
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2003/2004

September/October 2003

CCS504 – Computer Vision and Image Processing

Duration : 3 hours

INSTRUCTION TO CANDIDATE:

- Please ensure that this examination paper contains **SIX** questions and **ONE** Appendix in **SEVEN** printed pages before you start the examination.
 - Answer any **FIVE (5)** questions.
 - If you choose to answer **question 5**, your answer for **question 5(c)** must be written on **page 7**. Then it must be taken off and bind together with your answer script book.
 - You can choose to answer either in Bahasa Malaysia or English.
-

ENGLISH VERSION OF THE QUESTION PAPER

1. (a) Discuss various factors that influence the brightness of a pixel in an image.
(4 marks)
- (b) Explain in words and illustrate with a diagram the form of a gray scale transfer function you would use to decrease image contrast.
(4 marks)
- (c) What gray scale transfer function would you use to increase contrast in the bright portions of the image, while decreasing the contrast in the darker regions?
(4 marks)
- (d) Derive the quadtree representation of the image in Figure 1 using a homogeneity criterion of your choice.

65	68	63	100	135	87	95	100
66	64	98	88	110	93	94	121
91	95	87	92	102	105	123	125
91	92	88	84	100	110	120	119
200	239	155	145	73	78	130	185
225	200	145	148	69	72	176	145
200	210	139	200	65	95	120	123
209	199	154	150	66	83	121	130

Figure 1

(8 marks)

2. (a) How do Gaussian and median filters compare as smoothing operators?
(4 marks)
- (b) How can the zero-crossings of the Laplacian of an image be used as an edge detector?
(4 marks)
- (c) Why is smoothing usually implemented prior to edge detection?
(4 marks)
- (d) What advantages are there in considering the Laplacian at more than one value of the blurring parameter σ (Laplacian of Gaussian)?
(4 marks)

- (e) Apply Laplacian edge detector in Figure 2(a) to the image in Figure 2(b) and compute the output image. Explain how you deal with the pixels near the edge of the image area.

1	1	1
1	-8	1
1	1	1

Figure 2(a)

5	3	6	7	0	2
2	2	8	4	4	1
5	7	0	5	0	0
4	3	6	1	6	2

Figure 2(b)

(4 marks)

3.



Figure 3

- (a) Describe what you would expect the grey-level histogram for the image in Figure 3 to look like and explain why.

(3 marks)

- (b) What is image segmentation and why is it usually carried out?

(3 marks)

- (c) It is required to segment the child's face from the background in Figure 3. Describe and discuss the results expected from each of the following segmentation algorithms:
- (i) P-tile thresholding
 - (ii) Region growing
 - (iii) Region merging
- (14 marks)
4. (a) What is meant by "invariance" in relation to object features?
- (5 marks)
- (b) In a parts sorting problem, three classes are to be separated:
- Class 1: Square washers with round centred holes;
 - Class 2: Round washers with square centred holes;
 - Class 3: Round discs.
- The specifications are:
- Class 1: Side of square = 8cms. Inner radius = 3 cms.
 - Class 2: Outer radius = 4cms. Side of square = 5cms.
 - Class 3: Radius = 2 cms.
- (i) Evaluate the features a to d, below, for each class:
- a Number of contours
 - b Area of object
 - c $(\text{outer perimeter})^2 / (\text{area included in outer perimeter})$
 - d Euler number
- (8 marks)
- (ii) Choose adequate features to discriminate between these objects and draw a diagram showing how the feature space can be partitioned into 3 classes.
- (4 marks)
- (iii) Comment on the robustness of your choice of features.
- (3 marks)

5. (a) Describe binary morphological opening operation in detail and illustrate it with an example. (7 marks)
- (b) Discuss any one application of the opening operation. (3 marks)
- (c) Given the image and the structure element in Figure 4, compute the output images for the following operations:
- (i) Dilation
- (ii) Erosion

[Note: Use the figures in the Appendix to give your answer.]

	1	1							
	1	1	1						
		1	1						
	1	1				1		1	
			1		1	1	1	1	1
				1	1	1	1		1
			1		1	1	1		1
					1	1	1		1
				1	1			1	
			1	1	1	1	1	1	
			1	1	1	1	1	1	

image

	1	
1	1	1
	1	

structuring element

Figure 4

(10 marks)

6. (a) Explain the following in detail:

(i) CIE standard observer

(ii) Tristimulus values

(iii) Color gamuts

(10 marks)

(b) Describe RGB and HSI colour spaces with suitable illustrations and discuss the suitability of each of these representations in image processing.

(10 marks)

Answer Question 5(c) on this page:

