Algorithm 2 Shapes

Introduction to Computer Graphics, Fall 2012

Due Sunday, September 16 at noon

Instructions: The instructions are the same as last time. No collaboration is allowed. Complete this assignment by yourself and hand it in to the cs123 hand-in bin or by e-mail attachment to cs123tas@cs.brown.edu. This assignment is worth 11% of your final grade for Shapes. To complete this assignment, you'll need to look at the shapes project demo: /course/cs123/bin/cs123_demo

1 Cube

[1 point] Take a look at one face of the cube. In fact, take a look at one edge of one face in wireframe mode. Change the tesselation parameter. How do the number of small squares against one edge correspond to the tessellation parameter?

[1 point] Consider a unit cube at the origin with tessellation parameter 2. Its front face lies in the +XY plane. What are the normal vectors that correspond with each of the eight triangles that make up this face? (Note: when asked for a normal, you should always give a normalized vector, meaning a vector of length one.)

2 Cylinder

[1½ points] The caps of the cylinder are regular polygons with N sides, where N's value is determined by parameter 2. You will notice they are cut up like a pizza with N slices which are isosceles triangles. The vertices of the N-gon lie on a perfect circle. How will you figure out where they lie in terms of the radius (0.5) and the parameter θ? (What is the equation of the circle that they lie on?)

[1½ points] What is the surface normal of an arbitary point along the barrel of the cylinder? It might be easier to think of this problem in cylindrical coordinates, and then transform your answer to cartesian after you have solved it in cylindrical coords.

3 Cone

[1 point] Look at the cone with Y-axis rotation = 0 degrees, and X-axis rotation = 0 degrees. How many triangles make up one of the p2 "sides" of the cone when p1= 1? When p1 = 2? 3? n?

[1 point] What is the surface normal at the tip of the cone? A singularity does not have a normal. You may achieve a good shading effect by thinking of p2 vectors with their base at the tip of the cone, each pointing outward, normal from the face of the triangle assocated with it along the side of the cone. This implies that there will not be a unique normal at the tip of the cone. Each of the p2 attached triangles will have a normal dependent on its own position in the surface; specifically, the normal for a given triangle at the tip should be normal to the plane defined by that specific triangle. (Think about how OpenGL can use this information to make a realistic point at the top of the cone) Draw a simple schematic sketch illustrating the normal for one of the triangles at the tip. As long as it is clear that you "get the idea", you will recieve full credit.

[1 point] Take the two dimensional line formed by the points $(0, \frac{1}{2})$ and $(\frac{1}{2}, \frac{-1}{2})$ and find its slope, m.

[1 point] Then, $\frac{-1}{m}$ is the slope perpendicular to this line. Using this slope, we can find the vertical and radial/horizontal components of the normal on the cone body. The radial/horizontal component is the component in the XZ plane. What is the magnitude of this component in a normalized normal vector?

[1 point] The component in the y direction is the vertical component. What is the magnitude of this component in a normalized normal vector?

4 Sphere

The sphere in the demo is tesselated in the latitude-longitude manner, so the points you want to calculate are straight spherical coordinates. The two parameters can be used as θ and ϕ, or longitude and latitude. The conversion from spherical to Cartesian coordinates is given by...

$$x = r \cdot sin\phi \cdot cos\theta$$

$$y = r \cdot cos\phi$$

$$z = r \cdot sin\phi \cdot sin\theta$$

[1 point] In Shapes, you'll need to compute normals yourself. What is the surface normal of the sphere at an arbitrary surface point (x,y,z)?