

**PRIFYSGOL CYMRU; UNIVERSITY OF WALES**

**DEGREE EXAMINATIONS JANUARY 2003**

**SWANSEA**

**Computer Science**

**CS 217 Computer Graphics I**

**Attempt 2 questions out of 3**

**Time allowed: 2 hours**

**Students are permitted to use the dictionaries provided by the University**

**Students are permitted to use the calculators provided by the University**

**CS\_217**  
**COMPUTER GRAPHICS I: IMAGE PROCESSING AND SYNTHESIS**  
(Attempt 2 questions out of 3)

**Question 1**

- (a) Given the following pattern dithering matrix:

3	7	5
6	1	2
9	4	8

and the following 6x3 grey-level image (with levels from 0 to 255):

100	100	110	120	120	140
110	110	120	120	140	150
120	140	150	150	180	180

demonstrate all of the stages of the two processes of dithering and halftoning to obtain a bi-level image. Also create a bi-level image using the thresholding algorithm. Compare the total error resulting from using the thresholding algorithm with the dithering and halftoning algorithms.

Using the same 6x3 grey-level image given above, also perform standard error diffusion on the first *two* rows of the image. Again compare the total error from the thresholding result for the first two rows with the total error resulting from using the standard error diffusion algorithm.

You should include a description of each method as part of your answer, along with the advantages and disadvantages of each method.

**[20 marks]**

- (b) Write a *detailed* description (1-1\_ pages) about *lossy* compression techniques for still images and for video. You could include some or all of JPEG, JPEG2000, MPEG1, MPEG2, MPEG4, MJPEG, DV, DIVX, or any other *lossy* techniques with which you are familiar.

**[5 marks]**

## Question 2

- (a) State the two-dimensional line equation. From this equation derive the basic line incremental algorithm for the situation where  $-1 \leq m \leq 1$ , and use it to demonstrate the drawing of the line (8,10) to (12,12).

Also derive the algorithm for the case where  $m < -1$  or  $m > 1$ , and use it to demonstrate the drawing of the line (8,10) to (10,14).

What benefit does this algorithm have over the naïve implementation? What property can we take advantage of to accelerate the drawing of a circle? Indicate how that property is used by showing what points are plotted.

[8 marks]

- (b) How does the recursive flood fill algorithm work? You should mention boundary and interior defined objects, 4-connected and 8-connected pixels, and give psuedo code for the algorithm for one of the cases. Briefly describe an iterative method for filling. Indicate which method would be better and why.

[7 marks]

- (c) Show the matrices used for rotation, scaling and translation using two-dimensional coordinates. Indicate how it is inefficient to use these matrices to perform many transformations on two-dimensional points. What are homogenous coordinates? Show the matrices used for rotation, scaling and translation using homogenous coordinates. Premultiply the scaling and translation matrices (such that scaling is applied first, followed by translation). Show that this one matrix gives an identical result when transforming a point (x,y,1) as applying the matrices separately.

[10 marks]

## Question 3

- (a) What causes aliasing effects? Describe the method of over-sampling as an anti-aliasing method and indicate the benefits and drawbacks of the method. You should use an example or diagram as part of your answer. Describe what variation adaptive over-sampling introduces to the algorithm. What benefits does adaptive over-sampling bring to anti-aliasing?

[7 marks]

- (b) Write precise descriptions about three out of the following five topics:

Histogram equalisation;

RGB and HSV colour models;

Good and bad methodology for creating a graphics application;

Event programming;

Gamma correction and the human eye.

[9 marks]

- (c) What applications result in a three-dimensional volume of data? Discuss either blobby modelling or distance fields as a source of three-dimensional volume data. Describe the process of volume rendering when applied to a three-dimensional voxel data set. You may wish to include the pseudo-code for the volume rendering process in your answer. Your answer should also include the concepts of light source, transparency / opacity, attenuation of light source and sampling using trilinear interpolation.

[9 marks]