COMP 37212

Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Computer Vision

Date: Wednesday 5th June 2019

Time: 09:45 - 11:45

Please answer all THREE Questions
Each question is worth 20 marks

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 COMP37212 student is studying faces, and how they vary based on identity. She has obtained a training set of face images, and some examples from her training set are shown in **Figure 1**, as well as some images that she has processed to extract face patches.
All the images in this dataset show people with neutral expressions.

Figure 1: **Top Row:** Three face images from a larger training set.
Bottom Row: Face patches extracted from these images.

a) Explain **in detail** how this training set could be used to create an **Eigenfaces** model (similar to that developed by Turk and Pentland). You should also include a brief explanation of how the model could be used in recognition. **[10 marks]**

b) The student now wishes to consider a dataset with a wider range of faces, which show varying **expressions**, variation in **position**, variation in **pose**, variation in **lighting** and so on.

i. What are the main disadvantages of the Eigenfaces approach? **[4 marks]**

ii. Explain why and how **either** the Active Shape Model (ASM) **or** the Active Appearance Model (AAM) was designed to improve upon the Eigenfaces approach when it comes to facial recognition.

[6 marks]

End of Question 1

2.

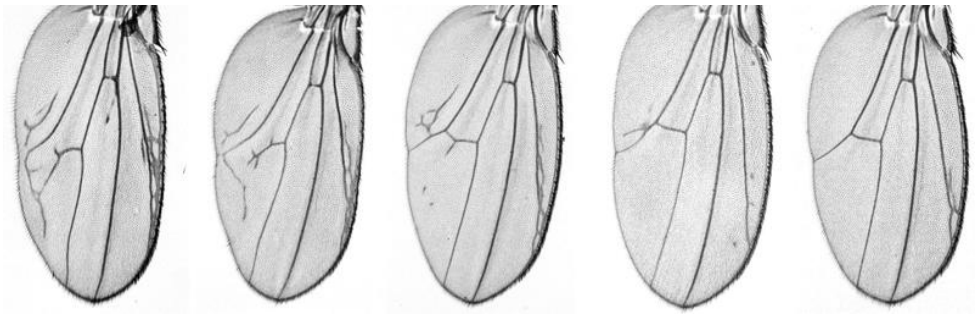

Figure 2: Wings from fruit flies, showing the dark veins in the wing membrane, and how the pattern of veins varies between flies.

a) The greyscale image in **Figure 2** shows examples of fruit fly wings. Researchers studying evolution require image analysis software that will automatically extract the pattern of the veins in each wing. In particular, they want to measure the positions of all the branches, junctions, and ends of the veins. Describe what image processing steps could be used to complete these tasks, and how your algorithm would achieve the desired results. You should mention any difficulties that might arise, and how values of any parameters used might be determined. **[10 marks]**

b) Consider the data in **figure 3**.

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

ii) What will happen if instead we run the EM algorithm with *three* clusters on this data set? Explain why you expect this to happen. [**4 marks]**

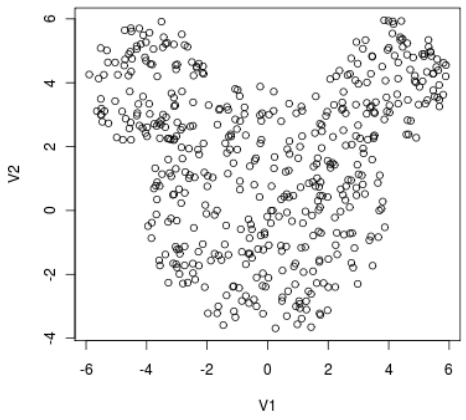

Figure 3

End of Question 2

3.

a) Explain what an **interest point** is. **[2 marks]**

b) You are asked to develop a computer vision system that can detect motorbikes from side views, such in the images below (**Figure 4**).

Figure 4

Suppose that we have computed clusters of local 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 Words**" motorbike detector. **[8 marks]**

c) Explain how you could use the pair of images in **figure 5** to calculate the distances from the camera of the surface features that appear in the scene.

Figure 5

In your answer you need to consider all steps in the process, from images to depth values. You also need to give a diagram to illustrate your answer.
[10 marks]

End of Question 3

END OF EXAMINATION