Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2013-2014 (2 hours)

EEE6082 Computational Vision 4

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

1. a. Many vision tasks start with a feature extraction or region detection step. Explain what properties a good local region detector should have. **4**

b. The salient region detector is based on the unpredictability in the feature space and over scale. Calculate the feature-space saliency of the three image regions in Figure 1.1. The descriptor used here is grayscale intensity. **6**

c. Illustrate how to calculate the feature-space saliency and the inter-scale saliency of the image region with pixel values in bold in Figure 1.2. Here a region is represented as a square and ds=1. Draw and derive how you obtain the results. You are only required to show the formulas. No need to calculate the final results. **5**

d. Repeatability is usually used as a criterion for measuring the robustness of a local region detector. An original image has the size of 100x100 and the transformation is scaling with the factor of 2 both horizontally and vertically, i.e. the transformed image is 200x200. A local region detector detects 4 square regions on the original image. The locations of the top-left corners of the 4 regions are (10, 10), (10, 90), (90, 10), (90, 90) and the size of the regions is all 5x5. The same detector detects 3 square regions on the transformed image. The locations of the top-left corners of the 3 regions are (21, 21), (22, 178), (177, 182) and the size of the regions is all 10x10. Show how the repeatability rate is calculated. Two regions are considered to be corresponding if the overlap error is less than 50%. **5**

2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5

(a)

8	8	6	6
8	8	6	6
6	6	8	8
6	6	8	8

(b)

2	2	2	2
2	2	2	2
6	5	4	4
8	7	4	4

(c)

Figure 1.1

30	25	25	25	30
25	**20**	**15**	**20**	25
25	**15**	**15**	**15**	25
25	**20**	**15**	**20**	25
30	25	25	25	30

Figure 1.2

2. **a.** Describe the Bayer colour filter used in most modern 1-CCD cameras. (You may use a diagram for your answer.) Why are the colours in the Bayer pattern unequally sampled? **4**

b. **i)** Explain the trade-offs that must be considered when choosing aperture size and shutter speed. Then, explain how the aperture and shutter speed differed to capture the two images shown in Fig 2.1.

ii) Similarly, explain in general terms what effect differing focal lengths and fields of view have on a photograph. How can we achieve a weak perspective/strong perspective of an object in a photograph, while maintaining the same scale?

iii) Give the equation for the field of view in terms of the focal length and sensor size of the camera. **10**

c. After examining Fig 2.2, calculate the 2-D coordinates of point A on projection plane PP for the following values of B: (10,0,1) (3,4,2) (-5,6,5) **6**

Figure 2.1

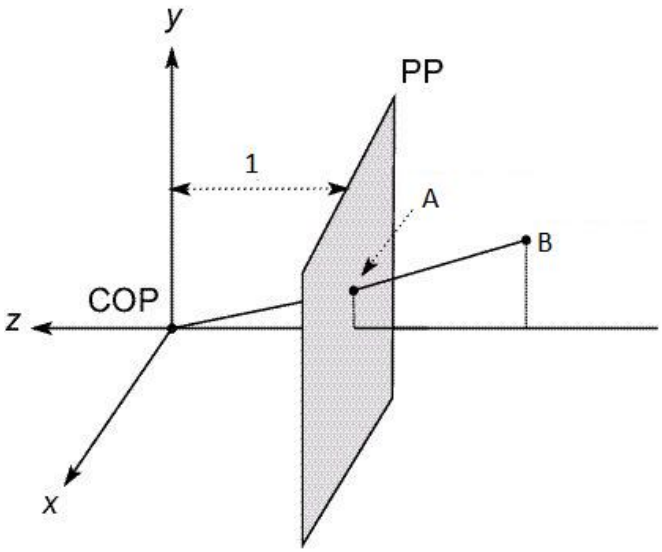

Figure 2.2

3. **a.** Why is segmentation useful in image processing/computer vision? **3**

b. **i)** Clustering is one technique that can be used for segmentation. Give the basic structure of the K-means clustering algorithm.

ii) What strategy can we adopt to find the best K in the K means algorithm?

iii) Even with the correct K, the K-means algorithm does not usually return globally optimal clusters. Explain why this is, and how it is possible to mitigate this problem to some extent. **10**

c. **i)** Are segmented regions effective for content-based image retrieval? Why?

ii) What are advantages of salient regions in comparison to segmented regions for content-based image retrieval? **4**

d. How can we segment textured areas in images, such as fur or clothing, and what is the motivation for that? **3**

4. **a.** Give the comparative advantages of the parts-based and global approaches to image classifications. **4**

b. When using the Bag of Features method for image classification, the size of the visual vocabulary has a large effect on the algorithm's accuracy. Explain why both too large and too small a vocabulary is detrimental to accuracy. **3**

c. In the diagram shown in Fig. 3 are the gradient magnitudes and orientations respectively for a grid of pixels. Assuming 4 orientation bins equally spaced from 0-360 degrees, draw a HOG (Histogram of Oriented Gradients) histogram for this grid, marking your measurements on the histogram clearly. Where appropriate, you should perform linear interpolation on the orientations. (The first bin should be from 0-90 degrees) **7**

d. **i)** What's the difference between face detection and face recognition?

ii) Roughly outline how a face detector via a binary classifier works. **6**

2 315°	3 270°	3 135°	1 315°
1 225°	1 315°	1 270°	1 0°
2 90°	2 180°	3 225°	1 270°
3 45°	1 0°	2 315°	1 180°

Figure 3: The gradient magnitudes (above) and orientations (below) of a 4x4 square of pixels