UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	VISION SYSTEM
COURSE CODE	:	BEH 41902
PROGRAMME	:	BEJ
EXAMINATION DATE	:	DECEMBER 2018/JANUARY 2019
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Give two examples of feature extraction implementation in robotic application.

(2 marks)

(b) The Harris corner detector algorithm relies on a central principle: at a corner, the image intensity will change largely in multiple directions. This can alternatively be formulated by examining the changes of intensity due to shifts in a local window. Around a corner point, the image intensity will change greatly when the window is shifted in an arbitrary direction.

(i) Explain how the algorithms work for building reconstruction in outdoor scene of autonomous mobile robot

(3 marks)

(ii) Investigate the correspondence points matching problem occur using this method (Please use proper example)

(3 marks)

(c) One of the bottlenecks of using camera for quadrotor navigation is a small field of view (FOV). Such problem can be alleviated by using a fish eye lens, but the problem is that the obtained image is highly distorted.

(i) Develop a procedure to undistort the image. You need to explain in detail each step taken, e.g., number of minimum samples, name of the algorithm and extracted information.

(5 marks)

(ii) If the 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.

(4 marks)

(d) From the binary image depicted in **Figure Q1(d)**, analyse the object center location by using geometrical moment features.

(8 marks)

Q2 You have been given a task to segment out objects carried on a conveyor. The captured grayscale image is underexposed and overexposed in some of the area. There are two methods that can be used to accomplish the task:

(a) The first method is by improving image quality prior to the segmentation process.

(i) Illustrate a histogram of an underexposed and overexposed image.
(2 marks)

(ii) Construct an algorithm to adaptively improve the underexposed/overexposed area in the image. (Please state clearly each step taken including the utilised equation).
(4 marks)

(iii) From the enhanced image, propose a solution to automatically determine an optimal threshold value. (Please explain the method as detail as possible).
(4 marks)

(b) The second method is by using an adaptive threshold technique.

(i) Explain how the adaptive threshold technique can be invariant under various lighting condition.
(2 marks)

(ii) Analyse the binary image of **Figure Q2(b)(ii)** using mean-C adaptive threshold with 3X3 mean kernel and C= 25.
(13 marks)

Q3 From the image shown in **Figure Q3** :

(a) Find the new image after been transformed using Histogram Equalization.
(9 marks)

(b) Compare the image before and after transformation in term of the histogram distribution and the image quality.
(2 marks)

(c) Find the edge map from the transformed image using following Prewitt operator if the threshold value is 200.

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

(10 marks)

(d) From the edgels locations, design a procedure to determine number of straight lines in the object and consequently the type of object shape (Please use illustration and explain in detail each steps).

(4 marks)

Q4 (a) A fully connected Multi layer Perceptron Neural Network (MLPNN) classifier was developed with linear activation function in the input nodes (O_i) and log sigmoid activation functions in the hidden node (O_j) and output node (O_k) as shown below :

$$f(net_j) = \frac{1}{1 + e^{-0.7 net_j}}$$

The classifier consist of three input nodes, three hidden nodes, and one output node that is responsible to classify between two groups of output labeled as '0' and '1'.

(i) Illustrate the architecture of the MLPNN model if $w_{ij}(i,j)$ is the weights between input and hidden layer and $w_{jk}(j,k)$ is the weights between hidden and output layer. (Please label your drawing)

(3 marks)

(ii) If $w_{ij}(0,0)$= 0.47, $w_{ij}(0,1)$ = 0.07, $w_{ij}(0,2)$ = 0.4, $w_{ij}(1,0)$ = 0.27, $w_{ij}(1,1)$ = 0.48, $w_{ij}(1,2)$ = 0.16, $w_{ij}(2,0)$ = 5.17, $w_{ij}(2,1)$ = 6.43, $w_{ij}(2,2)$ = 6.43, $w_{jk}(0,0)$ = -5.05, $w_{jk}(1,0)$ = -6.76 and $w_{jk}(2,0)$ = -6.69, analyse the group category given inputs A= [1 1 0], B= [1 1 1] and C= [0 0 0].

(14 marks)

(b) You have been given a stereo vision system with two cameras aligned as shown in **Figure Q4 (b)**.

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

(3 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 QUESTIONS –

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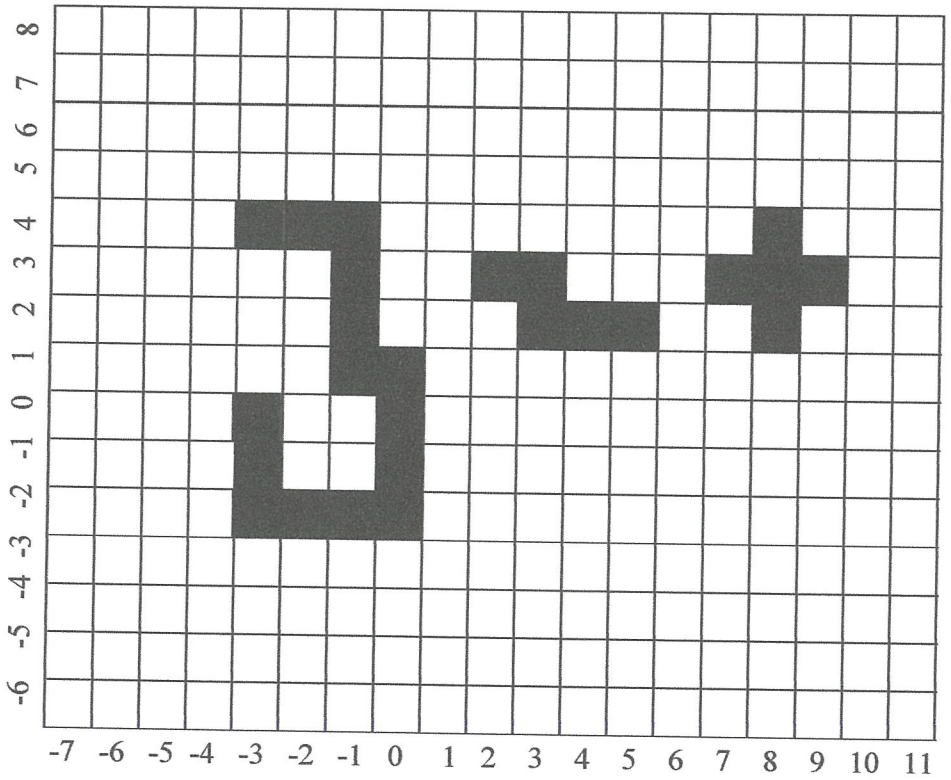

Figure Q1(d)

40	50	30	20	20
40	100	80	30	20
200	150	107	109	40
207	205	106	103	50
200	180	170	150	30

Figure Q2(b)(ii)

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

Figure Q3

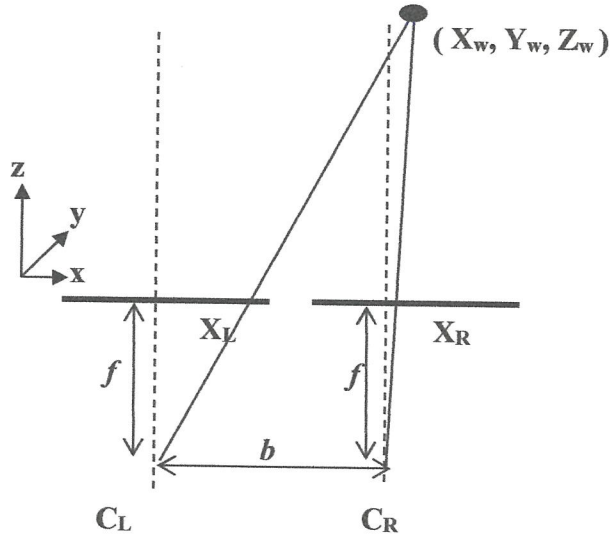

Figure Q4(b)

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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 $\bar{y} = \frac{m_{01}}{m_{00}}$