Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	VISION SYSTEM
COURSE CODE	:	BEJ 34202
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	2 HOURS
INSTRUCTION	:	1. ANSWER ALL QUESTIONS 2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Part A Objective (25 marks)
Answer all the questions in the answer script.

Q1 Select the difficulty in the image segmentation process.

I. No control of the environment
II. Uniform illumination
III. Noise
IV. Adequate model of the object of interest

A I and II
B I and III
C III and IV
D II and III

(1 mark)

Q2 Identify the examples that are related to segmentation algorithms in a variety of applications.

I. Automatic Target Acquisition
II. Colorization of Motion Pictures
III. Detection and measurement of bone and tissues in medical images
IV. Optical character recognition

A I and II
B II and III
C I, II and III
D All above

(1 mark)

Q3 Construct a correct sequence of flow to apply the Mean-C segmentation algorithm.

I. Threshold the difference image with C
II. Subtract the original from the convolved image
III. Convolved the image with a suitable operator (mean or median)
IV. Invert the threshold image

A III,II, IV, I
B III , I, II, IV
C III, II, I, IV
D III,IV, II,I

(1 mark)

Q4 Calculate the suitable value for the gamma (γ) in gamma correction process shown in **Table Q4.**

Table Q4

Original Image	Gamma Process
110	212
110	216
120	219
130	223
150	239
170	236

A γ=0.1
B γ=0.2
C γ= 0.3
D γ= 0.4

(2 marks)

Q5 Analyze the effect of an image of gamma, $\gamma<1$.

A An overexposed image can be corrected
B An overexposed image cannot be corrected
C An underexposed image can be corrected
D An underexposed image cannot be corrected

(2 marks)

Q6 Analyze the algorithm that can be used to correct/segment underexposed/overexposed area in an image.

I. Gamma Correction
II. OTSU
III. Hough Transform
IV. Adaptive Threshold

A I and II
B II and IV
C II and III
D II and IV

(2 marks)

Q7 The cumulative distribution function (Cdf) is shown in **Table Q7**. Referring to the Table Q7, calculate the Cdf value for A, B, C and D.

Table Q7

Value	Count	Cdf	Scaled
211	8	8	0
216	6	A	48
219	6	B	96
223	6	C	143
229	5	D	G
235	9	40	H

A A=14, B=18, C=25 and D =30
B A=14, B=20, C=26 and D =31
C A=14, B=20, C=25 and D =31
D A=14, B=20, C=26 and D =30

(4 marks)

Q8 The cumulative distribution function (Cdf) is shown in **Table Q7**. Referring to the Table Q7 calculate the scaled value for G and H.

A G=184 and H = 255
B G=174 and H = 255
C G=184 and H = 250
D G=174 and H = 205

(3 marks)

Q9 The cumulative distribution function (Cdf) is shown in **Table Q7**. Referring to the Table Q7 examine the contrast and illumination condition of an image after undergoing such a pre-processing stage.

A Histogram equalization produces evenly illumination and low contrast
B Histogram equalization produces evenly illumination and high contrast
C Histogram equalization produces quite bright illumination and high contrast
D Histogram equalization produces quite bright illumination and low contrast

(2 marks)

Q10 Image below shows a linear convolution process using a 3 x 3 mean filter. Find the value for A.

4	2	4	6	7
1	5	6	1	7
6	4	5	2	8
2	1	4	7	5
7	1	4	3	2

Local image

0	0	1
0	1	1
0	1	1

Filter

		A		

Modified image data

A 5
B 10
C 20
D 19

(3 marks)

Q11 Analyze the effect of the image below after being corrected using histogram equalization in term of illumination and contrast.

50	50	50	50	50	17
17	17	17	17	33	33
20	0	60	60	70	33
20	0	60	80	80	33
20	0	70	90	80	0
50	20	33	33	0	0

Original image

179	179	179	179	179	43
43	43	43	43	128	128
77	0	204	204	221	128
77	0	204	247	247	128
77	0	221	255	247	0
179	77	128	128	0	0

New image

A Histogram equalization produces quite bright illumination and high contrast
B Histogram equalization produces quite bright illumination and low contrast
C Histogram equalization produces evenly illumination and low contrast
D Histogram equalization produces evenly illumination and high contrast

(2 marks)

Q12 Determine the suitable threshold value to obtain the binary image below.

70	90	90	100	80
80	60	60	100	140
70	60	140	140	140
120	120	60	60	70
60	70	100	60	70

Original image

0	1	1	1	1
1	0	0	1	1
0	0	1	1	1
1	1	0	0	0
0	0	1	0	0

Binary image

A Th=80
B Th=90
C Th=100
D Th=120

(2 marks)

Part B Subjective (75 Marks)
Answer all the questions.

Q1 You have been given a task for processing and segmenting out the object of interest from image *A* and image *B* as shown in **Figure Q1.** For segmentation, the global method shall be executed using OTSU between class variance while the local method using *mean-C* with 3x3 kernel and C =150.

(a) Investigate the suitable method of segmentation to separate the foreground and background of image *A* and image *B* respectively. (Please use illustration and provide a clear explanation. Your first task is to segment out the foreground using the optimal threshold value).

(4 marks)

(b) Analyze the optimal threshold value of image *A*.

(16 marks)

(c) From the threshold value obtained in **Q1(b)**, construct an edge map of image *A* by using Prewitt operator given by:

$$dx = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}, \quad dy = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

(5 marks)

Q2 Referring to Convolutional Neural Network (CNN) code in **Figure Q2:**

(a) Illustrate the model structure with details of layer labeling.

(3 marks)

(b) Analyze image output shape and its total trainable parameters for each stack of the CNN layer.

(20 marks)

(c) Illustrate the new model structure if VGG pre-trained model is to be integrated to the existing CNN structure.

(2 marks)

Q3 (a) If a rectified image consists of five big circles and five small triangles with known and uniform dimension, list a morphological based procedure to automatically eliminate the small triangles while retaining the circles.

(5 marks)

(b) From the binary image depicted in **Figure Q3(b)**, analyse the object center location by using geometrical moment features.

(10 marks)

(c) You have been given a stereo vision system with two cameras aligned as shown in **Figure Q3(c)**.

(i) Derive the equation to relate the real 3D coordinate with the pixel locations in the left and right camera images.

(5 marks)

(ii) Detecting conjugate pairs in stereo images is a challenging research problem known as the correspondence problem, e.g., to find for each point in the left image, the corresponding point in the right one. Explain how SAD (Sum of Absolute Differences) works to determine the correspondence between the left and right images.

(3 marks)

(iii) Construct a method for detecting ground plane and ceiling information from the depth map.

(2 marks)

- END OF QUESTION -

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110	110	110	110	110	110	110	110
120	120	160	160	180	120	120	110
120	150	150	150	180	180	180	120
120	120	160	160	180	180	130	120
120	180	180	180	180	130	130	130

Image A

110	150	180	180	180	130	150	110
120	130	160	180	180	150	150	130
110	110	180	180	180	160	160	110
120	120	110	110	130	130	120	110
120	150	160	180	160	150	130	120

Image B

Figure Q1

```
cnn_model = models.Sequential()
cnn_model.add(layers.Conv2D(16,(11,11), activation='relu', input_shape=(256,256,3)))
cnn_model.add(layers.MaxPooling2D((2,2)))
cnn_model.add(layers.Conv2D(32,(7,7),activation='relu'))
cnn_model.add(layers.MaxPooling2D((2,2)))
cnn_model.add(layers.Conv2D(64,(1,1),activation='relu'))
cnn_model.add(layers.Conv2D(128,(5,5),activation='relu'))
cnn_model.add(layers.MaxPooling2D((2,2)))
cnn_model.add(layers.Conv2D(256,(3,3),activation='relu'))
cnn_model.add(layers.MaxPooling2D((2,2)))
cnn_model.add(layers.Conv2D(512,(3,3),activation='relu'))
cnn_model.add(layers.Flatten())
cnn_model.add(layers.Dense(512, activation='relu'))
cnn_model.add(layers.Dense(1,activation='sigmoid'))
```

Figure Q2

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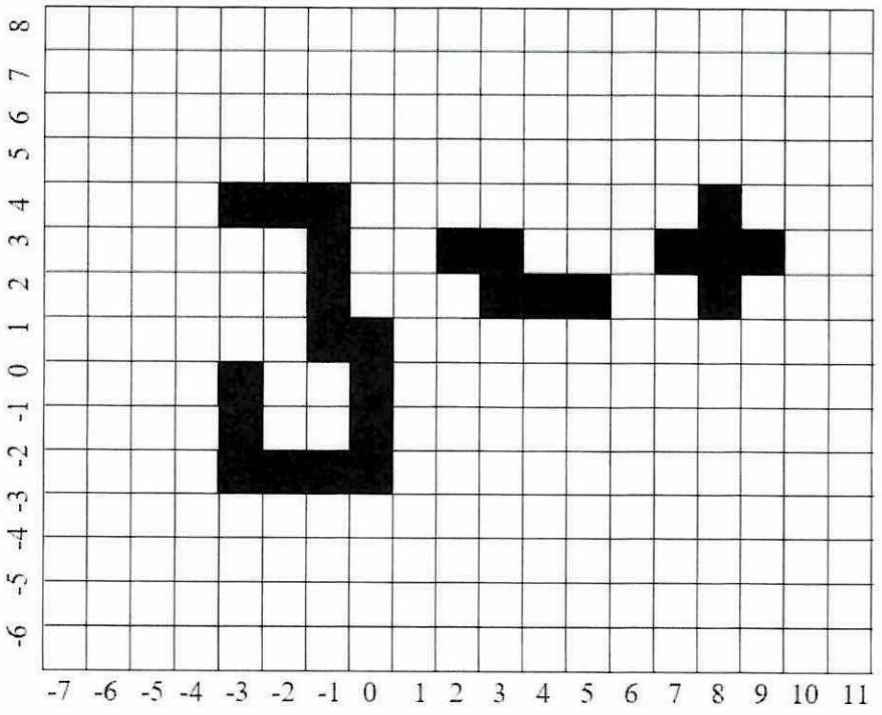

FigureQ3(b)

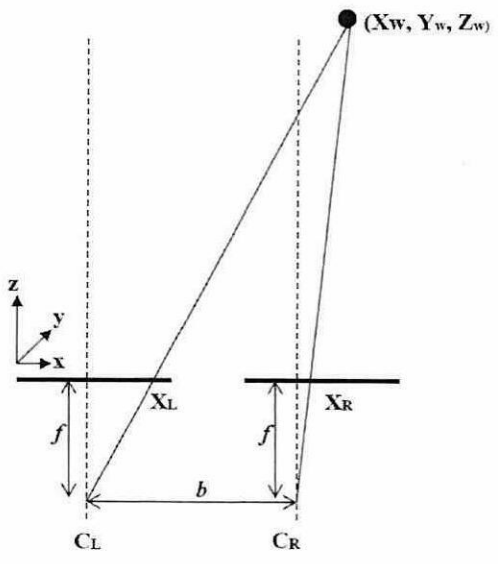

Figure Q3(c)

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Geometrical Moment Definition

General Moment Equation $$m_{pq} = \sum_{(x,y)\in R} \sum x^p y^q$$

Central Moment of the Image $$\mu_{pq} = \sum_{x} \sum_{y} (x-\bar{x})^p (y-\bar{y})^q f(x,y)$$

Where: $\bar{x} = \frac{m_{10}}{m_{00}}$ and $\bar{y} = \frac{m_{01}}{m_{00}}$