The University of Nottingham

SCHOOL OF COMPUTER SCIENCE

A LEVEL 2 MODULE, SPRING SEMESTER 2008-2009

INTRODUCTION TO VISION AND GRAPHICS

Time allowed: **Two Hours**

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

Only silent, self contained calculators with a Single-Line Display or Dual-Line Display 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

Question 1

(a) In the context of human visual system model

i. Explain the following concepts

- Weber's law
- Mach band effect
- Simultaneous contrast

(9 marks)

ii. Discuss the implications that each of the above concepts may have on image processing.

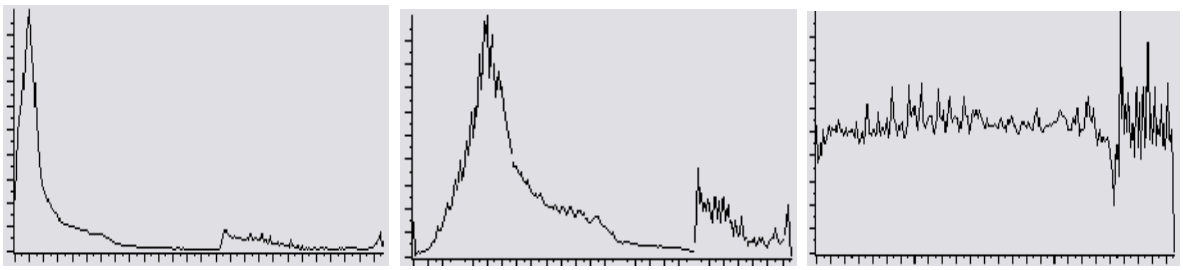
(6 marks)

(b) Explain why an object that appears brightly coloured in daylight will be seen colorless in moonlight (hint: consider elements of human visual perception)

(5 marks)

Question 2

(a) The histograms of three versions of a grayscale image are shown in Fig. Q2 (a).



Version A **Version B** **Version C**

Fig. Q2 (a)

i. Compare the visual appearances of the three images in terms of brightness and contrast.

(9 marks)

ii. It is known that Version B was obtained by applying an intensity transform to version A. Sketch a plot of the intensity transform function, give as much information as possible.

(6 marks)

(b) A uniform quantizer is to be applied to quantize the following 8 bits/pixel 4 x 4 grayscale image patch to 2 bits/pixel.

0	69	170	200
50	78	137	211
40	91	148	250
61	101	169	255

The quantized pixels are to be rescaled to the range [0, 255] for display. Calculate the quantized display pixel values.

(5 marks)

Question 3

(a) The pixel values of a small 5 x 5 image patch are shown in Fig. Q3 (a)

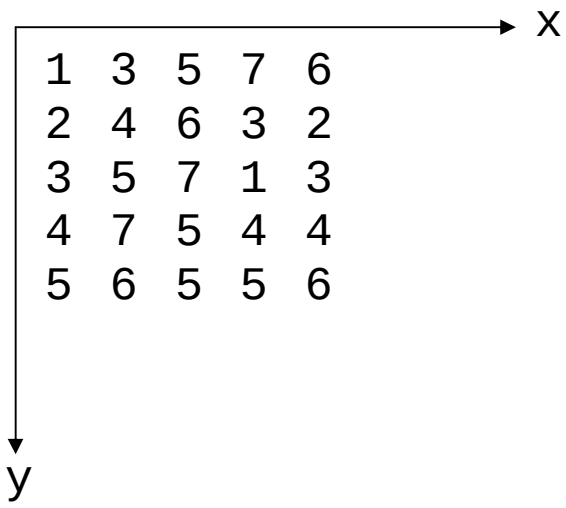


Fig. Q3 (a)

Compute the output of the pixel at the co-ordinate x = 2 and y = 2 (co-ordinate values start from 0) for the following spatial filtering operations (approximate your answer to the nearest integer).

i. 3 x 3 median filtering
ii. 3 x 3 average filtering
iii. 3 x 3 Laplacian with the following filtering mask

1	1	1
1	-4	1
1	1	1

(6 marks)

(b) Describe the phenomenon of aliasing in digital images and explain the underlying cause of such phenomenon (hint: frequency domain processing and sampling theorem).

(14 marks)

Question 4

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

(3 marks)

(b) For each type of redundancy, give an example compression technique and explain the way in which it exploits the redundancy to compress images.

(12 marks)

(c) An image has the following histogram. Derive the Hoffman code for the pixel values.

(7 marks)

Pixel values	Number of pixels
0	1
1	4
2	10
3	40
4	15
5	5
6	20
7	5

Question 5

(a) An image processing package allows the user to design 3x3 convolution filters.

i. Design a 3 x 3 filter to perform edge detection of the horizontal edges.

(2 marks)

ii. Use the following 6x6 image as an example, explain how edge detection using the filter you have just designed works.

100	100	100	10	10	10
100	100	100	10	10	10
100	100	100	10	10	10
100	100	100	100	100	100
100	100	100	100	100	100
100	100	100	100	100	100

(6 marks)

(b) Briefly explain how the following image segmentation algorithms work and discuss their respective advantages and disadvantages.

- Intensity thresholding
- Splitting and merging
- Region growing

(12 marks)

End