UNIVERSITY OF SOUTHAMPTON ELEC6213W1

SEMESTER 2 EXAMINATIONS 2015-16

IMAGE PROCESSING

DURATION 120 MINS (2 Hours)

This paper contains 6 questions

Answer **ONE** question from section **A.**

Answer **ONE** question from section **B.**

Answer **ONE** question from section **C.**

An outline marking scheme is shown in brackets to the right of each question.

Only University approved calculators may be used.

A foreign language dictionary is permitted ONLY IF it is a paper version of a direct 'Word to Word' translation dictionary AND it contains no notes, additions or annotations.

Section A

Q1)

a) **Discuss** the motivation for feature extraction in computer vision and **give** examples of feature that could be useful in an image recognition system.

[8 marks]

b) **State** the conditions that a distance measure must satisfy for it to be a metric. **Describe** three different metrics that could be used to measure the distances in feature space.

[10 marks]

c) **Describe** the *k*-nearest neighbour rule, giving a pseudo code implementation

[8 marks]

d) **Describe** how you could build an Iris recognition system using ideas in (a), (b) and (c).

[7 marks]

Q2) An image of part of a human face is shown in figure (1). **Describe** the following techniques and **discuss** how they might be applied to the image in figure (1) as part of a face analysis system:

a) Histogram Stretching [8 marks]

b) Hough Transform [9 marks]

c) Texture Analysis [8 marks]

d) Supervised Classification [8 marks]

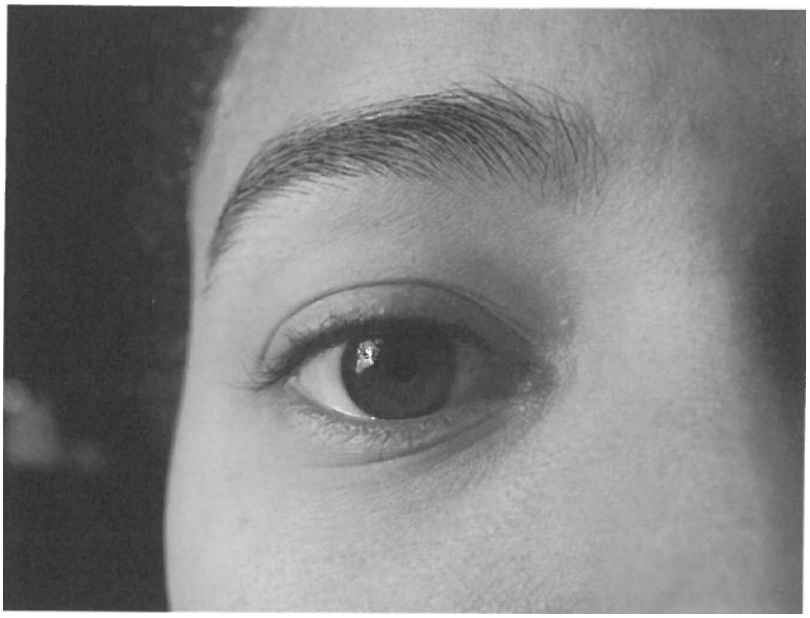

Figure (1)

TURN OVER

Section B

Q3)

a) **Provide** the equation for the *Discrete Fourier Transform* (DFT) and its inverse for discrete images and **explain** what Fourier transform actually does. [7 marks]

b) **Describe** what is meant by *Wavelet Transform* and **explain** what is the main advantage of Wavelet Transform over Fourier Transform [6 marks]

c) A skilled medical technician is assigned the job of inspecting a certain class of images generated by an electron microscope. In order to simplify the inspection task, the technician decides to use digital image enhancement and, to this end, examines a set of representative images and finds the following problems:

i) Bright, isolated dots that are of no interest
ii) Lack of sharpness
iii) Not enough contrast in some images
iv) A Sinewave interference with a certain frequency in some images

Propose processing steps that the technician can follow to correct the above problems. [20 marks]

Q4)

a) **Describe** what *pseudo-inverse* and *Wiener filtering* are.

[6 marks]

b) **Explain** why the Wiener filter shows a better performance than the inverse filter at the presence of noise.

[8 marks]

c) A professor of archaeology doing research on currency exchange practices during the Roman Empire recently became aware that four Roman coins crucial to his research are listed in the holdings of the British Museum. Unfortunately, he was told that the coins recently had been stolen but the museum keeps photographs of them. However the photos of the coins are blurred to the point where the date and other small markings are not readable. The cause of blurring was the camera being out of focus when the pictures were taken. Given that the original camera is still available in the museum, **propose** a step by step solution to help the professor make the images more readable.

[19 marks]

Section C

Q5)

a) **Describe** what *histogram* is and what is meant by *histogram normalisation* [6 marks]

b) **Describe** the method of *histogram equalisation* [7 marks]

c) An image with intensities in the range [0, 1] has the *probability distribution function* (PDF) $p_r(r)$ obtained from the image histogram and shown in figure (2-left). It is desired to transform the intensity levels of this image so that they will have the specified $p_z(z)$ shown in figure (2-right). Assume continuous quantities and **find** the transformation (in terms of *r* and *z)* that will accomplish this. [20 marks]

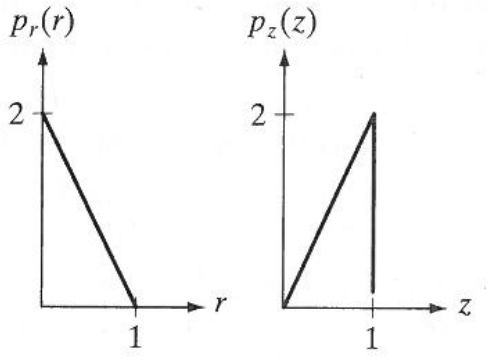

Figure (2)

Q6)

a) **Describe** what the *Prewitt* and *Sobel* filters (masks) are and **explain** what the advantage of Sobel filter over the Prewitt filter is. [6 marks]

b) **Propose** a 3 x 3 mask for *Laplacian* [4 marks]

c) **Describe** what *Laplacian of Gaussian(LoG) filter* is [3 marks]

d) **Show** that the average value of the Laplacian of a Gaussian (LoG) filter is zero. [5 marks]

e) **Show** that the average value of an image convolved with *LoG* filter is also zero. [8 marks]

f) **Show** that the statement in section (e) of this question is always true for any filter whose average value is zero. [7 marks]

END OF PAPER

