MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

TDS3651 – VISUAL INFORMATION PROCESSING
(All sections / Groups)

12 OCTOBER 2019
9:00 a.m - 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with 4 Questions only.

2. Answer **ALL** the FOUR questions. All questions carry equal marks and the distribution of the marks for each question is given.

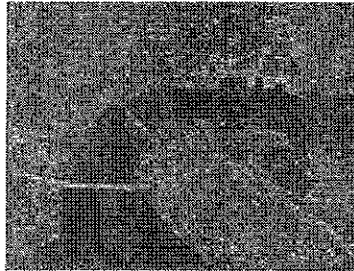3. Please write all your answers in the Answer Booklet provided.

Question 1

a) Name a problem that could occur for each of the following cases:
   i. an image is subsampled to low resolution
   ii. an image does not have sufficient gray levels

[2 marks]

b) A grayscale image of a satellite image is shown below:

Images A, B and C are results of one of the transformation functions; T1, T2 and T3 illustrated below. State (match) the transformation function for images A, B and C.
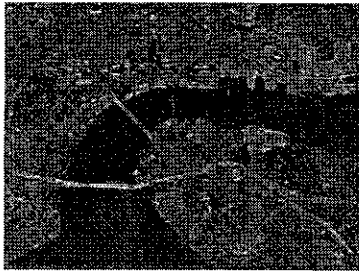
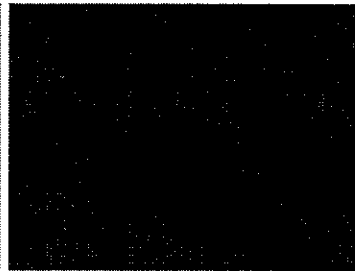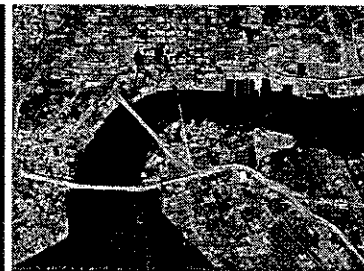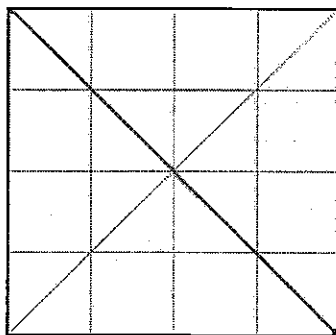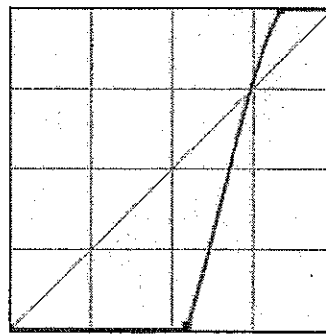| Image A	Image B	Image C

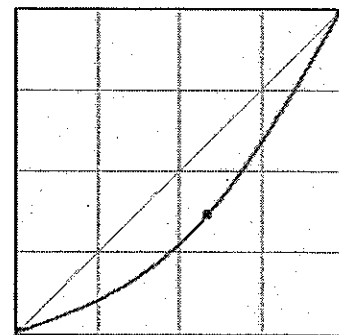| T1	T2	T3

[3 marks]

Transformation function for Image A = _____
Transformation function for Image B = _____
Transformation function for Image C = _____

Continued...

c)

0	1	1	3	4
0	2	3	4	4
2	3	4	4	5
3	4	4	5	6
4	4	5	6	7

Image

For the image shown above, apply histogram equalization to improve the image contrast.

i) Show how you compute the new values for the equalized image using histogram equalization by filling in the blanks in the following table.

[3 marks]

f_k	$p_F(k)$	$g(k)=\sum_0^k p_F(k)$	$[g(k)_k \times 7]$	$p_G(k)$	g_k
0	2/25				0
1	2/25				1
2	2/25				2
3	4/25				3
4	9/25				4
5	3/25				5
6	2/25				6
7	1/25				7

ii) Draw the **histogram of the equalized image**, and the **transformed image**. Assume the processed image can only take integer values between 0 and 7 (including 0 and 7).

[2 marks]

Continued...

Question 2

a) Morphological operation changes the shape of the foreground regions via intersection/union operations between a scanning structuring element and a binary image.

i) What type of morphological operation(s) can be used to remove noise in the following fingerprint image (left image) to produce the resulting image (right image)?

[2 marks]

ii) Is the result shown on the right image above good enough? Justify your answer. If it's not good enough, provide one or more extra operations to improve it.

[2 marks]

b) Noise reduction is an inherent problem in many image-based applications. Median and alpha-trimmed mean filters are order-statistics filters that can be used for reducing noise in an image.

Given a "1D" image I = {4 2 3 6 2 3 4 5 2 3 4 5 5 1 5}:

i) State the output of filtering with a 1x5 **alpha-trimmed mean filter**, with $\alpha = 2$

[2 marks]

ii) Name one type of noise that can be reduced effectively by (a) a **median filter** and (b) an **alpha-trimmed mean filter** respectively.

[2 marks]

c) Name a **perceptual color space** that is good for modification of image brightness. Justify your choice of color space.

[2 marks]

Continued...

Question 3

a) Texture is a fundamental characteristic of many types of images, and texture representation can be used to solve various practical tasks including image segmentation/classification and image retrieval.

   i)   What is an advantage of texture over color in image representation?

[1 mark]

   ii) Given a collection (database) of images and a query image, depict the steps to perform texture-based image retrieval.

[3 marks]

b) Segmentation attempts to assign the same label to pixels that "belong together."

   i.   List two criteria of "**sameness**" that might be used for segmentation – i.e., pixels may be grouped together if they have similar _____ .

[1 mark]

   ii. Graph cut optimization is a popular and effective method to solve the image segmentation problem. State the strengths of graph cut optimization that makes it such a popular choice.

[2 marks]

c) **Background subtraction** and **frame differencing** are two methods used to identify the *foreground objects in* that image in motion segmentation

   i.   Name the core advantage of frame differencing method over background subtraction.
   ii.   State two scenarios where frame differencing may fail to detect the foreground objects
   iii. Name two applications where motion segmentation is required.

[3 marks]

Continued...

Question 4

a) F_1-score (also known as F-measure) is often used in the field of information retrieval for measuring search, document classification, and query classification performance. F_1-score and is the harmonic mean of precision and recall and can be computed as:

$$F_1 = 2 * \frac{\text{precision} * \text{recall}}{\text{precision} + \text{recall}}$$

The confusion matrix below contains the performance of a 3-class image classification task, which predicts whether the type of defect in a textile image photograph is 'Knot', 'Mispick' or 'Hole'.

<table>
<tr><td rowspan="5">Actual labels</td><td></td><td colspan="3" style="text-align:center">Predicted Labels</td></tr>
<tr><td></td><td>Knot</td><td>Mispick</td><td>Hole</td></tr>
<tr><td>Knot</td><td>165</td><td>25</td><td>10</td></tr>
<tr><td>Mispick</td><td>50</td><td>138</td><td>12</td></tr>
<tr><td>Hole</td><td>15</td><td>5</td><td>180</td></tr>
</table>

Compute the **F-measure** of the 'Hole' category. Assume that 200 images per category were evaluated.

[3 marks]

b) The SIFT descriptor is a popular method for describing selected feature points based on local neighborhood properties so that they can be matched reliably across images.

   i.   Name two scenes or image changes that the SIFT descriptor is invariant to (i.e., relatively insensitive to) and explain why SIFT is invariant to these image changes.

[2 marks]

   ii. SIFT feature matching can be used in image stitching for fully automated panorama reconstruction. Given a set of non-panoramic images in left-to-right sequence, describe how the SIFT descriptor can be used to perform panorama stitching.

[5 marks]

End of Paper