Univ. at Albany, SUNY CSI 422/502 Computer Graphics Fall 2005 Professor Chaiken
Homework 5 Due 11/2/05

Note: Classes suspended 11/4/05

1 More Blender

1. Start Blender.

2. Move the object insertion cursor to the side by clicking Lmb (Left mouse button) with the mouse pointer to the side.

3. Using the Add/Mesh/IcoSphere menu selection, and click OK for subdivisioning of 2, add an Icosphere to the scene.

4. Observe that your recently added Icosphere is selected, and Blender is in Edit Mode. Note that a Mesh button appeared at the bottom of the 3D View Window. Use the Mesh/Transform Properties... selection to command Blender to display the Transform Properties dialog box.

5. Observe that the transform properties you see apply to OB:Sphere, which is your selected Sphere object. The transform properties dialog lets you modify the values of Median X, Median Y and Median Z. Please modify some of those numbers and watch the sphere move.

6. Look at the bottom of the 3D View window and select the Select/(Select/Deselect All) choice (or be a Blender Wizard and press the hotkey "a"; see how the menu text helps the user learn the hotkeys.)

   Observe that the Transform Properties dialog becomes blank.

7. In edit mode, the Right mouse button (Rmb) does "selection". To edit something, you have to select it first.

   The next to the last group of buttons at the bottom of the 3D view window contains 4 buttons. The first 3, with "dots", "bar" and "triangle" icons, determine whether the Rmb selects vertices, edges, or faces of the object being edited.

8. The original setting is vertices. Click Rmb on a vertex of your IcoSphere. Observe that the Transform Properties dialog displays that vertex's coordinates.

   Move a selected vertex by changing values in the transform dialog.

   Also move the selected vertex with menu item Mesh/Transform/(Grab Move G). As you drag the mouse, the vertex moves. Finish inputting that transformation by clicking Lmb.

9. Using the Mode menu at the bottom of the 3D edit window, select Object Mode. Observe the transformations that Blender stores with the whole object.

   Try changing the numeric values for the Sphere's rotation, location and size.

10. In Object Mode, you can move, rotate and rescale the Sphere by selecting the desired transform action from the object menu and then some mouse action. Try it!

2 OpenGL Perspective Projection

Read Appendix F of the RedBook.

The OpenGL Standard defines the behavior of **glFrunstum**$(\mathbf{l}, \mathbf{r}, \mathbf{t}, \mathbf{n}, \mathbf{f})$ to generate the matrix specified below:

$$R = \begin{bmatrix} \frac{2n}{r-l} & 0 & \frac{r+l}{r-l} & 0 \\ 0 & \frac{2n}{t-b} & \frac{t+b}{t-b} & 0 \\ 0 & 0 & \frac{-(f+n)}{f-n} & \frac{-2fn}{f-n} \\ 0 & 0 & -1 & 0 \end{bmatrix}$$

1. Write this matrix for values $l = -1$, $r = +1$, $b = -1$, $t = +1$, $n = +1$ and $f = 2$. This will give you a particular example of R.

2. Write 4-component homogeneous coordinates that result from applying the linear trasnformation given by your particular example to point $A[X, Y, Z, 1]^t$. (Just matrix-vector multiply RA.)

3. Note that the 4th component of the above result is not 1. Suppose the above result is $[X', Y', Z', H']$. Write the 3 formulas for the 3 non-homogeneous coordinates of the point whose homogeneous coordinates are $[X', Y', Z', H']$.

   To do this, perform the **perspective division**: Just write the 3 formulas for X'/H', Y'/H', and Z'/H'.

   Try to simplify them.

4. Demonstrate that as Z *decreases*, the value of Z'/H' *increases*. Z decreasing means Z becomes more negative, which in viewing coordinates meaans the $[X, Y, Z]$ becomes further away from the eye in the direction which the eye is looking.

3 Write down a proof

Referring to the 2nd page of the handout, write out the mathematics that about how a linear combination of homogeneous coordinates corresponds to an intermpolation, ie. weighted average, of coodinates of the corresponding ordinary point coordinates.