CARDIFF UNIVERSITY
EXAMINATION PAPER

Academic Year: 2011–2012

Examination Period: Spring

Examination Paper Number: CM0311/CM0411

Examination Paper Title: Image Processing

Duration: 2 hours

Do not turn this page over until instructed to do so by the Senior Invigilator.

Structure of Examination Paper:

There are 4 pages.
There are 4 questions in total.
There are no appendices.
The maximum mark for the exam paper is 60, and the mark obtainable for a question or part of a question is shown in brackets alongside the question.

Students to be provided with:

The following items of stationery are to be provided:
ONE answer book.

Instructions to Students:

Answer 3 questions.

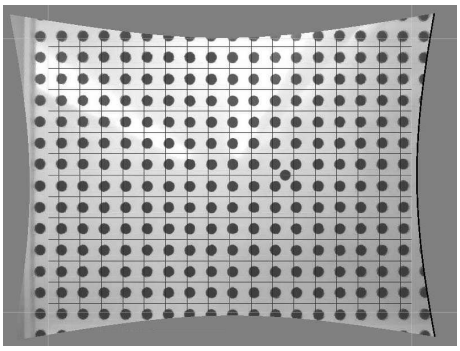
The use of translation dictionaries between English or Welsh and a foreign language bearing an appropriate school stamp is permitted in this examination.

Q1. (a) Consider two computer vision tasks: identifying an item from a bar code, and understanding the scene outside my office. What makes one task so much more difficult to solve than the other? [5]

(b) Designers of computer vision systems can learn some useful approaches from how the human visual system operates. Describe two such design rules which can be transferred from human to computer vision. [4]

(c) Below are shown images demonstrating some applications of techniques in computer vision: (i) replacing an advertising slogan with another, (ii) a post-processed image of a cheap webcam shot of a calibration board. Briefly describe the computer vision techniques required to achieve these tasks. [6]

(i)



(ii)

(d) David Marr was a neurobiologist at MIT whose theories later became very influential in the area of computer vision in the 1980's. Describe five features of Marr's approach to computer vision. [5]

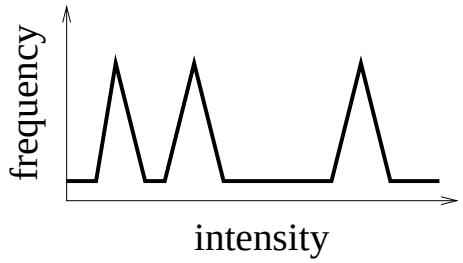
Q2. (a) Describe four features of an **image pyramid**, including how it is constructed and used, and the benefits obtained by using it. [4]

(b) An automatic **threshold selection** algorithm will choose a threshold and convert a grey level image into a black and white image.

(i) Briefly describe a threshold selection algorithm. [2]

(ii) What will the effect of the above threshold selection algorithm be if the image histogram is flat (i.e. all intensities have equal frequency)? [2]

(iii) What will the effect of the above threshold selection algorithm be if the image histogram is as shown below?



[2]

(iv) How can the above thresholding algorithm be modified to cope with uneven illumination across the image? [3]

(c) (i) Briefly describe the principles of **edge detection** and name an edge detector that follows the above approach. [4]

(ii) Explain how the efficiency of the edge detection algorithm can be improved using **separable** filters. [3]

Q3. (a) A **connected component labelling** algorithm takes a binary image and labels each foreground (e.g. black) pixel in the image with a region label (ID).

(i) Why is it useful to perform connected component labelling? [2]

(ii) Describe an algorithm for performing connected component labelling. [5]

(iii) Briefly state any advantages or disadvantages of the above algorithm. [1]

(b) Describe how **template matching** using **normalised correlation** works. What are the advantages and disadvantages of this approach? [6]

(c) Below is shown an image before and after motion blur. Describe how the blurring can be reduced using the **Fourier transform**. [6]

(i)

(ii)

Q4. (a) Describe the **Adaboost** approach for building strong classifiers. [5]

(b) Describe the **pose clustering** method for object detection. [5]

(c) Describe in detail how **stereo** is used in computer vision to generate 3D information; include discussion of the problems that arise and their solutions. [10]