UNIVERSITY OF SOUTHAMPTON COMP6223W1

SEMESTER 1 EXAMINATION 2016 - 2017

COMPUTER VISION (MSC)

DURATION 120 MINS (2 Hours)

This paper contains 6 questions

Answer **THREE** questions.

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

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.

7 page examination paper.

Question 1.

(a) **Explain** what is meant by edge detection in computer vision. **Describe** the difference in principle between first- and second-order edge detection.

[9 marks]

(b) **Provide** a pseudocode description of the Laplacian operator which, given a grey-level image as input, delivers a binary image where points are '1' where an edge occurs and '0' otherwise. **Explain** precisely how your code should operate, and **justify** any choices you have made in your implementation.

[16 marks]

(c) **Describe** two ways in which the basic Laplacian operator can be made less sensitive to noise. **Discuss** the relative advantages and disadvantages of your approaches.

[8 marks]

Question 2.

(a) **Describe** the aims and differences between the processes of intensity normalisation and histogram equalisation.

[9 marks]

(b) A monochrome camera is known to have a poor response to low light and an excessive response to bright illumination. For grey levels between zero and 127 the gain is 0.5 whereas for grey levels between 128 and 255 the gain is 1.5. **Sketch** the relationship between camera output and grey level. **Describe** using pseudocode an operator that normalises the output so that the effective camera gain for all grey levels is 1.0.

[16 marks]

(c) One (rather dated) approach to find image features of interest is to apply histogram equalisation followed by optimised thresholding. **Discuss** advantages and limitations of your new approach developed in part (b), followed by a form of thresholding, in comparison with the histogram equalisation based approach.

[8 marks]

TURN OVER

Question 3.

(a) **Show** the bases of the Hough transform for conic sections wherein the Cartesian parameterisations of a line and of a circle can be viewed as a parameter space analysis.

[10 marks]

(b) **Show** how the *foot-of-normal* parameterisation of a line is derived.

[14 marks]

(c) **Describe** how the *foot-of-normal* line parameterisation limits the parameter ranges leading to a practical implementation of the HT for lines.

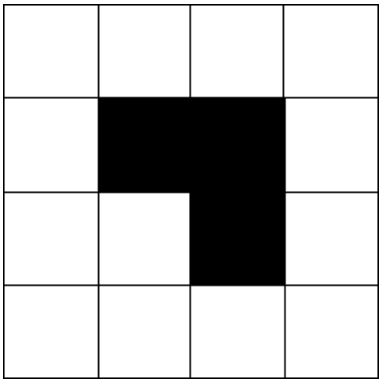
[9 marks]

Question 4.

(a) **State** the two categories in which shapes (represented by connected components) can be described. For each category, **provide** details of a specific descriptor, and briefly **describe** how it can be computed from a connected component.

[8 marks]

(b) Consider the connected component depicted by the solid black pixels below:



Ensuring you show all working, **compute**:

- the compactness
- a 4-connected chain-code representation

[11 marks]

(c) **Describe** in detail the process of creating a *Point Distribution Model* to describe the shape of a human face.

[14 marks]

TURN OVER

Question 5.

The government of the country of Taghum wants to introduce alpha-numeric license plates for the owners of motorised vehicles, and roll-out a state-wide surveillance programme to track vehicles using Automatic Number Plate Recognition (ANPR) using Computer Vision. You have been asked to design the system. The government has specified that it is expecting its license plates to be around the same size as those used in countries like the UK, and to use some combination of letters from the English alphabet and digits from standard (Arabic) numerals.

(a) Given that vehicles in Taghum do not currently have license plates, **describe** how you would design the licence plates and hardware aspects of the computer vision system for performing ANPR. **State** the rationale for your design choices.

[15 marks]

(b) Starting with an image captured by your ANPR hardware, **describe** in detail the processing that your system will perform to recognise the individual characters within a licence plate.

[18 marks]

Question 6.

(a) **Describe** in detail how the Harris and Stephens Corner Detection algorithm works.

[15 marks]

(b) Given the following *Structure Tensor*,

$$\begin{bmatrix} 1600.0 & -50.0 \\ -50.0 & 1600.0 \end{bmatrix}$$

assuming $k = 0.04$, **compute** the Harris Corner Response, showing all working. **Sketch** the type of image patch that this structure tensor is likely to belong to. [8 marks]

(c) Briefly **describe** how SIFT features are computed and give **details** of a robust method for finding correspondences between two images using interest points described by SIFT features. [10 marks]

END OF PAPER