CIS 440/640

Midterm

Wednesday, October 22, 2003

*Only graduate students are required to answer questions **1.5**, **3.3(b)**, and **4.2** of this exam. Point totals will be normalized to a common scale (the exam is worth 15% of your grade). Partial credit will be given in half-point gradations.*

Part 1

1.1 (2 points)

What is the homogeneous form of a 3-D point? What is the homogeneous equation of a plane? How can the plane equation be expressed as a vector operation to determine whether a point is on a plane? What do non-zero values of this operation mean?

1.2 (1 point)

Define a 3-D rigid transformation in as much detail as you can. Explain its place in the geometry pipeline.

1.3 (1 point)

What is the difference between a transformation and a projection? How do parallel and perspective projections differ?

1.4 (2 points)

Name two transformations in the geometry pipeline that depend upon a homogeneous coordinate representation. Specifically, how are homogeneous coordinates used in these transformations?

1.5 Graduate students only (2 points)

Explain the Cohen-Sutherland line clipping algorithm, including the role of outcodes. How do the 2-D and 3-D cases differ?

Part 2

2.1 (1 point)

Intuitively, what is the difference between diffuse and specular materials? What is the purpose of the ambient term in local lighting models?

2.2 (1 point)

What is the relationship between the reflection vector $\mathbf{r}(l)$ and the viewing vector $\mathbf{v}$ at the point of greatest brightness of a highlight caused by light l?

2.3 (1 point)

Explain the **over** blending operator. How is it related to the calculation of z fog?

Part 3

3.1 (2 points)

What is the *decision function* used in the midpoint (Bresenham's) line drawing algorithm? What is being decided and how?

3.2 (1 point)

When and why does Gouraud shading have problems with highlights? Give two possible fixes for this problem (in the context of Gouraud shading).

3.3(a) (1 point)

Define aliasing and describe some examples of it.

3.3(b) Graduate students only (1 point)

Briefly, what is the difference between the coverage approach to anti-aliasing vs. using super-sampling?

Part 4

4.1 (2 points)

What are the Z-buffer algorithm and the painter's algorithm? Briefly explain how they work and give at least one positive and one negative feature of each.

4.2 Graduate students only (2 points)

Consider the set of 2-D line segments in the figure below. Suppose we pick the partitioning line for a given level of a BSP tree as the first in a list ordered using the lines' numerical labels. The ordering rule is "smallest-to-largest even numbers, then largest-to-smallest odd numbers."

Give the steps to construct a BSP tree from the figure's line segments using this rule, indicating any splits that are necessary. For clarity, the only splits possible are: line 2 splits 3 and 4, line 1 splits 3, and line 3 splits 5.

Now suppose the viewer is positioned at the dot in the figure. In what order would the BSP tree you constructed be traversed for the painter's algorithm?