UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 199912000

September 1999

CSC543 - Digital Image Processing

Duration : [3 hours]

INSTRUCTION TO CANDIDATE:

- Please ensure that this examination paper contains **TEN** questions in **THREE** printed pages before you start the examination.
- Answer **ALL** questions.

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1. (a) Explain image sampling and gray level quantization.

(4 marks)

(b) A certain graphical environment uses icons that are 32 by 32 pixel images, and each pixel is one of 16 colors. How many different icons are possible? Assuming that one in million of the possible icons is potentially useful, how many 8 inch by 10 inch print out sheets would be required to catalogue the useful icons? Assume that 100 pixel per inch can be printed.

(6 marks)

2. (a) Derive the transformation matrix for rotation of a point about y axis by an angle p. Assume homogenous coordinates are used.

(4 marks)

(b) The transformation of a cube located away from the origin is done by scaling transformation with respect to the coordinate origin. The scaling parameter was set to 2 uniformly in all the three axes directions. What is the effect of this transformation with respect to the location and size of the cube. Justify your answer by an example.

(6 marks)

3. (a) Define the convolution of two functions f(x) and g(x).

(2 marks)

(b) Illustrate graphically the convolution operation.

(3 marks)

(c) State the convolution theorems and explain as to how they are used in Image Processing.

(5 marks)

4. a) What is the histogram of an image. Sketch and explain the histogram of dark, bright, low contrast and high contrast images.

(5 marks)

(b) What is histogram specification? Explain as to how it is done.

(5 marks)

5. Spatial lowpass filtering is done by mask processing an image with a mark having all coefficients as 1. The processing is done by allowing the use of an algorithm called box-filter algorithm, which consists of updating only the part of the computation that changes from one location to the next.

(a) Formulate such an algorithm for an n x n filter, showing not only the nature of the computation involved, but also the scanning sequence involved for moving the mask around the image.

(5 marks)

(b) Find the computational advantage of the above algorithm. (The computational advantage is defined as the ratio of the number of computations performed by a brute-force implementation to the number of computations performed by the implementation of a new algorithm).

(5 marks)

6. (a) From a given original image, a lowpass spatial filtered image was obtained by using 3 x 3 filter. How can a highpass filtered image be, now, obtained without using a filter again? Justify your procedure.

(4 marks)

(b) Under what condition does the Butterworth lowpass filter become an ideal lowpass filter?

(2 marks)

(c) What is the relationship between a highpass filter function and the lowpass filter function in the transform domain? Show that this relation ship is satisfied by the two Butterworth filters.

(4 marks)

7. (a) What is a color model? Describe the RHB color model. Illustrate by choosing and explaining typical points in the RGB color cube.

(6 marks)

(b) What is pseudo-color Image Processing? Explain the use of the technique of intensity slicing for pseudo-color Image Processing.

(4 marks)

8. Explain with suitable sketches as to how spatial transformation and gray level interpolation are used in image restoration.

(10 marks)

9. What are the different types of data redundancy and how are they identified and exploited in digital image data compression?

(10 marks)

10. The arithmetic decoding process is the reverse of the encoding procedure. Decode the message 0.23355 given the coding model:

symbol	Probability
a	0.2
e	0.3
i	0.1
o	0.2
u	0.1
!	0.1

(10 marks)

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