COMP37212

Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Computer Vision

Date: Tuesday 24th May 2016

Time: 14:00 - 16:00

Please answer any THREE Questions from the FOUR Questions provided

Use a SEPARATE answer book for each QUESTION

This is a CLOSED book examination

The use of electronic calculators is permitted provided they
are not programmable and do not store text

[PTO]

1. A student working on interpreting images of faces encounters problems when she has images of people wearing glasses. Examples are shown below.

Figure 1. Examples face images of people wearing glasses, frontal view.

She decides to study the variation in shape of the rims of glasses as seen in frontal view, and obtains a database of images of glasses frames ***without*** faces.

Figure 2. Three example images of the rims of frames.

To extract the shapes of the frames from such images, a fellow student suggests that she uses an Active Contour Model (ACM).

a) An Active Contour Model involves optimizing a combination of two energy terms.

What is the purpose of these two terms? **[2 marks]**

Suggest a suitable choice of terms for an Active Contour Model to be used on the glasses frames images above. What problems might arise when using such a model to search in these images? **[3 marks]**

The student decides instead to construct a statistical model to represent the shape and the variation in shape of the glasses frames.

b) Describe ***in detail*** how she could construct such a model. You may assume the frames are all horizontal and level, as in the examples shown above.

[8 marks]

c) Given this shape model, describe the steps involved in constructing an **Active** Shape Model (ASM), suitable for locating the positions of the rims in face images such as those in Figure 1. You may assume the approximate position of the face has been found. What problems might your model encounter when used in search? **[7 marks]**

End of Question 1

2.

a) Using appropriate mathematical expressions and/or diagrams, define the operation of **rank filtering**, and briefly explain its functions and applications when processing **binary** images such as those derived from thresholding.

[6 marks]

b) Consider the two operators **a)** and **b)** given in the diagram below.

a)

-1	0	1

b)

-1	2	-1

0	0	0	0	5	5	5	5	5	0	0	0	0

?	?	?	?	?	?	?	?	?	?	?

For each operator, compute the output (at the positions shown in the bottom row), after convolution with the one-dimensional image values given in the centre row.

[2 marks]

c) Hence (or otherwise), explain ***why*** and ***how*** first-derivative filters (such as the Sobel or Prewitt operators) are combined with second-derivative operators in an **edge-detector** suitable for use on two-dimensional images. In particular, you should explain how such a detector is capable of sub-pixel edge location accuracy.

[8 marks]

d) Explain how the concepts of:

- **i.** Scale **[2 marks]**
- **ii.** Non-maximum suppression **[2 marks]**

can be incorporated into a practical edge-detector.

End of Question 2

3.
You are asked to develop a computer vision system that can detect motorbikes from side views, such in the images below (Figure 3).

Figure 3

a) Describe one method for detecting interesting feature points, which occur at a range of scales in an image **[6 marks]**

b) Describe one method for computing the "signature" representing the image structure around a point, assuming the scale has been estimated **[6 marks]**

c) Suppose that we have computed clusters of features from a training set, and determined how likely features in each cluster are to be part of a motorbike. Describe how this information could be used in a "Bag of Features" motorbike detector. **[8 marks]**

End of Question 3

4.

Consider the data in figure 4.

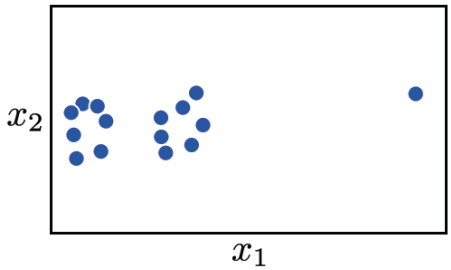

Figure 4

a) What do you expect to happen if we run the K-means algorithm with two clusters on this data set? Explain why you expect this to happen. **[6 marks]**

a) Propose and describe an alternative algorithm to cluster the data in figure 4 that overcomes the limitations of k-means. **[7 marks]**

b) What are the advantages and disadvantages of K-means clustering algorithm and your proposed alternative algorithm? **[7 marks]**

End of Question 4

END OF EXAMINATION