CPSC 314, Midterm Exam 2

28 Mar 2007

Closed book, calculators allowed. One single-sided sheet of handwritten notes allowed, put your name on it and turn it in with your exam. Please place your student ID face up on the desk beside you. Answer the questions in the space provided. If you run out of room for an answer, continue on the back. You may fill in your name below, but do not open exam until told to do so.

Signature: ______________________________

Printed Name: ______________________________

Student Number: ______________________________

Question	Points Earned	Points Possible
1		28
2		8
3		40
4		24
Total		100

1. (28 pts) True/false

   - LCD monitors can display all perceivable colors.
   - The high-resolution foveal region covers roughly half of the human visual field.
   - The CIE XYZ color space can represent all perceivable colors.
   - Two different spectral distributions can represent the same perceivable color.
   - For a display of 800x600 pixels, a buffer of size 800 is sufficient to support the flood fill rasterization algorithm.
   - A parity test to check whether pixels are outside or inside a polygon works for both convex and concave polygons.
   - The point with barycentric coordinates $\alpha = 2.0, \beta = .34, \gamma = 1.0$ is always inside a triangle.
   - The point with barycentric coordinates $\alpha = 0, \beta = 0, \gamma = 0$ is always inside a triangle.
   - Interpolating values across a triangle with barycentric coordinates yields the same answer as with bilinear interpolation (up to roundoff error).
   - Diffuse lighting depends on the viewpoint and the orientation of the object with respect to the light.
   - Ray tracers generate exactly one ray for each object in the scene.
   - Ray tracing and radiosity are both view independent.
   - Subsurface scattering occurs when light enters and leaves the surface at different wavelengths.
   - In orthographic projection, the center of projection can be anywhere between the near and far clipping plane.

2. (8 pts) N is the world coordinate system (WCS). Name the coordinate systems L and M, given the code below:

```
glMatrixMode(GL_MODELVIEW);
glLoadIdentity();
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
<coordinate system L>
glFrustum(-5,5,-5,5,2,10)
<coordinate system M>
glMatrixMode(GL_MODELVIEW);
glLoadIdentity();
glTranslate(0,0,-5);
<coordinate system N>
glVertex(-1,-1,1);
```

3. (40 pts) A polygonal model has 6 faces and 7 vertices. There are two lights in the scene. The cost of a component-wise multiplication is C, the cost of a dot product is D, and the cost of exponentiation is E. The cost of normalizing a vector is N. The cost of adding or subtracting vectors, or multiplying a vector by a scalar, is A. The cost of a cross product in X. Assume that all vertices and faces are visible from the current viewpoint, and that there are F pixels in total that need shading. Each face is processed individually during scan conversion. The model has precomputed normals at the vertices of the model which are already normalized, and barycentric coordinates for interpolation have already been precomputed. There is no ambient light, so the modified Phong lighting equation used is

$$\mathbf{I_{total}} = \sum_{j=1}^{numlights} \mathbf{I_j}(\mathbf{k_d}(\mathbf{n} \cdot \mathbf{l}) + \mathbf{k_s}(\mathbf{r} \cdot \mathbf{v})^{shiny}))$$

a) Give the complete cost V of doing a lighting calculation at a vertex. Show your work.

b) Give the cost of flat shading the entire model in terms of F and V (and any other quantities from above). Show your work.

c) Give the cost of Gouraud shading the model in terms of F and V (and any other quantities from above). Show your work.

d) Give the cost of Phong shading the model in terms of F and V (and any other quantities from above). Show your work.

4. (24 pts) In Phong lighting, specularity is computed with the equation $I_s = k_s I_L (R \cdot V)^n$, where $R = 2(N(N \cdot L) - L)$. Give the derivation of R.