COMP61342

Two hours

Question ONE is COMPULSORY

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Computer Vision

Date: Tuesday 24th May 2016

Time: 14:00 - 16:00

Please answer Question ONE
and also THREE other Questions from the FIVE Questions provided

Use a SEPARATE answerbook for each QUESTION

This is a CLOSED book examination

The use of electronic calculators is NOT permitted

[PTO]

1. **<u>This question is COMPULSORY.</u>**

Answer **any four** (from 6) of the following parts.

a) How does a *median filter* reduce random noise in an image whilst tending to preserve edges? **[5 marks]**

b) What is the *optical flow constraint* and why does it not uniquely determine the flow at each point in an image? **[5 marks]**

c) Is the Harris corner detector a linear filter? Argue why or why not. Assume that the Harris corner detector is applied to an unsmoothed image. What type of image would trigger the detector at places that clearly don't contain a corner? **[5 marks]**

d) Define *disparity* in stereo vision. Given a pair of stereo images, what do we mean by the term *image rectification*?

[5 marks]

e) What is the main assumption that lies behind the idea of using image smoothing for noise suppression? **[5 marks]**

f) Explain and contrast the region-based and edge-based approaches to extracting structure from images.

[5 marks]

End of Question 1

2.

A student has a database of images containing various different examples of a suitable class of object. She decides to study the variation of the objects, and decides to start by learning a deformable shape model from the database.

a) For such learnt deformable shape models, shapes may be represented in various ways. Describe ***briefly*** the **distance map** and **medial** methods of shape representation, and their advantages/disadvantages.

[3 marks]

b) She decides to build a Statistical Shape Model (SSM). Describe in detail how she would build a Statistical Shape Model (SSM) from the database. In particular, you should describe any annotation that may be required.

[7 marks]

The student builds the SSM, and decides that it has been successful in describing the variation of shape seen in her training set.

c) Explain **in detail** how this SSM could be incorporated into a learnt model that would be suitable for searching for new examples of similar objects in previously unseen images. In particular, you should explain how the relevant information is learnt from the training set, how the final model could be used to search in a new image, and what failure modes might occur.

[10 marks]

End of Question 2

3.

Consider the data in figure 1.

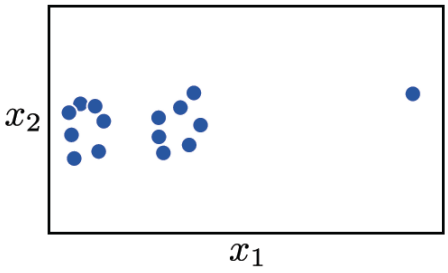


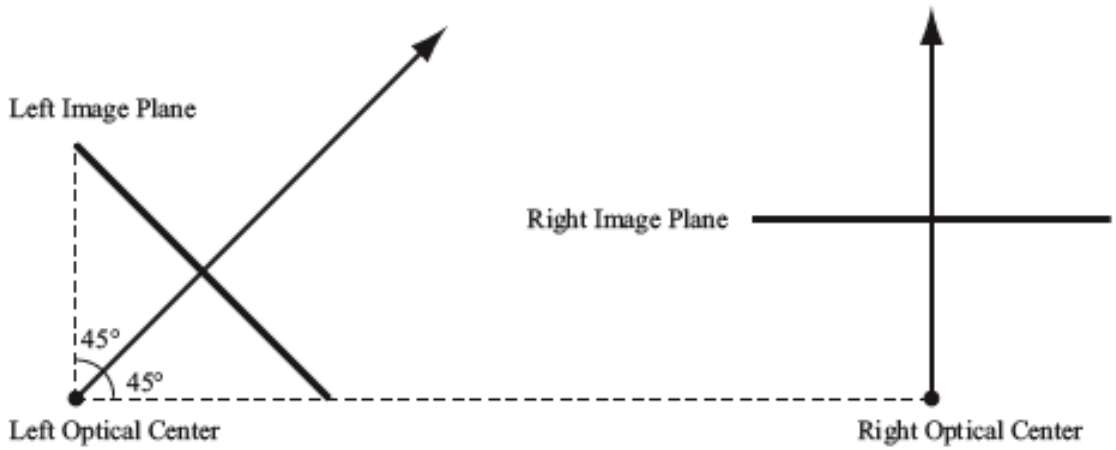
Figure 1

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]**

b) Propose and describe an alternative algorithm to cluster the data in figure 1. **[7 marks]**

c) Given a pair of stereo images, what do we mean by the term **image rectification**? Why is it important? **[3 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. **[4 marks]**

End of Question 3

4.

a) Define **disparity** in stereo vision. **[2 marks]**

b) Explain what **"calibrated cameras"** means. **[2 marks]**

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

d) Describe a method for detecting interest points in an image. **[6 marks]**

e) You are asked to develop a computer vision system that can detect motorbikes from side views, such in the images below (Figure 2).

Figure 2

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 Features" motorbike detector. **[8 marks]**

End of Question 4

5.

a) Explain ***in detail*** the **push-forward** and **pull-back** mappings, and how they are used to create warped images in image registration. What computational issues lead to one method often being preferred over another?

[6 marks]

b) Once you can create warped images, what other components are required when constructing a general non-rigid ***pairwise*** image registration algorithm? What extra issues occur if you want to perform registration across an entire population, rather than just between two images.

[6 marks]

c) Compare and contrast **elastic image registration** and **fluid image registration**. For each method, give an example application from biomedical imaging for which that method would be the most suitable. Explain your choices in each case.

[6 marks]

d) Given the cases of elastic and fluid registration, which were inspired by the behaviour of real physical materials, a student suggests that a **gas-based** model might be appropriate, obtained by removing the viscosity. Do you think this would be a course worth pursuing? Explain your answer.

[2 marks]

End of Question 5

END OF EXAMINATION