

CS 112: Introduction to Computer Graphics
Written Assignment 3 (Total Points = 84)
Due: Wednesday, Oct 29, 2008, 11am (PST)
Estimated Time: 7-8 hrs

MODEL-VIEW AND ILLUMINATION

GOAL: The goal of this assignment is to see if you have understood the model, view and projection transformations clearly, and you are able to implement the operations related to them. Also, we will test your knowledge of the illumination equations.

1. Consider three vertices A, B and C. How do you compute the normal of a face ABC? [2]
2. Now consider a vertex V surrounded by four triangles T1(V,A,B), T2(V,B,C), T3(V,C,D) and T4(V,D,A). Assuming N(T) computes the normal of triangle T, a way to compute the normal at vertex V is computing $[N(T1)+N(T2)+N(T3)+N(T4)]$ normalized. Do you see a problem with this? How could you fix it? (Think on what would be the result of this calculation on the corners of a cube made out of triangles. You may have to carefully draw it.) [3+3=6]
3. The model transformation for our scene is a rotation R about the Y axis in the counter clockwise direction by 90 degrees, followed by a translation T in the positive X direction by 20 units. What is the resulting transformation? [3+3=6]
4. Choose the correct answer: If V is a vertex in our scene, then after model transformation, the transformed vertex is computed as (a) $RxTxV$ (b) $TxRxV$. [4]
5. The view transformation for our scene is the identity matrix. What does this mean? In other words, what is the position and orientation of the OpenGL camera? [5]
6. In homogeneous coordinates, the fourth coordinate W is 0 for normals, but it is not 0 (often 1) for vertices. How could you interpret this geometrically? How does a translation transformation affect a normal? Show it. [2+6=8]
7. The order in which we apply rotations and translations to vertices is important ($RTv \neq TRv$). Is it the same for normals? Show it. [6]
8. When is the vertex illumination computed in the OpenGL pipeline? (a) Between the model-view and the projection transformations, or (b) After the projection transformation, before clipping. Why is it this way? [2+6=8]
9. You are shown an implementation of the Gouraud shading method that computes the normals inside the triangle by mere linear interpolation of the normals at the vertices. It is noticeable that the illumination inside the triangle is not as bright as near the vertices. Can you propose an explanation and a solution to the problem? Perhaps drawing a graph of

- the normals' linear interpolation would help. [8]
10. OpenGL can be instructed to cull (avoid rendering) triangles that are facing away from the viewer. Given viewing direction V and a triangle ABC both in world coordinates, how can you tell whether ABC is facing the viewer or not? Assume orthographic projection. How would this change if we use perspective projection? Do you need additional information to compute the orientation of the triangle? [4+6=10]

COLOR

11. The spectrum of color $C_1 = (X_1, Y_1, Z_1)$ and $C_2 = (X_2, Y_2, Z_2)$ are given by $s_1(\lambda)$ and $s_2(\lambda)$ respectively. Let the color formed by multiplications of the spectrums s_1 and s_2 be s_3 , i.e. $s_3(\lambda) = s_1(\lambda) * s_2(\lambda)$. Is it true that the XYZ coordinate corresponding to s_3 , denoted by C_3 , is (X_1X_2, Y_1Y_2, Z_1Z_2) ? Justify your answer with calculations. [5]
12. C_1 and C_2 are colors with chromaticity coordinates $(0.33, 0.12)$ and $(0.66, 0.66)$ respectively. In what proportions should these colors be mixed to generate a color C_3 of chromaticity coordinates $(0.55, 0.48)$? If the intensity of C_3 is 90, what are the intensities of C_1 and C_2 ? [5+5=10]
13. Color blind people have a reduced ability to perceive some tones. For example, cones sensitive to the Z primary color might be missing. Over the chromaticity chart, represent the range of color tones visible by such an individual. [4]
14. When you switch on the projector in the class you see that it is projecting predominantly blacks and purples. You figure out that one of the wires connecting to the primaries R, G and B may be malfunctioning. Which one is it and why? [2]