The University of Nottingham

SCHOOL OF COMPUTER SCIENCE

A LEVEL 2 MODULE, AUTUMN SEMESTER 2013-2014

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. (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) A 3-bit per pixel image has a normalized histogram as listed in the following table

Pixel value	Normalized frequency
0	0.3
1	0.3
2	0.1
3	0.2
4	0.05
5	0.05
6	0
7	0

Apply histogram equalization to this data and show

(i) the mapping from input pixel values to output pixel values
(ii) the normalised histogram of the output image

(10 marks)

2. Image noise is a common problem in image processing, and a number of noise reduction methods exist.

(a) Compute the result of applying

i) a 3 x 3 mean filter
ii) a 3 x 3 median filter

to the image fragment shown below.

9	8	6
9	6	3
8	5	1

(4 marks)

(b) Which of the methods from part (a) of this question would you use to reduce the noise in the image shown below, and why?

End

(6 marks)

(c) An alternative approach to dealing with noisy images is to use methods that are insensitive to noise, one such method being the Hough Transform. Explain how a Hough Transform based on the equation $\rho = x.\cos\theta + y.\sin\theta$ can be used to detect straight lines in the output of an edge detector.

(10 marks)

3. (a) When applying a Gaussian smoothing filter of $\sigma = 2$, how would you set the size of the convolution mask?

(2 marks)

(b) What does it mean to say that the 2D Gaussian filter is "separable"?

(3 marks)

(c) Explain with the aid of a diagram how Gaussian smoothing may be used to enhance image edges via unsharp masking

(5 marks)

(d) An alternative way to emphasise image edges is to apply a high-pass filter in the frequency domain. Explain, with the aid of a block diagram, the steps involved in this

(6 marks)

(e) What other effects would you expect an ideal high-pass filter to have on the image?

(4) marks

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End