CE316-6-SP

UNIVERSITY OF ESSEX

Undergraduate Examinations 2011

IMAGE PROCESSING AND COMPUTER VISION

Time allowed: **TWO** hours

The following items are provided:
Graph paper (available on invigilator's desk)

Candidates are permitted to being into the examination room:
Hand-held, non programmable calculators (containing no textual information)

Candidates must answer **QUESTION 1** in **SECTION A**
and **THREE** questions from **SECTION B.**

The paper consists of **FIVE** questions.

All questions are of equal weight.

The percentages in brackets provide an indication of the proportion of the total marks for the **PAPER** which will be allocated.

Please do not leave your seat unless you are given permission by an invigilator.
Do not communicate in any way with any other candidate in the examination room.
Do not open the question paper until told to do so.
All answers must be written in the answer book(s) provided.
All rough work must be written in the answer book(s) provided. A line should be drawn through any rough work to indicate to the examiner that it is not part of the work to be marked.
At the end of the examination, remain seated until your answer book(s) have been collected and you have been told you may leave.

SECTION A

Candidates must answer QUESTION 1 in Section A.

Question 1

(a) Figure 1.*a* shows the luminance values of a part of an 8-bit digitised image. This image is to be median filtered with a 5-tap median operator given in Figure1.*b*. Find the values of the 4 pixels inside the box. [6%]

180	175	130	140
120	130	180	170
200	190	200	160
120	110	90	80

Figure 1.a

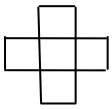

Figure 1.b

(b) Explain what is meant by *colour gamut*. Sketch a rough colour gamut for the human visual system, including displayed and printable colours. Discuss the range of colour on each gamut and explain how the displayed colour quality of various video displays can be contrasted with each other. [6%]

(c) A motion tracking system involves tracking markers as they move in 3D. If a particular marker moves from (54,70) to (60,74) in the *xy*-plane and from (54,50) to (65,91) in the *xz*-plane, how far has it moved in three dimensions? [6%]

(d) A vision system has two forward-looking video cameras of focal length (450 ± 0.2) mm mounted on the wings of a flying robot (1.40 ± 0.05) m apart, arranged so that their optical axes are exactly parallel. A particular feature is identified in the left frame at location (-12, 6) relative to the optical axis, and at (8,6) in the right frame relative to the optical axis. The cameras have 10 pixels per millimetre. Determine the distance to the feature. [7%]

END OF SECTION A

SECTION B

Candidates must answer THREE questions in Section B.

Question 2

(a) Explain how the luminance histogram of an image can be generated. [4%]

(b) Draw a rough histogram of an 8-bit image, in which pixels are mainly concentrated in the range of 150 to 200. Comment on the appearance and the contrast quality of this image and briefly explain how the image contrast through transformation can be improved. [7%]

(c) Describe how the colour histograms of images can be used in image retrieval. [7%]

(d) Describe how texture based image retrieval is achieved. [7%]

Question 3

(a) Draw a block diagram of an image encoder. Briefly explain the role of each block in the compression chain. [15%]

(b) To achieve a ‘loss-less’ image compressor, explain what is expected from each block in your diagram from (a), and which particular part has a major role in data compression. [5%]

(c) If the diagram of part (a) is to represent a ‘lossy’ image compressor, which part has the most important role in the compression chain and how is the compression ratio determined? [5%]

Question 4

(a) What is *corner detection* in computer vision? Why is it so widely used? [5%]

(b) The operator due to Moravec is widely used for detecting corners. Describe the major stages of this operator. [6%]

(c) If `im[y,x]` is an image indexed by `y` (row) and `x` (column), write an implementation of the Moravec corner detector. Your answer should be given in pseudo-code. Marks are allocated for a clear exposition of the algorithm rather than for the syntax of your pseudo-code. [14%]

Question 5

(a) Define the terms *true positive, true negative, false positive* and *false negative.* Explain how these measures are typically used in assessing the performance of computer vision algorithms. [5%]

(b) Two vision algorithms are evaluated on the same dataset. The values in Figure 5.1 are obtained for two of the quantities defined in (a) as a threshold is varied. Draw the receiver operating characteristic (ROC) curve for the two algorithms. [10%]

False positive rate	True positive rate (algorithm A)	True positive rate (algorithm B)
0.17	0.46	0.62
0.33	0.69	0.74
0.5	0.85	0.77
0.67	0.92	0.8
0.83	0.96	0.82
0.95	0.98	0.86

Figure 5.1

(c) Explain which of the two algorithms in part (b) you would recommend for the following applications: [10%]

(i) the determination of whether features are tumours;

(ii) a face recognition system for controlling access to a restricted area.

END OF SECTION B

END OF PAPER CE316-6-SP