CE316-6-AU

UNIVERSITY OF ESSEX

Undergraduate Examinations 2017

COMPUTER VISION

Time allowed: **TWO** hours

Candidates are permitted to bring into the examination room:

Calculator — Casio FX–83GT PLUS or Casio FX–85GT PLUS **only**

The following items are provided:

Graph paper (available on the invigilator's desk)

The paper consists of **FIVE** questions.

Candidates must answer **Question 1** in **Section A** and **three** questions in **Section B**.

All questions are of equal weight.

The percentages shown 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 ALL questions in Section A.

Question 1

(a) An image is shown in Figure A.1. Convolve this image with a 3×3 Laplacian mask. You should wrap the image around cyclically at the edges. **[10%]**

5	5	0	0	5	4	4
1	3	3	3	0	2	2
4	5	5	3	2	1	0
0	2	1	2	5	3	3
1	0	1	0	3	5	4
1	5	4	4	5	4	4
2	5	5	0	4	4	2

Figure A.1

(b) A *convolutional neural network* is built up from five types of layers. Describe briefly what these layers do. **[5%]**

(c) Outline briefly the principle of the FAST corner detector, and hence explain whether it is able to operate at video rates. **[5%]**

(d) The face location algorithm due to Viola and Jones makes use of Haar features. Explain what a Haar feature is and why using these features is attractive in a system that must run quickly. **[5%]**

END OF SECTION A

SECTION B

Candidates must answer THREE questions in Section B.

Question 2

A local company, Wivenhoe Innovative Software Engineering (WISE), has appointed you as a consultant because of the extensive knowledge of computer vision you have gained from CE316. WISE is developing a system that will be attached to lamp-posts and will read the rear number plates of cars as they drive past during the day.

(a) Describe a series of processing stages that will allow the rear number plates to be detected, then the individual characters identified and recognised. **[17%]**

(b) Recent registration numbers in the UK conform to a syntax of two letters followed by two digits followed by three letters. Discuss whether this makes the recognition task easier or more difficult. **[8%]**

Question 3

(a) The operator due to Moravec is widely used for detecting corners in images. With the aid of a diagram, describe the major stages of this operator. **[10%]**

(b) The BRIEF descriptor is commonly used to match corners between images. Describe briefly how BRIEF works. **[10%]**

(c) Describe the major shortcoming of BRIEF and how it is overcome in the ORB descriptor. **[5%]**

Question 4

Eigenfaces is a well-established technique for performing face recognition based around Principal Component Analysis (PCA).

(a) With the aid of a diagram, outline briefly the principle of principal component analysis. **[8%]**

(b) Effective use of eigenfaces depends crucially on aligning faces and facial features accurately. Explain why this is so and how the use of Haar features and adaptive boosting learning makes it possible to achieve this. **[10%]**

(c) When people have face images taken for use in 'biometric passports,' a common requirement is that they remove any spectacles they may normally wear and avoid smiling. With reference to your answers in (a) and (b), explain why this is done. **[7%]**

Question 5

A group of sports scientists want to be able to estimate the speed of an athlete running on an outdoor grass track using an application running on a mobile 'phone. Their idea is to have the athlete run towards them and capture video frames at regular intervals, then use the size of the athlete to estimate the distance from the camera.

(a) With the aim of a diagram, obtain an expression that relates the size of a feature in an image to the distance from the camera. **[10%]**

(b) Hence, describe how the speed of the athlete may be determined. **[5%]**

(c) Describe what might be done to make the athlete easier to segment from the background. **[5%]**

(d) Discuss how effective this approach is likely to be in practice. **[5%]**

END OF PAPER CE316-6-AU