University of Nottingham Malaysia

SCHOOL OF COMPUTER SCIENCE
A LEVEL 2 MODULE, SUMMER SEMESTER 2021-2022
RESIT

INTRODUCTION TO IMAGE PROCESSING (COMP 2032)

Time allowed: **ONE** Hour

An additional 30 minutes to cover IT issues and upload time

Answer ALL questions

Submit your answers containing all the work you wish to have marked as a **single PDF file, with each page in the correct orientation, to the appropriate Dropbox on the module's Moodle page.**

Use the standard naming convention for your document: **[Student ID]_[Module Code]**. Write your student ID number at the top of each page of your answers. Do not include your name.

Although you may use any notes or resources you wish to help you complete this open-book examination, the academic misconduct policy that applies to your coursework also applies here. You must be careful to avoid plagiarism, collusion, or false authorship. This statement refers to, and does not replace, the University policy which stipulates severe penalties for academic misconduct.

Staff are not permitted to answer assessment or teaching queries during the period in which your open-book examination is live. If you spot what you think may be an error on the exam paper, note this in your submission but answer the question as written.

IMPORTANT: Lateness penalties will not be applied, and late submission will not be accepted.

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

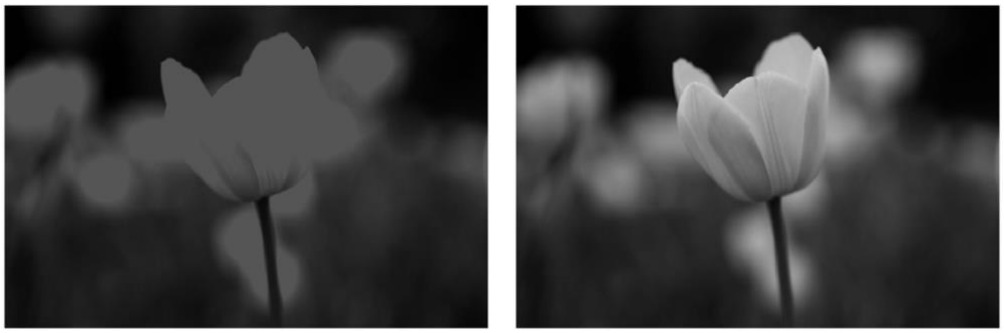
No calculators are permitted in this examination

1. Digital Images and Point Processing [30%]

(a) Based on your understanding, explain in your own words, what does the following terms imply:

i. Sampling [**2 marks**]
ii. Quantisation [**2 marks**]
iii. Nyquist Rate [**2 marks**]

(b) What is meant by **aliasing** and how can we handle it? [**4 marks**]



(a) (b)

Figure 1

(c) Figures 1(a) and (b) are greyscale results generated using two commonly used approaches to converting a coloured image into a greyscale image, respectively. Figure 1(a) is computed using the traditional approach whereas Figure 1(b) is computed using an average approach. Based on your understanding, list the formula used to generate:

i. Figure 1(a) [**2 marks**]
ii. Figure 1(b) [**2 marks**]
iii. Using the formulas listed in (i) & (ii), respectively, compute the greyscale value for a given pixel if R = 30; G = 45 and B = 90, whereby RGB represents *red, green,* and *blue* [**6 marks**]

(d) HSV space is a famous alternative to RGB colour space.

i. Justify what does the abbreviation **H, S, V** stands for and represent? [**7 marks**]
ii. What makes it **different** to RGB space? [**3 marks**]

2. Filtering, Thresholding and Edges [30%]

(a) Image noise are small errors in image values that is often modelled as additive of intensity true value, added with random noise value(s). Filtering is a process commonly used to reduce image noise. Based on your understanding, justify the following filtering approaches:

i. Gaussian Filter [**3 marks**]
ii. Mean Filter [**3 marks**]
iii. Median Filter [**3 marks**]

(b) What are **separable filters** and which filter is commonly associated to it? [**3 marks**]

P.T.O

(c) What is Otsu Threshold method? How can it be implemented? [**8 marks**]

(d) Sobel filtering is a famous edge-detection techniques commonly used to extract the edge properties of a given image.

i. Give the 3x3 Sobel filter for detecting **horizontal** edges of an image. [**2 marks**]

ii. Give the 3x3 Sobel filter for detecting **vertical** edges of an image. [**2 marks**]

110	112	111
108	109	107
105	107	105

Figure 2

iii. Compute the results of applying the filters you provided in (i) and (ii), respectively to the central pixel of the image fragment shown in Figure 2. Show your workings. [**6 marks**]

3. Segmentation & Geometric Transformation [40%]

(a) Image segmentation is the process to identify meaningful regions for further processing by partitioning or grouping of pixels according to local image properties (e.g., colour intensities, textures, patterns, spectral profiles). Several common approaches exist to solve segmentation problems. Detail the **implementation steps** for the following approaches:

i. K-Means [**5 marks**]
ii. Region Growing [**5 marks**]
iii. Split and Merge [**5 marks**]
iv. Watershed [**5 marks**]

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

Figure 3

(b) 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**]

(c) What is **image interpolation**? [**1 mark**]

(d) List and detail the common approaches used from **image interpolation**. [**9 marks**]

END