Angel and Shreiner: Interactive Computer Graphics, Seventh Edition

Chapter 12 Solutions

12.1 Let's do the problem in two dimensions. The solution in three dimensions is essentially the same. Assume that the vertices are used in a consistent clockwise or counterclockwise manner. Starting at some vertex, that vertex and the next determine a line of the form

$$ax + by + c = 0.$$

If we evaluate $ax + by + c$ for a given point, the result will be positive or negative depending on which side of the line the point lies. If we are following the vertices in a clockwise manner, the point is inside the polygon if and only if it is to the right of each of these lines.

12.3 Consider two identical circles of radius r centered at $(a, 0)$ and $(-a, 0)$. We can describe them through the single implicit equation

$$((x-a)^2 + y^2 - r^2)((x+a)^2 + y^2 - r^2),$$

by simply multiplying together their individual implicit equations. We can form the torus by rotation these circles about the y axis which is equivalent to replacing x^2 by $x^2 + z^2$.

12.5 The line from the center of the circle to the closest point on the ray must be perpendicular to the ray. Thus, if the ray is written as $\mathbf{p} = \mathbf{p_0} + \mathbf{td}$ and the circle has radius r and center $\mathbf{p}_c$, we can solve

$$\mathbf{d} \cdot (\mathbf{p_0} + \mathbf{td} - \mathbf{p_c}) = \mathbf{0},$$

for t. We can then check the distance between this point and the center. If it is greater than r, the ray misses the sphere.

12.7 Generally, the depth information has to be retained so that the raster processors can determine which entities are in front.

12.9 As was discussed in the text, pipeline strategies can be adapted to non–shared-memory architectures. Ray tracing is more difficult to adapt because if there are multiple reflections or translucent objects, all object must be available when a ray is traced. For large data sets, a distributed memory architecture may not have sufficient memory to allow storage of

the entire object database on each processor. In this case, a shared-memory machine has a huge advantage.

12.13 $i + j + k$

12.19 There are 256 (2^8) ways to color the vertices of a cube. If we take out symmetries (rotations, swapping colors), there are 14 distinct cases. Of these 4 cases gave a face with two whites on one diagonal and two blacks on the other and thus have an ambiguous interpretation.