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SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
SEPTEMBER 2014 SESSION

SUBJECT CODE	:	**FSB33503**
SUBJECT TITLE	:	**IMAGE PROCESSING**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**9.00 AM – 12.00 PM (3 HOURS)**
DATE	:	**07 JANUARY 2015**

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This questions paper consists of five (5) questions. Answer any four (4) questions only.**
6. **Answer all questions in English.**
7. **Graph paper is appended**

THERE ARE 7 PRINTED PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: Answer four questions only.
Please use the answer booklet provided.

Question 1

(a) List two advantages of Digital Image Processing

(2 marks)

(b) Calculate the number of bits required to store a 512 X 512 image with 256 gray levels. Define how Intensity level resolution refers to the number of intensity levels used to represent the image

(4 marks)

(c) Let

$$a = \begin{bmatrix} 1 & -1 & 3 & 0 \\ -2 & 1 & 1 & 3 \\ 2 & 1 & 5 & -2 \\ 0 & -1 & 4 & 1 \end{bmatrix}$$

Define the values of the arrays after execution of each assignment statement?

i. B = a < 0
ii. C (~B) = 5
iii. D = a ([4 3], 2:-1:1)

(6 marks)

(d) Problem statement: Intelligent Traffic Light can be built by integrating the controller system and high end camera. It can count and detect various type of vehicle such as normal vehicle like car, lorry and motorcycle as well as emergency vehicles. In advance applications of traffic light, the controller are able to distinguish between two categories of vehicle so that any emergency vehicle can smoothly drive in through traffic congestion. Figure 1 shows the fundamental steps in image processing technique. Based on the steps shown in Figure 1, explain briefly on how to solve this problem statement based on the following question.

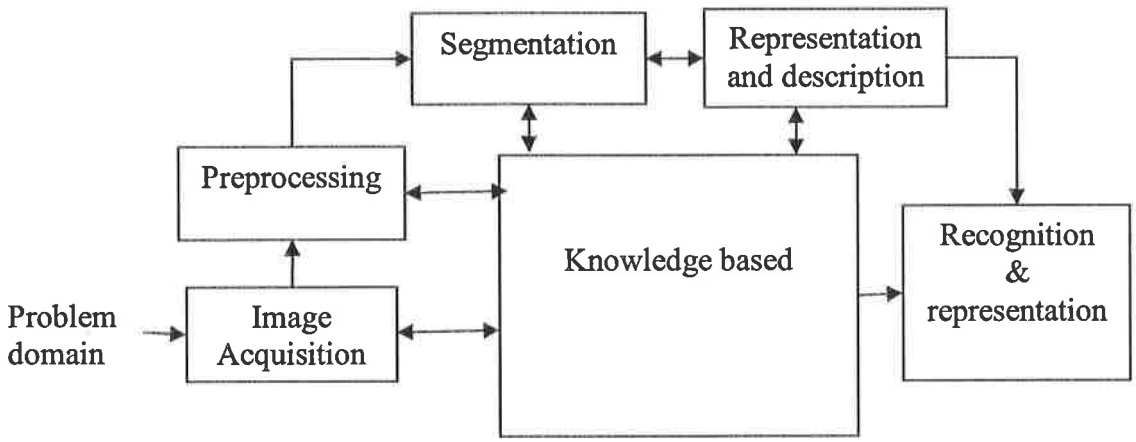

Figure 1 Step in Image Processing

i. The first step in the process is image acquisition that is acquiring a digital image. It requires an imaging sensor and the capability to digitize the signal produced by the sensor. After the digital image has been obtained the next step deals with preprocessing that image. State the key function of preprocessing technique and give an example of the technique that can be used.

(4 marks)

ii. The next stage deals with segmentation. Define the key role of the segmentation. What is the expected output for the segmentation stage? State one of the technique for segmentation

(4 marks)

iii. Choosing a representation is only part of the solution for transforming raw data into a form suitable for subsequent computer processing. What is the role of feature extraction? State the features that can be extracted to differentiate the vehicle.

(3 marks)

iv. The last stage involves recognition and interpretation. Define the difference between recognition and interpretation in image processing.

(2 marks)

Question 2

(a) i. Define the meaning of transformations.

(2 marks)

ii. State the reason why we need to have transformation.

(3 marks)

(b) Define the need to rotate an image. Give one example of image rotation application. Explain briefly.

(5 marks)

(c) A point (P) of an object is translated with a translation vector (7, 4) as shown in Figure 1.

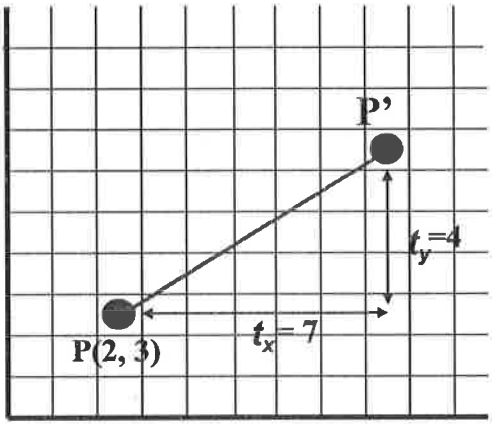

Figure 1: Rotation of a point (P) of an object

i. Write translation matrix of the operation and find the point P'.

(5 marks)

ii. Then point P' is rotated through an angle of 60°. Write the Rotation matrix of the above operation and find the transformed point (P_R) of P', caused by this rotating operation.

(5 marks)

iii. Finally the point P_R is scaled by a scale factor (0.5, 2) to P_S. Write the scale matrix of the operation and find the point P_S.

(5 marks)

Question 3

(a) Specify the objective of image enhancement technique.

(1 marks)

(b) In electronics industries, quality inspection is part of manufacturing process to ensure production rejection rate always at minimum level. The following Figure 2 shown an image of PCB inspection in electronic industries. The image was captured using low resolution camera and we need to enhance the image using filtering technique. Spatial filtering method is a common technique to smoothing a noisy image and given in the following equation.

$$g(x,y) = \sum_{s=-a}^{a}\sum_{t=-b}^{b} w(s,t) f(x+s, y+t)$$

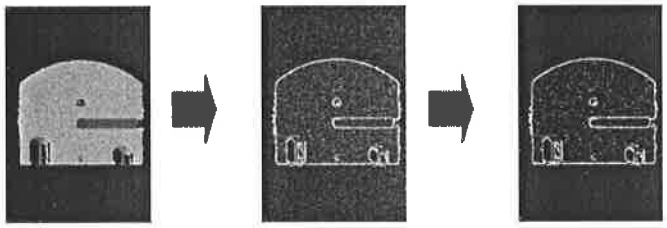

Figure 2 (a) Before and (b) after smoothing process

i. *g(x,y)* with 4x4 size of matrix has been taken from part of PCB image and its pixel values shows in Table 1. Apply averaging smoothing filtering to the image in Table 1 with windowing size 3x3 and averaging factor 1/9. The boundary pixel should be padding duplicate intensity.

Table 1

100	44	67	81
150	24	18	70
145	43	25	71
24	200	215	105

(10 marks)

ii. Histogram of grayscale value for both images has a different distribution. Sketch the histogram of PCB images before and after applying smoothing filtering. Explain your answer.

(5 marks)

(c) Perform filter operation of the image in Table 1 using convolution and correlation spatial filter with kernal in Table 2.

Table 1: 4*4 Scales Image

9	9	9	9
11	12	12	12
11	11	11	12
8	7	7	8

Table 2: 1*3 Kernel spatial filter

-1	0	1

Note: Show all your calculations

(6 marks)

(d) Given Laplacian equation for sharpening operation as follow:

$$\nabla^2 f = [f(x+1,y)+f(x-1,y)+f(x,y+1)+f(x,y-1)-2f(x,y)]$$

Deduce the Laplacian filter based on the equation given above.

(3 marks)

Question 4

(a) Briefly explain image enhancement and why we need to enhance the image.

(5 marks)

(b) State the objective and the application for the grey level slicing intensity transformation

(3 marks)

(c) Matrix image A is given in Table 3. The image A has been enhanced using intensity transformation function as shown in Figure 3. Find the transformation function T(r) and determine the output image matrix of the transformation.

Table 3: Matrix Image A

54	151	151	151	152
151	200	150	152	158
158	151	151	157	160
155	156	56	55	160
153	235	155	158	245

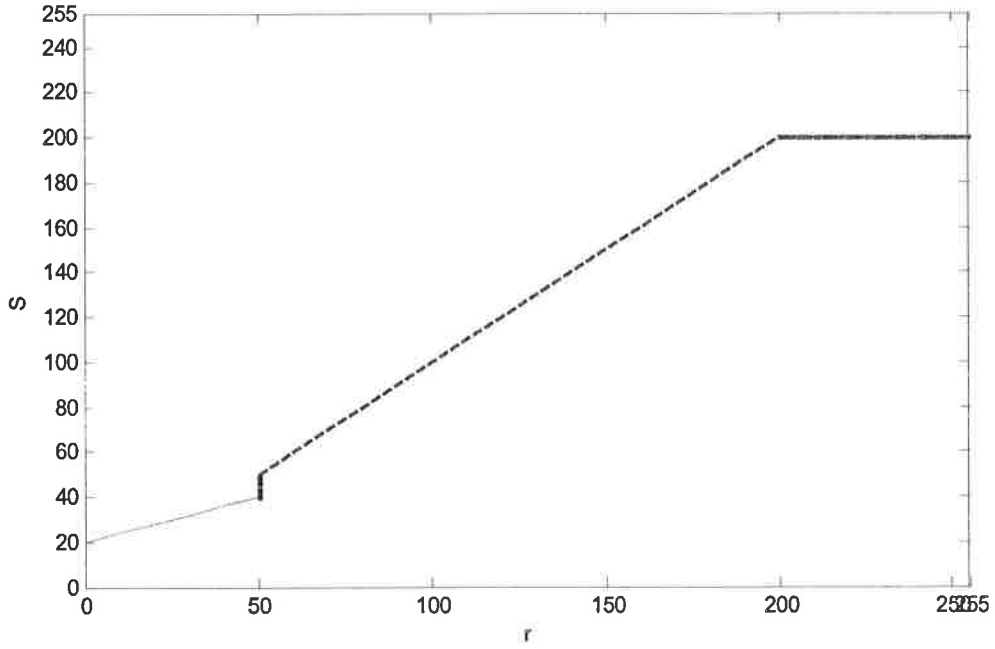

Figure 3: Transformation Function

(7 marks)

(d) Consider you are given a 3 bits/pixel image matrix as in Table 4.

Table 4: Image matrix B

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

i. Create histogram to the image in Table 4

(2 marks)

ii. Build enhancement operation in order to improve the appearance of the Table 4 image using ***histogram equalization*** technique and the result will be stored in the form of matrix 4x4 called Image E.

(8 marks)

Question 5

(a) State the goal of image segmentation.

(2 marks)

(b) Define two major problems that may affect the result of segmentation:

(2 marks)

(c) State three main categories in image segmentation techniques

(3 marks)

(d) Connectivity refers to the way in which we define an object. State possible neighbors where a pixel can connect and define three ways of the connectivity.

(4 marks)

(e) List the dissimilarities between dilation and erosion.

(2 marks)

(f) A Figure 4 shown snapshot of Matlab code applying morphology technique (imdilate, imerode and imclose). Draw the original image, structuring element and the outputs after this code were executed.

```
A=[0 0 0 0 0 0 0; 0 0 1 1 0 0 0 ;0 0 0 1 0 0 0; 0 0 0 1 1 0 0; 0 0 1 1
1 1 0; 0 0 1 1 1 0 0; 0 1 0 1 0 1 0; 0 1 1 1 1 1 0; 0 0 0 0 0 0 0];
strel=[1 1 1]';

C1=imdilate(A,strel);
D1=imerode(A,strel);
E1=imclose(A,strel);

figure(1);
  subplot(321); imshow(A);          % a. (2 marks)
  subplot(322); imshow(strel);      % b. (2 marks)
  subplot(323); imshow(C1);         % c. (2 marks)
  subplot(324); imshow(D1);         % d. (2 marks)
  subplot(325); imshow(E1);         % e. (2 marks)
                              % f. Perfect answer(2 marks)
```

Figure 4: Snapshot of Matlab Code

(12 marks)

END OF QUESTIONS