

# University of Nottingham Malaysia

SCHOOL OF COMPUTER SCIENCE  
A LEVEL 2 MODULE, SUMMER SEMESTER 2022-2023  
RESIT

## INTRODUCTION TO IMAGE PROCESSING (COMP 2032)

Time allowed: **ONE** Hour

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*Candidates may complete the front cover of their answer book and sign their desk card but must NOT write anything else until the start of the examination period is announced.*

### ***Answer ALL Questions***

Marks available for sections of questions are shown in brackets in the right-hand margin.

No calculators are permitted in this examination.

*Dictionaries are not allowed with one exception. Those whose first language is not English may use a standard translation dictionary to translate between that language and English provided that neither language is the subject of this examination. Subject specific translation dictionaries are not permitted.*

*No electronic devices capable of storing and retrieving text, including electronic dictionaries, may be used.*

**DO NOT turn your examination paper over until instructed to do so.**

### **ADDITIONAL MATERIAL:**

None

### **INFORMATION FOR INVIGILATORS:**

Questions papers should be collected in at the end of the exam – do not allow candidates to take copies from the exam room.

## 1. Linear and Non-linear Filtering [30%]

- a) Why do we perform spatial filtering? [6 marks]
- b) Based on your understanding, explain in your own words, what does the following terms imply:
- i. Image Noise [2 marks]
  - ii. Gaussian Noise [2 marks]
  - iii. Salt and Pepper Noise [2 marks]
- c) Detail the process of **convolution** using examples to support your explanation. [5 marks]
- d) What is the **difference** between linear and non-linear filtering? [3 marks]
- e) Given the intensity of a local region, as shown in Figure 1 below:

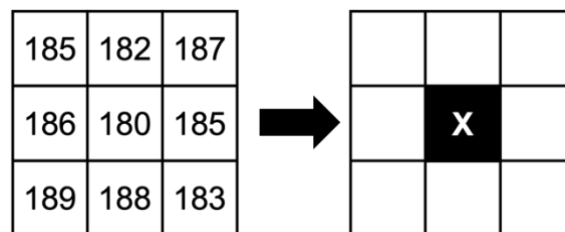


Figure 1

By showing your workings, compute the value of **X** when using the following approach:

- i. Mean filtering [4 marks]
  - ii. Median filtering [4 marks]
- f) Gaussian filter is said to be **separable**. How can we apply a 2D Gaussian into two 1D Gaussian? [2 marks]

## 2. Whole Image Methods and Segmentation [40%]

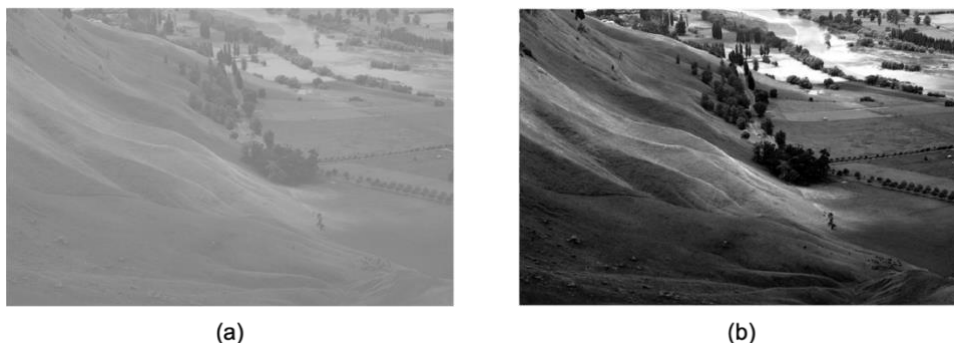


Figure 2

- a) Figure 2(b) is obtained by performing **histogram equalisation** onto Figure 2(a). Detail how the algorithm works, practically. [6 marks]

P.T.O

- b) Based on your answer in 2(a), apply histogram equalisation to a 3-bit per pixel image as listed in Table 1.

Table 1

Pixel Value	Normalised Frequency
0	0.05
1	0.2
2	0
3	0.1
4	0.5
5	0
6	0.05
7	0.1

Show your workings and compute the:

- Mapping from input pixel values to output pixel values.
- Normalised histogram of the output image.

[14 marks]

- c) Colour histograms are commonly used for image matching. Detail how this can be done, **step-by-step**. [5 marks]
- d) Please list all the steps involved in the application of the basic concept of Watershed to image segmentation. [5 marks]

4	4	2	2
2	3	1	3
1	2	3	2
1	1	3	2

Figure 3

- e) Consider the image fragment in Figure 3 (*in which the numbers represent intensity values*). Using letters of the alphabet to label regions, show how this image fragment would be segmented by the **Watershed** algorithm. [10 marks]

### 3. Interactive Methods and Compositing [30%]

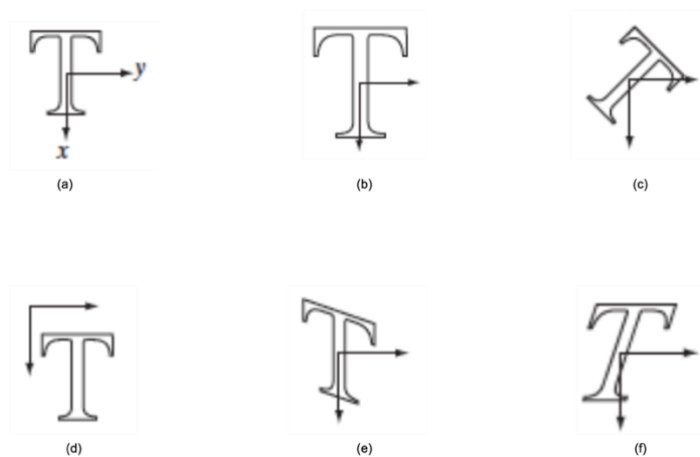


Figure 4

- a) Figure 4 is a result obtained after performing the **livewire algorithm**. Detail each step of the algorithm. [8 marks]

P.T.O

b) What is meant of the term **cooling** in the context of the livewire algorithm. [2 marks]



**Figure 5**

- c) Figure 5 shows different types of **affine transformations**. Please list down transformations (a) to (f). [6 marks]
- d) Applying transformation can be done via **two types of mapping** approaches. Please name them and explain how they are performed. [8 marks]
- e) Based on your understanding, explain in your own words, how does the following approaches work:
- i. Nearest neighbour interpolation [2 marks]
  - ii. Bilinear interpolation [2 marks]
  - iii. Bicubic interpolation [2 marks]

**END**