CS413 Visualisation
Semester 2, 2003

Sample exam paper

Time allowed: 2 hours
Reading time: 10 minutes

Candidates should answer **ALL** questions in this paper
Marks for this paper total 80

Question 1 (20 marks)

(i) (2 marks)
What is visualisation?

(ii) (6 marks)
As a successful graduate of this course, your expertise is being called upon to visualise a large dataset for a client. You have asked all the basic questions about the file formats, data representation, etc., and have successfully written a small program to unpack and read the data. Before proceeding any further, what questions would you ask your client? For each question, explain why you asked that question. Note that you must ask 3 questions (2 marks for each question).

(iii) (6 marks)
Given that the scalar values at the vertices of a two-dimensional rectilinear grid are known, explain how bilinear interpolation can be used to sample scalar values between the grid points. How many multiplications would be required to perform a single bilinear interpolation? Explain how you would extend bilinear interpolation to trilinear interpolation.

(iv) (4 marks)
Draw a diagram showing the way a ray-traced image is built up. Keep this drawing simple: a scene with a single object and a single light source will suffice.

(v) (2 marks)
Show the recursive nature of the ray tracing procedure on your diagram. Add a sentence or phrase of further explanation here if necessary.

Question 2 (20 marks)

(i) (3 marks)
Visualisation data are either *regular* (i.e. structured) or *irregular* (i.e. unstructured). Describe these two types of visualisation data.

(ii) (2 marks)
What is meant by a “hard” shadow?

(iii) (3 marks)
Hard shadows are not very realistic, but are often more than adequate for visualisation. Under what situation does this unrealistic approach work?

(iv) (4 marks)
What are bounding volumes? What purpose does a bounding volume serve?

(v) (5 marks)
In the *marching squares* algorithm,
a) how many different cases can a contour curve intersect a square?
b) what are the ambiguous cases that can arise? Explain what the contours are like in each of these cases.

(vi) (3 marks)
Instead of using the marching squares algorithm, the contour of a given contour value can be tracked using the contour tracking method. Explain how the contour tracking method works.

Question 3 (20 marks)

(i) (3 marks)
Consider a pixmap of dimensions 100×100. What are the memory requirements for representing the data using
a) (1.5 marks)
A structured point dataset of *float scalars* (4 byte per scalar).
b) (1.5 marks)
An unstructured point dataset of *double scalars* (8 bytes per scalar).

(ii) (5 marks)
Marching cubes visit each cell during algorithm execution. Many of these cells do not contain the isosurface. Describe a technique, which is to be carried out in data pre-processing, to improve the performance of isosurface extraction by eliminating visits to cells that do not contain the isosurface.

(iii) (4 marks)
Isoline contours of different values are typically shown together (as different colours) in one image. Describe the advantages and disadvantages of displaying isoline contours simultaneously.

(iv) (4 marks)
In ray casting, one often need to decide which projection model to use. Describe the two projection models, perspective projection and orthographic projection, and outline their differences.

(v) (4 marks)

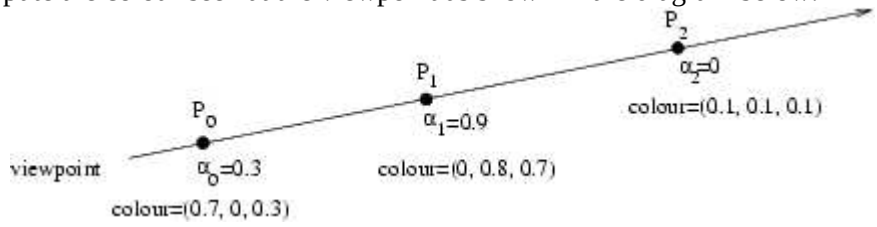
a) (2 marks) What is ray casting?

b) (1 mark) When traversing the volume of data in ray casting, the parameter α often arises. What does this parameter measure?

c) (1 mark) Use the formula

$$\sum_{i=0}^{n}\left(I_i \alpha_i \prod_{j=0}^{i-1}(1-\alpha_j) \right) = I_0\alpha_0 + I_1\alpha_1(1-\alpha_0) + I_2\alpha_2(1-\alpha_1)(1-\alpha_0) + \cdots$$

to compute the colour seen at the viewpoint as shown in the diagram below:



Question 4 (20 marks)

(i) (6 marks)

Describe in detail the two types of data structures for spatial subdivision that are often employed in practical ray tracing are: *octrees* and *spatial enumerated auxiliary data structure* (or *SEADS*).

(ii) (6 marks)

Vector data can be visualised with hedgehogs (lines oriented in the direction of the vector with length representing the magnitude). List two other techniques that can be used effectively. In each case, suggest a suitable application.

(iii) (6 marks)

a) (2 marks) What are the limitations of ray tracing that can be overcome by a radiosity method?

b) (4 marks) Briefly describe the radiosity method.

(iv) (2 marks)

Outline the differences between general texture mapping and view dependent mapping.

END OF PAPER