UNIVERSITY OF SOUTHAMPTON COMP3204W1

SEMESTER 1 EXAMINATION 2015 - 2016

COMPUTER VISION

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 + 1 supplementary sheet.

Question 1.

(a) **Describe** what is meant by the Discrete Fourier transform and how it can be applied in image analysis. [10 marks]

(b) **Describe** implementations of the standard averaging operator and of Gaussian average. **Describe**, with reference to the frequency domain, the function of the two operators.

[14 marks]

(c) **Show** how the continuous Fourier transform can be calculated for a pulse signal and from this explain how the Gaussian smoothing operator can provide better smoothing than its standard counterpart.

[9 marks]

Question 2.

(a) **Describe** the relationship between Template Matching and the Hough transform. Describe any advantages/ disadvantages the techniques might have in comparison with each other. [10 marks]

(b) **Describe** how the Template matching operator can be implemented, using pseudo-code where appropriate. [14 marks]

(c) **Determine** the computational requirements of the template matching operator you have defined in comparison with the computational requirements for the Hough transform for circles. **Show** precisely how these computational requirements are determined. [9 marks]

TURN OVER

Question 3.

Given images of blemished apples of the form shown in Figure 1, **design** a computer vision system that can be used to inspect these apples to determine their quality. Pay particular attention to illumination, the nature of blemish detection, and the requirement to deploy the system in an operation where apples are imaged on a conveyor belt twice every second. Provide pseudo-code for any operator used in the system you have described.

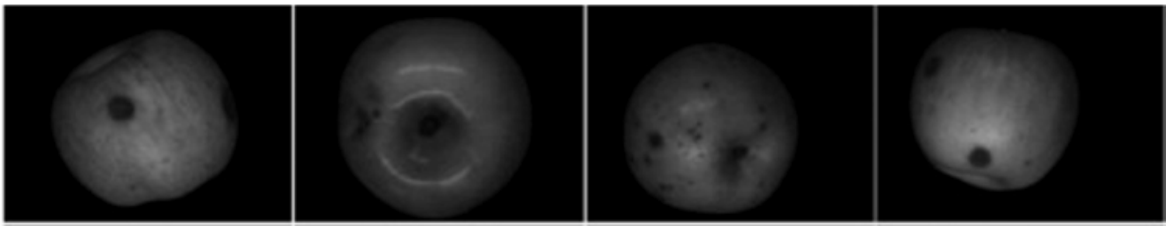

FIGURE 1: Images of Apples with Blemishes (Baohua Zhanga, Wenqian Huang, Liang Gong, Jiangbo Li, Chunjiang Zhao, Chengliang Liu, Danfeng Huang, Computer vision detection of defective apples, Journal of Food Engineering, 46, 2015)

Your answer will be assessed according to:

(a) overall system design and description [12 marks approx.]

(b) range of techniques used and their justification [12 marks approx.]; and,

(c) consideration of practical requirements of the system [9 marks approx.].

[33 marks]

Question 4.

(a) **Define** what is meant by repeatability in the context of local interest points under changes in camera position and object pose. [4 marks]

(b) **Describe** a technique for finding repeatable local interest points within an image. [11 marks]

(c) **Provide** details of two approaches to representing the image content in a local region around an interest point. What are the advantages and disadvantages of these approaches in terms of invariance to lighting changes and camera/object pose? [11 marks]

(d) **Describe** a robust method for finding interest point correspondences between two images. [7 marks]

TURN OVER

Question 5.

Optical character recognition (OCR) is the electronic conversion of images of typed or printed text into machine-encoded text. Figure 2 shows a section of a scanned page of text in which we wish to recognise the individual characters.

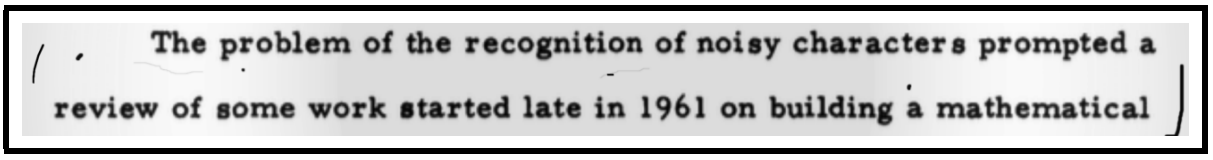

FIGURE 2: Sample of some scanned text from an early paper on Optical Character Recognition. Taken from a scan of Muerle, J. L., Perceiving and Recognition Automata, Annual rept. 1 Jan-31 Dec 1962, Cornell Aeronautical Lab Inc., Buffalo NY, created by the Armed Services Technical Information Agency: http://www.dtic.mil/docs/citations/AD0296522

Using your knowledge of segmentation, feature extraction and machine-learning techniques, **describe** how the individual characters in Figure 2 could be extracted and then classified as belonging to particular letters of the alphabet. In addition to reasoning for your choices of technique, your answer should include pseudo-code and diagrammatic descriptions of algorithms as appropriate.

[33 marks]

Question 6.

(a) **Describe** in detail the steps you would take to create histograms of "Visual Word" occurrences from a set of images represented using a local feature like SIFT [14 marks]

(b) **Describe** how you might use Visual-Word representations to create a system for searching large numbers of images. **Relate** your answer to the techniques used for efficient text indexing and search. [11 marks]

(c) A key parameter of a Visual-Words representation is the size of the vocabulary. **Provide** details of the trade-offs in vocabulary size for the tasks of (a) image search and (b) image classification. [8 marks]

END OF PAPER