CPSC 414, Written Homework 1

Out: Mon 6 Oct 2003
Due: Wed 15 Oct 2003 9am
Value: 7% of final grade

Note: solutions will be handed out Fri 17 Oct at 9am, so no late homeworks will be accepted after then.

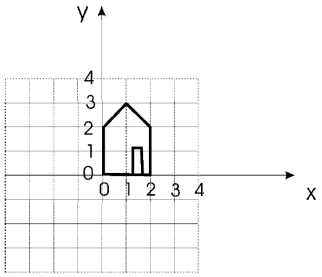
Total Points: 35

Transformations (9 pts)

1. (1 pt) Write down the 4x4 matrix for scaling an object by 35% in all directions.
2. (2 pts) Describe in words what this matrix does (be specific about the order of operations)

$$\begin{bmatrix} .5 & -.866 & 0 & 2 \\ .866 & .5 & 0 & -3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

3. (1 pt) Draw a picture of the object below transformed by the above matrix



4. (1 pt) Give the series of affine transformations needed to rotate a scene by 30° around the x axis with a fixed point of (3,5,12,1).
5. (1 pt) Give sequence of OpenGL commands necessary to implement the above transformation.
6. (3 pts) Show that the inverse of a rotation matrix is its transpose

Viewing (11 pts)

7. (2 pts) Give the viewing transformation matrix for an eye position (0,1,0), a lookat point (0,-1,0) and an up vector (1,1,0).
8. (1 pt) Write out the OpenGL perspective projection matrix with a near plane of 1 and a far plane of 2.
9. (3 pts) Show algebraically that the OpenGL perspective matrix preserves order of z values within a view volume.
10. (2 pts) Draw a cabinet projection of a cube of size x=4, y=2, z=3. Use a 15° projection (that is, the z axis in the scene should make a 15° angle with the x axis in the projection).
11. (3 pts) Give the 4x4 matrix that would product the above cabinet projection. Remember to ensure that points in the xy plane are not changed by the projection.

Lighting (15 pts)

12. (1 pt) State three visual effects that cannot be modelled when considering light as photons.
13. (2 pts) Briefly describe the rationale for and limitations of the ambient term in the Phong illumination model.
14. (2 pt) The moon is poorly approximated by Phong or diffuse shading. What observations tell you this is true?

15. (1 pt) Show that if the view vector V lies in the same plane as the lighting vector L, the surface normal N, and the reflected vector R that the halfangle satisfies $2\psi = \phi$.

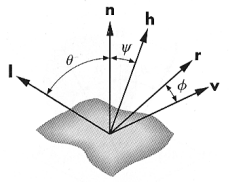


Figure 6.22 Determination of the halfway vector.

16. (1 pt) Show that if the above vectors are not all coplanar this relationship does not hold.

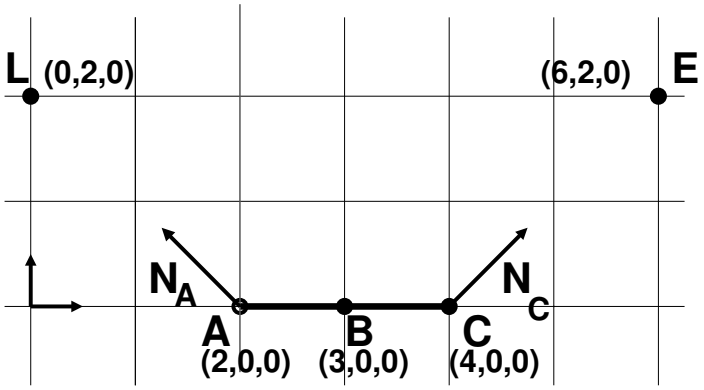
17. (2 pts) Show halfway vector v is the angle at which the surface must be oriented so that the maximum amount of reflected light reaches the viewer.

18. (1 pts) Give the ambient, diffuse, specular, and combined total illumination at each of points A, B, and C under the flat shading model (assume the point used for the flat shading calculation is A). In all cases use the Phong illumination model given by

$$I = I_a k_a + k_d I_L (N \cdot L) + k_s I_L (R \cdot V)^n$$

with parameters

$$I_a = .8, I_L = 1.0, k_a = .2, k_d = .9, k_s = .5, n = 30.$$



19. (2 pts) Same as above, for the Gouraud shading model.

20. (3 pts) Same as above, for the Phong shading model.