

Two hours

**UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE**

Computer Vision

Date: Wednesday 6th June 2018

Time: 14:00 - 16:00

Please answer all Questions.

Use a SEPARATE answer book for each QUESTION

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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 working with a large set of images of faces, and studying how they vary across a population. A sample of images from her training set is shown in **Figure 1**. She annotates every image with 58 suitable shape landmark points as shown.

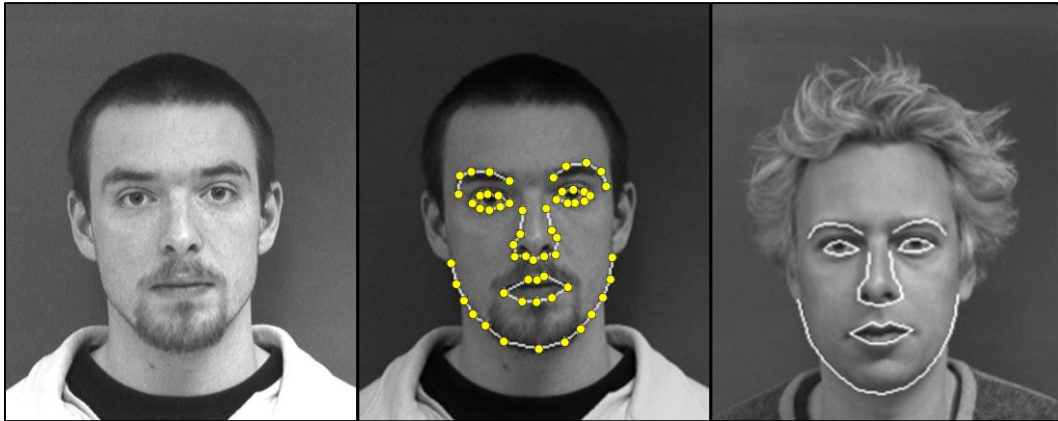


Figure 1: **Left:** An example face image, **Centre:** the same image with shape annotation (points shown), **Right:** Another face with similar shape annotation.

All the images in this dataset show people with neutral expressions.

- a) Describe the steps she would need to perform to **align** the set of shapes of faces given by her annotation. **[4 marks]**
- b) Describe *in detail* how she could now use this set of aligned face shapes to build a Statistical Shape Model (SSM), and hence then an Active Shape Model (ASM) for faces. **[12 marks]**

She now extends her training set by including extra images of the same people, but with varying facial expressions. A fellow student suggests that she now builds an Active Appearance Model (AAM) rather than an Active Shape Model (ASM).

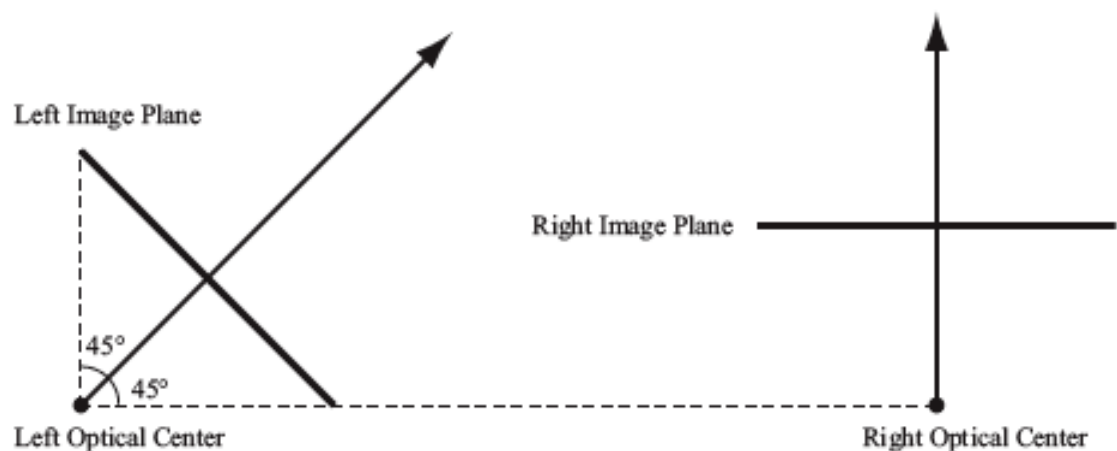
- c) Which of these approaches, the ASM or the AAM, do you think would be more successful in finding the face of a smiling person in a previously unseen image? Explain the reasoning behind your answer.

[4 marks]

End of Question 1

2.

- a) By means of a diagram, equation(s), or otherwise, explain the process of **convolution** as used in the filtering of two-dimensional images. Your answer should include an example of **one** such filter, and describe briefly how it achieves the result it does. [5 marks]
- b) Explain how the **Hough transform** could be used to find **horizontal** straight lines, given that you have been provided with an **edge-strength** image of a scene. [5 marks]
- c) Explain the difference between **sparse** and **dense** matching algorithms for stereo-based scene reconstruction. [5 marks]
- d) Consider two ideal pinhole cameras with the following top view configuration:



Draw the epipole and a few epipolar lines on the front view of the two 2D images. [5 marks]

End of Question 2

3.

- a) Describe one method for detecting interesting feature points, which occur at a range of scales in an image [6 marks]
- b) The *SIFT descriptor* is a popular method for describing selected interest points based on local neighborhood properties so that they can be matched reliably across images. Assuming *interest points* (*keypoints*) have been previously detected, briefly describe the main steps of creating the SIFT keypoint *descriptor* at a given interest point. [8 marks]
- c) Explain the role of the following parameters in the SIFT algorithm: [6 marks]
- Contrast threshold,
 - Curvature threshold and,
 - Dimensionality of feature vector.

End of Question 3

END OF EXAMINATION