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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2023/2024**

- COURSE NAME : VISION SYSTEM
- COURSE CODE : BEJ 34202
- PROGRAMME CODE : BEJ
- EXAMINATION DATE : JULY 2024
- DURATION : 2 HOUR 30 MINUTES
- INSTRUCTIONS :
1. ANSWER ALL QUESTIONS
  2. THIS FINAL EXAMINATION IS CONDUCTED VIA
    - Open book
    - 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 **FOUR (4)** PAGES

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**TERBUKA**

- Q1** (a) In camera calibration, intrinsic and extrinsic parameters play important roles in finding the relationship between the coordinate of a point  $P$  in 3D world and a 2D pixel coordinate. Relate the focal lengths ( $f_x, f_y$ ), principal point ( $O_x, O_y$ ), rotation matrix ( $R$ ) and translation parameters ( $T$ ) in a Perspective Transformation Model. (4 marks)
- (b) Radial and tangential are the two types of distortions due to optics.
- (i) Illustrate each distortion with a proper explanation. (8 marks)
- (ii) Suggest how each of the distortion can be corrected. (4 marks)
- (c) Show the procedure to perform image calibration using *Camera Calibrator App* in Matlab. (9 marks)
- Q2** (a) Image segmentation is one of the crucial elements in vision system.
- (i) Define the non-contextual and contextual techniques of image segmentation. (4 marks)
- (ii) Propose two (2) methods to perform image segmentation. Explain briefly each method. (6 marks)
- (iii) One of the methods to find the threshold values is through Otsu's method. Explain how Otsu's is used to find the threshold value. (3 marks)
- (iv) In finding the threshold using Otsu's, there are several assumptions made. Suggest the assumptions. (6 marks)
- (b) Adaptive thresholding is very useful to compensate for the effects of non – uniform illumination. The threshold value depends on the coordinates  $x$  and  $y$ . Explain how adaptive thresholding using:

(i) Chow and Kaneko. (3 marks)

(ii) Local thresholding. (3 marks)

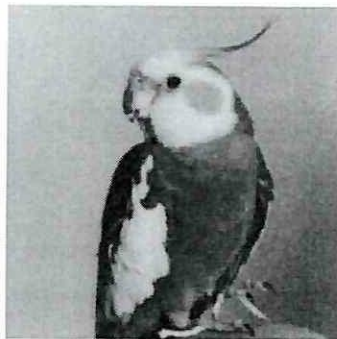
**Q3** (a) Illustrate the common process of computer vision. (4 marks)

(b) Suggest two (2) methods to enhance an image. (6 marks)

(c) An image  $I$  is shown in **Figure Q3.1**. The image can be enhanced using contrast stretching transformation whose function is given below:

$$f(x) = \frac{1}{1 + \left(\frac{0.5}{x}\right)^E}$$

where  $E$  is a constant.



**Figure Q3.1: Image  $I$**

(i) Write a Matlab code to implement the contrast stretching transformation with an appropriate  $E$  value to enhance the image. (13 marks)

(ii) Guest the effect of  $E$  value in contrast stretching transformation. (2 marks)

- Q4 (a) Convolutional Neural Network (CNN) code using Python is shown in **Figure Q4.1**. Illustrate the model structure with details of layer labelling. (3 marks)

```

model = Sequential()

model.add(Conv2D(64, (3,3), input_shape = (256,256,3)))
model.add(Activation("relu"))
model.add(MaxPooling2D(pool_size=(2,2)))

model.add(Conv2D(64), (3,3))
model.add(Activation("relu"))
model.add(MaxPooling2D(pool_size=(2,2)))

model.add(Flatten())
model.add(Dense(64))

model.add(Dense(1))
model.add(Activation('sigmoid'))
    
```

**Figure Q4.1: Convolutional Neural Network (CNN) code**

- (b) You are an engineer in a company that involves in vision system projects.
- (i) Write a code to implement Convolutional Neural Network (CNN) using Matlab considering the following requirements:

Input size	50 x 50 x 1
Number on convolution layer	3
Filter size	3
Padding	"Same"
Number of max. pooling	2
Stride	2
Output size	10

Set the number of filter at each layer twice than the previous ones. The initial filter number is 8.

Utilise **batchNormalizationLayer** function at every layer to speed up training of the CNN, followed by a rectified linear unit (ReLU) layer.

(15 marks)

- (ii) Write a code to train the network in **Q4 (a) (i)**. (5 marks)
- (iii) Show how to reduce initial learning rate and change the number of epochs. (2 marks)

- END OF QUESTIONS -