CS 465 Homework 5

out: Tuesday 11 October 2005
due: Friday 21 October 2005

Problem 1: Rasterization

In this problem we'll follow one triangle in detail from eye space through projection and rasterization, computing exactly the set of fragments it generates along with their associated data.

The eye space coordinates of the triangle's three vertices are $(0, 16, -32)$, $(-4, 0, -16)$, and $(24, -5, -64)$.

The camera setup is as follows. The near plane is at $z = -4$; the far plane is at $z = -48$. Measured on the near plane, the rectangle of the image is $[-2, 2] \times [-\frac{3}{2}, \frac{3}{2}]$—that is, the image width is 4 units and the height is 3 units. The viewport is 8 pixels across and 6 pixels high. In Shirley's notation, we have $n = -4$, $f = -48$, $l = -2$, $r = 2$, $b = -1.5$, $t = 1.5$, $n_x = 8$, $n_y = 6$. Use Shirley's convention of integer pixel centers (that is, the lower left pixel is at $(0, 0)$ and the boundaries of the image rectangle are on half-integers).

1. Write down the projection matrix and the viewport matrix.
2. Transform the vertices into clip space and write them down as 4-vectors. Which of these points are inside the view volume and which are outside?
3. Transform the vertices into screen space and give their (x', y', z') coordinates.
4. What is the rectangle of pixels enclosed by intersection of the triangle's screen-space bounding box with the image rectangle? These are the pixels that would be visited by a simple rasterizer like the one in the Pipeline framework. *Hint*: There are 20 pixels in this rectangle. All the pixels mentioned later in this problem are inside this rectangle.
5. Draw a picture (graph paper or drawing software will help) that shows the boundaries of the image, the screen-space position of the triangle, and the rectangle from part 4.
6. Assume the rasterizer interpolates screen-space barycentric coordinates to determine which fragments to generate, and it's also supporting z-buffering. This means it needs to interpolate four attributes (3 barycentric coordinates plus z'). What are the values

of the attributes at pixel $(2, 2)$ and what are the x and y increments? *Hint*: You can check your increments by using them to recompute the attribute values at the second and third vertices.

7. Compute the barycentric coordinates at the pixels $(5, 2)$ and $(5, 4)$. Which is inside and which is outside the triangle?

8. List all the fragments that will be generated for this triangle. Each one consists of (x, y) pixel coordinates and a value for the attribute z'. Assume the rasterizer will never generate fragments that are outside the view volume. *Hint*: There are nine fragments.