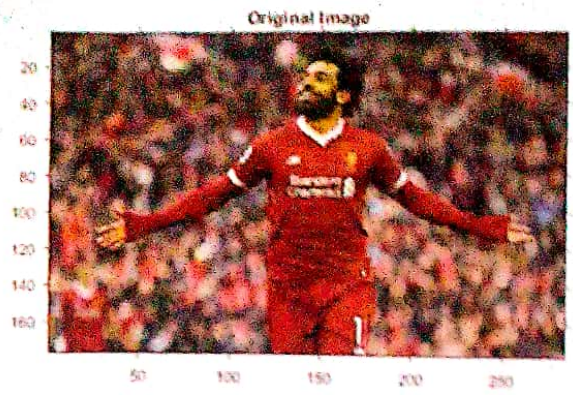
a. *"Does having an* earlobe *crease mean you're destined to have a serious heart condition?"* How can image processing helps to answer this question?

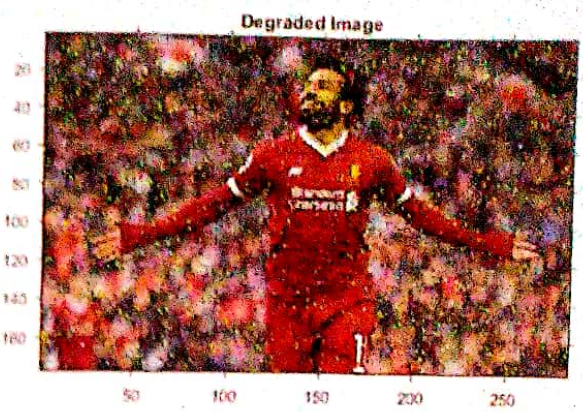




b. *"Inverse filtering may lead to errors in the filtered image".* Explain the concept of inverse filtering and the procedures that must be followed to overcome its disadvantages.
c. *"Thresholding can be useful in many situations".* Justify this statement. In which situations will adaptive thresholding be applied?
d. *"A color model is a method for specifying colors in some standard way".* Discuss the main three color models that are commonly used. Write down the MATLAB commands which can be used to transform between these models.

Q.3.a) Given an original image 'Mo_Salah.jpg' and a degraded version as shown in figure. What does the second image suffer from? Suggest a solution and write a well commented MATLAB code. Enhance the original image using unsharp masking. **[6 Marks]**





Q.3.b) ***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. **[12 Marks]**

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

Q.4.a) Consider the filtered image shown below:

0	15	15	15	15	15	15	0
15	-30	-15	-15	-15	-15	-30	1
10	-15	0	0	0	0	-15	10
10	-15	0	0	0	0	-15	10
10	-30	-15	0	0	0	-15	10
0	15	30	-15	0	0	-15	15
0	0	15	-30	-15	-15	-30	15
0	0	0	15	15	15	15	0

Apply "zero crossing" to obtain the edges of this image. **[6 Marks]**

Q.4.b) **Suppose a 4 bit grey-scale image has the following grey values:** **[6 Marks]**

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
n_i	0	0	0	0	0	100	150	80	90	30	50	0	0	0	0	0

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

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

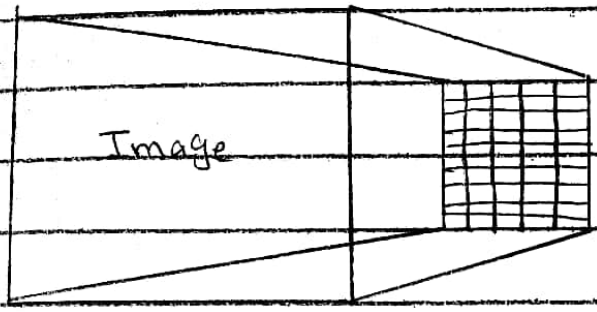
☺ ***Best wishes*** ☺

Assoc. Prof. Hossam El-Din Moustafa

Model Answer

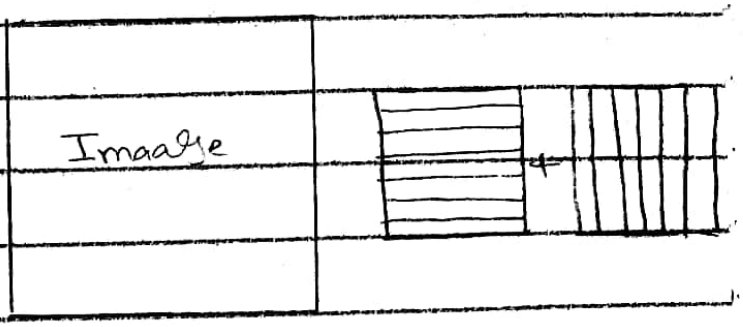
Question No. one

CCD Camera:

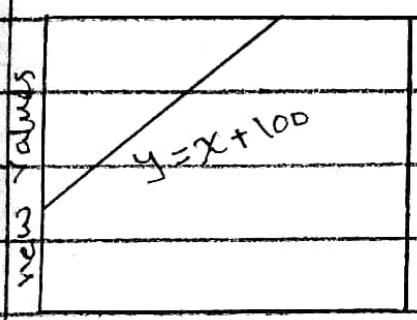


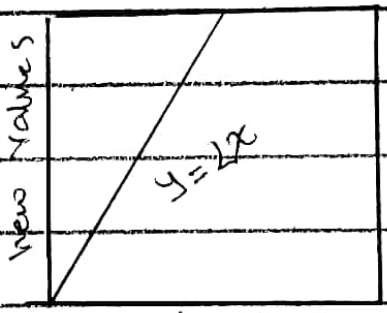
A matrix of photosites

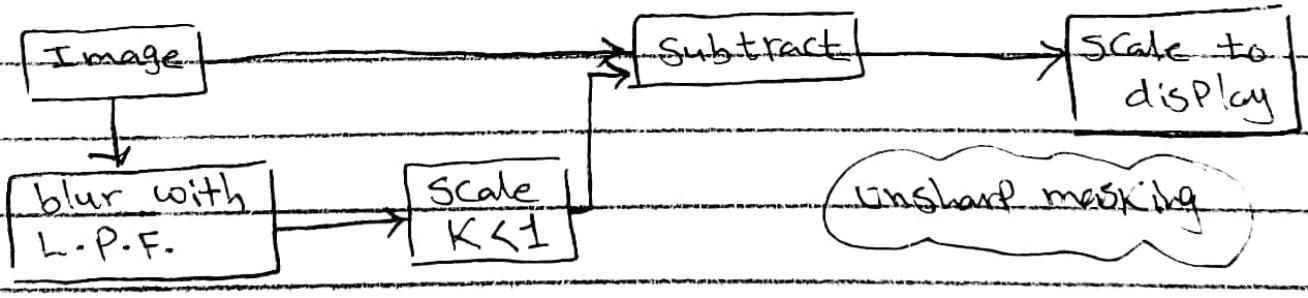
flat bed scanner:

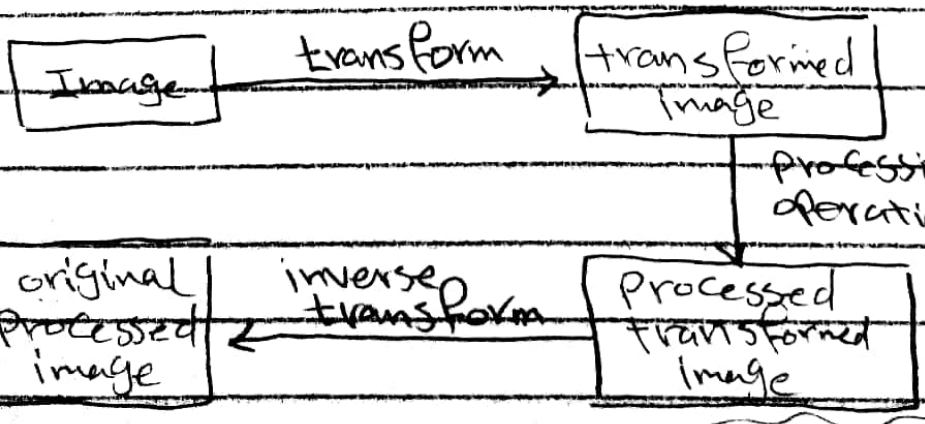


A Single row + A Single Column of photosites.



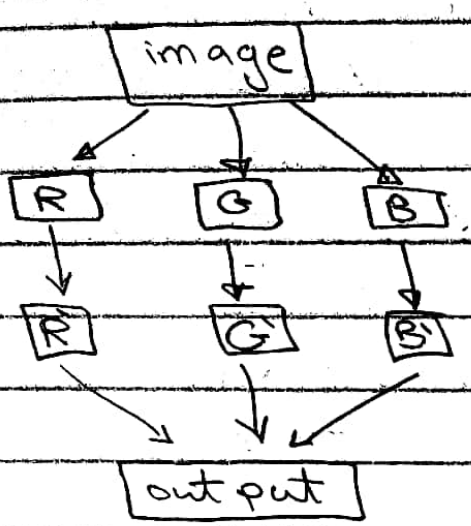






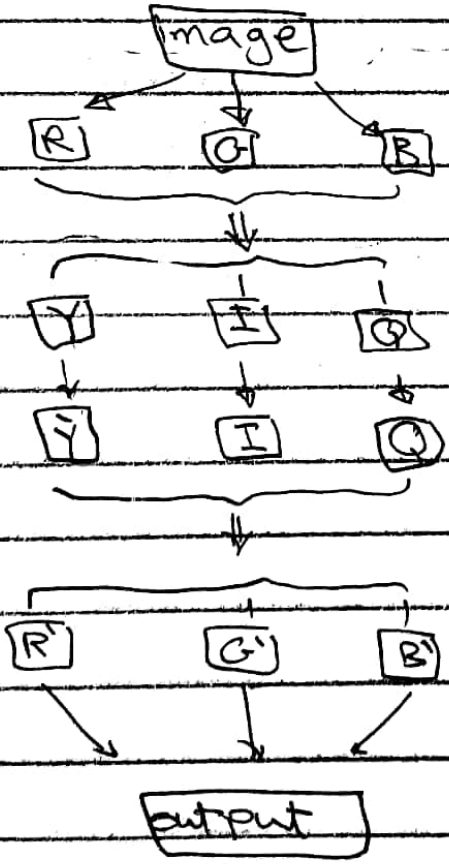
(d)

* Using RGB:



- processing on each layer.
- slow relativly.

* using intensity:



- processing on Y only.
- Fast.

rgb2ntsc

ntsc2rgb

(Q.2)

(a) we can detect it by finding edges this curve or line will be clear by this process.

↳ By doing merr Hildreith steps:

(1) Smooth the image with guassian filter.

(2) Convolve results with Laplacian.

(3) Finding zero crossing.

edge. تكون ظاهرة أكثر مع

b) **Inverse filtering:** Filtering in Fourier domain by multiplying DFT of the image by the DFT of the filter.

- this filter is direct application of convolution theorem.

$Y(i,j)$ → output image

$X(i,j)$ → image after DFT

$F(i,j)$ → Filter " "

$\therefore Y(i,j) = X(i,j) \cdot F(i,j)$

$\therefore X(i,j) = \frac{Y(i,j)}{F(i,j)}$

problem: $F(i,j)$ may be zero or very small value causing noise.

over came with:

(1) Butterworth LPF: to remove zero or small values $X(i,j) = \frac{Y(i,j)L(i,j)}{F(i,j)}$

(2) Constrained division:

- Choose threshold value (δ)

$$X(i,j) = \begin{cases} \frac{Y(i,j)}{F(i,j)} & \text{if } |F(i,j)| > \delta \\ Y(i,j) & \text{if } |F(i,j)| \leq \delta \end{cases}$$

the best method.

(c) Using of thresholding's

(1) To remove unnecessary detalies.
(2) Bring out hidden detalies.
(3) To remove varying background from text.
(4) we can use it in bactria image as an application of single threshold.
(5) we can use it in spine & more medical images as an application of double threshold.

•adptive thresholding's useful to separate object & background when there are interface between them

By (1) Cutting the image into slices.
(2) Apply thresholding on each slices individuly to obtain a complete separated image.

(d)

RGB: red - green - blue

there are three layer each pixel in these layers has 8*3 = 24 bit - it is commonly used.

HSV: Hue - Saturation - value.

- Hue: true color [green - yellow - red - ...]
- Saturation: the amount of color diluted with white, if more diluted with white the less saturation.
- value: the degree of brightness, if well Lit color the intensity is high if dark color the ~ ~ low.

YIQ: Y: (luminance) refer to brightness corresponding roughly with intensity.

I & Q: refer to color information we can called them (chrominance).

From	to	code
RGB	Hsv	rgb2 hsv
HSV	RgB	hsv 2 rgb
RGB	YIQ	rgb 2 ntsc
YIQ	RGB	ntsc 2rgb
HSV	YIQ	hsv2 rgb then rgb2 ntsc
YIQ	HSV	ntsc 2rgb then rgb2 hsv

(Q.3)

It suffers from: salt and pepper noise.

- Solutions:
  (1) LpF
  (2) median filter (the best)
  (3) outlier method (quick & dirty)

- Commented code:

```
i = imread('Mo_salah1.jpg');
% قراءة الصورة وتخزينها (الصورة الـ noisy)
y = medfilt2(i, [3,3]);
% عمل فلتر (medium) بحجم 3*3 على الصورة
figure, imshow(y); % عرض الصورة
```

- unsharp masking:

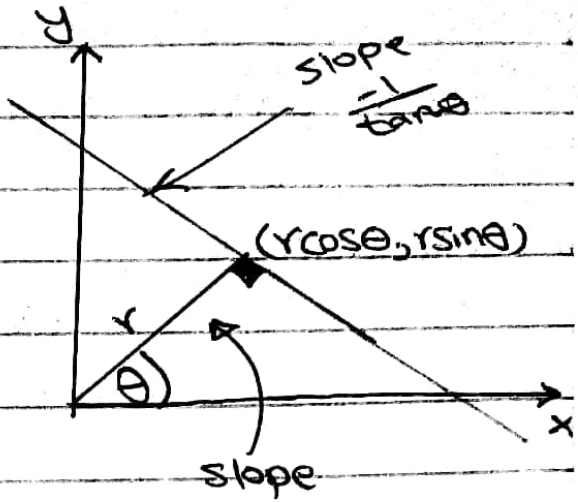
```
i = imread('Mo_salah.jpg');
F = fspecial('average', [5,5]);
y = filter2(F, i); j = i - y/k;
figure, imshow(j);
```

↑ scale according to image.

note * for code to clean noise if we use orignal:

```
i = imread('Mo-salah.jpg');
n = imnoise(i, 'salt & pepper', 0.05);
y = medfilt2(n, [3,3]);
figure, imshow(y);
```

(b)



$\therefore \frac{y - r\sin\theta}{x - r\cos\theta} = \frac{-\cos\theta}{\sin\theta}$

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

$\therefore \cos^2\theta + \sin^2\theta = 1$

$\therefore x\cos\theta + y\sin\theta = r$

(x, y)	−90	−45	0	45	90
(0, 0)	0	0	0	0	0
(0, 1)	−1	−0.7	0	0.7	1
(0, 4)	−4	−2.8	0	2.8	4
(0, 6)	−6	−4.24	0	4.24	6
(1, 1)	−1	0	1	1.4	1
(1, 5)	−5	−2.8	1	4.24	5
(2, 4)	−4	−1.4	2	4.24	4
(3, 3)	−3	0	3	4.24	3
(5, 1)	−1	2.8	5	4.24	1
(6, 0)	0	4.24	6	4.24	0

	-6	-5	-4.24	-4	-3	-2.8	-1.4	-1	-0.7	0
-90	1	1		2	1			3		2
-45			1			2	1		1	3
0										4
45										1
90										2

	0.7	1	1.4	2	2.8	3	4	4.24	5	6
-90										
-45					1			1		
0		2		1		1			1	1
45	1		1		1			6		
90		3				1	2		1	1

∴ (r,θ) $(0,0)$ & $(4.24, 45)$

∴ $x\cos\theta + y\sin\theta = r$

∴ $x = 0$

∴ $\frac{\sqrt{2}}{2}x + (\frac{\sqrt{2}}{2})y = 4.24$

∴ $x + y = 6$

$x=0$ $y=6$ $\quad$ $x=1$ $y=5$

« الرسم في الرسم ليبانى »

(Q.4)

(a)

edges

0	15	15	15	15	15	15	0
15	-30	-15	-15	-15	-15	-30	1
10	-15	0	0	0	0	-15	10
10	-15	0	0	0	0	-15	10
10	-30	-15	0	0	0	-15	10
0	15	30	-15	0	0	-15	15
0	0	15	-30	-15	-15	-30	15
0	0	0	15	15	15	15	0

→ Pixels satisfy:

(1) negative pixels & at least 4 (non-ve) or positive value of 8 neighbourhood

(2) zero value between (+ve) & (-ve) values

(b) It seems poorly contansted in

↳ the grey range not dark not light

"الرسم في الصفحة البيانية"

i	n_i	$\sum n_i$	$\frac{15}{500}\sum n_i$	rounded value
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	100	100	3	3
6	150	250	7.5	8
7	80	330	9.9	10
8	90	420	12.6	13
9	30	450	13.5	14
10	50	500	15	15
11	0	500	15	15
12	0	500	15	15
13	0	500	15	15
14	0	500	15	15
15	0	500	15	15

i	0	1	2	3	4	5	6	7	8	9	10
j	0	0	0	0	0	3	8	10	13	14	15
						100	150	80	90	30	50

i	11	12	13	14	15
j	15	15	15	15	15