The University of Nottingham

SCHOOL OF COMPUTER SCIENCE

A LEVEL 2 MODULE, SPRING SEMESTER 2018-2019

INTRODUCTION TO IMAGE PROCESSING

Time allowed ONE hour

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 THREE Questions

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: NONE

1. Image Compression

(a) List the three types of redundancy that can be exploited by image compression techniques.

(3 marks)

(b) Explain with the aid of an example how run-length encoding can be used to reduce the amount of memory needed to store a binary image. What type of redundancy does run-length coding exploit?

(7 marks)

(c) An image has the following normalized histogram. Derive a Huffman code for each pixel value, showing how you obtained your code.

Pixel value	Normalised Frequency
0	0.35
1	0.2
2	0.15
3	0.1
4	0.1
5	0.05
6	0.05
7	0

(10 marks)

2. Intensity Transforms and Filtering

(a) What is gamma correction, when is it needed, and why?

(4 marks)

(b) In the context of linear intensity transforms, what are gain and bias? How do they affect i) the appearance of an image and ii) its histogram?

(6 marks)

(c) Explain how you convert a very dark image whose grey levels were in the range 10–50 to one that made use of the full range of available pixel values (0-255). What is this process called?

(4 marks)

(d) Compute the result of applying

i) a 3 x 3 mean filter
ii) a 3 x 3 Sobel filter measuring gradient in the vertical direction (i.e. highlighting horizontal lines)
iii) a 3 x 3 median filter

to the central pixel of the image fragment shown below

7	8	4
3	6	8
8	5	1

(6 marks)

3. Segmentation

(a) Consider the image fragment below (in which the numbers represent intensity values)

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

Using letters of the alphabet to label regions, show how this image fragment would be segmented by the *Watershed* algorithm.

(10 marks)

(b) Why can the sort process incorporated in the Watershed algorithm be computed in linear time?

(2 marks)

(d) In most situations image gradients are computed and used to form the terrain input to the Watershed method. Why is the gradient magnitude an appropriate function to use in this way?

(2 marks)

(d) Image texture and noise often mean that a gradient-based terrain contains many local minima. Describe how this might adversely affect a watershed-based segmentation and how these problems could be reduced.

(6 marks)