Spring 2001 CS184 Midterm 01

Problem 1 [1 point]

Did you write your name on the front of this exam?

Problem 2 [5 points]

When performing perspective projection, which sets of parallel lines will **NOT** have a banishing point?

Problem 3 [9 points]

Given a frame buffer system with 10 bit planes, and a 1024 entry look up table (palette), with 30 bits for each entry (10 for each red, green, blue) answer the following:

(a) [3 points] How many bits should we have for each DAC (red, green and blue)?

(b) [3 points] How many colors will be simultaneously viewable on the screen (assuming 1024 x 1024 resolution)?

(c) [3 points] How many colors can be displayed (not necessarily at once)?

Problem 4 [18 points]

Line clipping.

(a) [6 points] Describe two trivial rejection cases for the Liang-Barsky line-clipping algorithm.

(b) [6 points] Show one example of a line segment that is trivially rejected by Liang-Barsky, that is not trivially rejected by Cohen-Sutherland. Briefly explain.

(c) [6 points] Show one example of a line segment that is trivially rejected by Cohen-Sutherland that is not trivially rejected by Liang-Barsky.

Problem 5 [14 points]

Consider the basic dimensional modeling transformations (translation, rotation, and scale):

$$T(t_x, t_y) = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

$$R(\theta) = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$S(s_x, s_y) = \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

(a) [6 points] What are the inverses of these transformations? (Do not sue brute force.)

(b) [4 points] Are there any special cases that are not invertible? If so, what are they?

(c) [4 points] Do your methods for computing the inverse matrices generalize to 3D? If not, explain why not.

Problem 6 [12 points]

In class we discussed two ways of setting up a perspective projection matrix. The two matrices are given below:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/d & 0 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & d \end{bmatrix}$$

(a) [6 points] One of these places the center of projection (COP) at z = 0 and the other places the projection plane (VP) at z = 0. Label the correct matrices with "COP = 0" and "VP = 0."

(b) [6 points] Is there a basic transformation that transforms one into the other? IF so, what is it?

Problem 7 [13 points]

There are several ways to represent rotations and orientations. In class we discussed rotation matrices, Euler angles, quaternions, and exponential maps (where the vector **r** describes a rotation with axis **r**/||**r**|| and angle ||**r**|| radians).

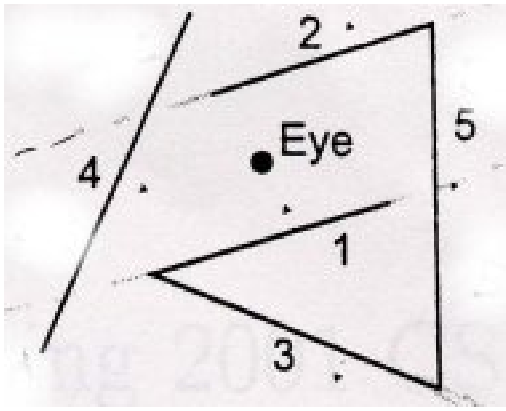
(a) [4 points] Which of these represent rotations (i.e. allowing tumbling) and which can only represent orientations (i.e. do not allow tumbling)?

(b) [3 points] Which of these suffers from gimbal lock?

(c) [6 points] Euler angles and exponential maps both use three nubmers to describe an orientation while quaternions use four and rotation matrices use nine. Does this mean that quaternions and rotation matrices can represent orientations that the other two cannot? Justify your answer.

Problem 8 [16 points]

Consider the line segments below. (Each line segment is labeled with a number, the little arrows indicate the segment's positive normal direction.)



(a) [9 points] Create a BSP Tree that holds these segments. Insert the segments in the order of the labels. If you need to split a segment, label the parts with letters (i.e. 1A and 1B).

(b) [7 points] Given the location of the "eye" indicated on the page, write down the order in which the nodes of your tree would be drawn. Assume we want to draw in back-to-front order.

Problem 9 [12 points]

Consider the three dimensional (non-homogeneous) matrices below.

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$

Determine which are rotations. For the one(s) that are not rotations, what are they?