CS 465 Prelim 2

Tuesday 1 November 2005—1.5 hours

Problem 1: Pipeline (21 pts)

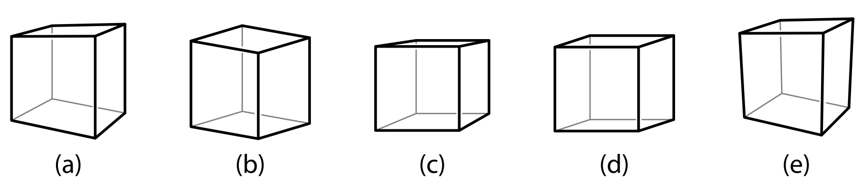
Consider the following types of rendering being done using a programmable graphics pipeline. For each rendering mode, answer (a) what attributes would be interpolated by the rasterizer; (b) what operations would be done by the vertex processor to compute those attributes (including transformations from one coordinate space to another); (c) what operations would be done by the fragment processor to compute a color and depth for the framebuffer. Assume infinite viewer and directional lighting unless otherwise specified.

1. (7 pts) Diffuse shading with a texture map controlling the diffuse color.
2. (7 pts) Phong lighting and shading, with a constant diffuse color but two separate texture maps controlling the specular coefficient and exponent.
3. (7 pts) Phong lighting and shading with constant colors and exponent, but with three local (not directional) light sources.

Remember that Phong shading refers to the practice of doing shading calculations at the fragment stage, while Phong lighting is an illumination model with diffuse and specular components.

Problem 2: Viewing (16 pts)

Here are several line drawings of a cube.



1. (8 pts) Classify each of the five views as parallel projection, one-point perspective, two-point perspective, or three-point perspective.
2. (8 pts) Classify each of the five views as either normal or off-axis (view direction perpendicular to projection plane or not).

Problem 3: Transformations (28 pts)

The following matrices as fall into at least one of the following classes of transformations: (a) Uniform scale; (b) Nonuniform scale; (c) Clockwise rotation (by $< 180°$) about $\mathbf{e}_1$, $\mathbf{e}_2$, or $\mathbf{e}_3$; (d) Counterclockwise rotation (by $\leq 180°$) about $\mathbf{e}_1$, $\mathbf{e}_2$, or $\mathbf{e}_3$; (e) Translation; (f) Shear; (g) Reflection; (h) Perspective projection; (i) Parallel projection.

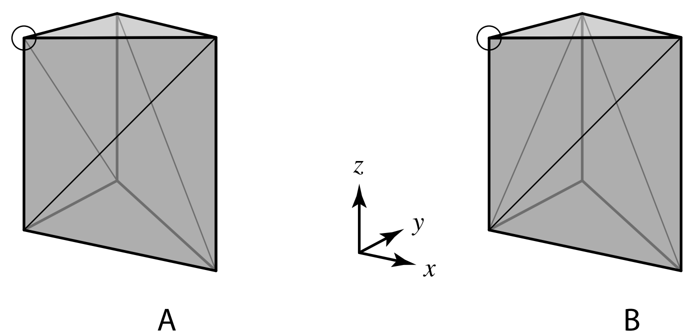
1. (20 pts) Indicate which class or classes each matrix belongs to. If a matrix falls into more than two classes, only list two of them; any two constitute a correct answer.
2. (4 pts) Which of the rotations has the largest rotation angle?
3. (4 pts) Which of the perspective transformations has the largest field of view?

$$(1)\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&0&0\\0&0&0&1\end{bmatrix}\quad(2)\begin{bmatrix}1&0&0&0\\0&0&-1&0\\0&1&0&0\\0&0&0&1\end{bmatrix}\quad(3)\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&1\\0&0&-2&0\end{bmatrix}\quad(4)\begin{bmatrix}1&0&0&0\\0&1&0&-1\\0&0&1&0\\0&0&0&1\end{bmatrix}$$

$$(5)\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&0&0\\0&0&-1&0\end{bmatrix}\quad(6)\begin{bmatrix}1&0&0&0\\0&-1&0&0\\0&0&1&0\\0&0&0&1\end{bmatrix}\quad(7)\begin{bmatrix}0&0&-1&0\\0&1&0&0\\1&0&0&0\\0&0&0&1\end{bmatrix}\quad(8)\begin{bmatrix}1&0&0&0\\0&-1&0&0\\0&0&-1&0\\0&0&0&1\end{bmatrix}$$

Problem 4: Triangle meshes (19 pts)

Here are two triangulated cubes. Each measures one unit on a side and both are positioned with their lower left front corners at the origin.



1. (7 pts) Write out just the front and right-hand faces of the triangulated cube A as a list of triangles (triples of 3D points). How much memory is required to store the entire cube in this representation?
2. (7 pts) Write out an indexed triangle set representation of the entire triangulated cube A. How much memory is required to store this representation?
3. (5 pts) Suppose we move the circled vertex slightly leftward to produce the new shapes A′ and B′. Of the four cubes A, A′, B, and B′, which subsets have the same geometry? Which subsets have the same topology?

Make sure your triangles are oriented consistently. Assume that integers and floating point numbers are both 32 bits long.

Problem 5: Perspective (16 pts)

Here is an unedited photograph of two normal-sized people:

The image above is 450 pixels high, and the two heads measure 90 and 15 pixels high. Assume all heads are 30 cm high. The image on the camera's film plane is 24mm high.

1. (8 pts) If I know that the person in the foreground is 2 meters from the camera, what is the camera's image plane distance (roughly, the focal length) and how far away is the other person?

2. (8 pts) If I know that the two people are standing 20 meters apart, what is the image plane distance and how far from the camera is the closer person?

(Photo courtesy of Seth Teller, who says, "no computers were used to make this picture.")