Angel: Interactive Computer Graphics, Third Edition

Chapter 1 Solutions

1.1 We can apply the formula from page 18

$$\theta = 2\tan^{-1}\frac{h}{2f},$$

where we have replaced the length of the camera d with the focal length of the lens f. Solving for f, we have

$$f = \frac{h}{2}\cot\frac{\theta}{2}.$$

We can use the diagonal of the 24 mm x 36 mm file for h. Solving, we find

$$f = 6\sqrt{13}\cot 45 = 6\sqrt{13} = 21.6mm.$$

1.3 Suppose that the line segment is between the points (x_1, y_1) and $(x_2, y_2$. We can use the endpoints of the line segment to determine the slope and y intercept of a line of which the segment is part,i.e.

$$y = mx + h = \frac{y_2 - y_1}{x - 2 - x_1}y + y_1 - \frac{y_2 - y_1}{x - 2 - x_1}x_2.$$

Note that we can deal with horizontal and vertical line segments as special cases. We can find the intersections with the sides of the window by substituting $y = y_{max}$, $y = y_{min},$, $x = x_{max}$, and $x = x_{min}$ (the equations for the sides of the window) into the above equation. We can check the locations of the points of intersection to determine if they are on the line segment or only on the line of which it is part.

1.5 Here we have to intersect the line segment against the polygons that determine the sides of the window. Each of these polygons is part of a plane. The equation of each plane is of the form

$$ax + by + cz + d = 0,$$

where the coefficients a, b, c, and d can be determined from the vertices of the parallelepiped. The line segment is either parallel to a particular plane or intersects it in exactly on place that can be determined from the equation of the line. For a line passing through the two three–dimensional points (x_1, y_1, z_1) and x_2, y_2, z_2, we can write its equation in parametric form as

$$x(t) = (1 - t)x_1 + tx_2,$$

$$y(t) = (1 - t)y_1 + ty_2,$$

$$z(t) = (1 - t)z_1 + tz_2.$$

We can substitute this equation in the equation for a plane and determine t for the point of intersection.

1.7 We have to process 1280 x 1024 x 72 pixels/sec. If we process each successively, there is only about 10 nanoseconds to process each. For a 480 x 640 interlaced display operating at 60 Hz we must process only 480 x 640 x 30 pixels/sec which gives us about 109 nanoseconds to process each pixel.

1.9 Good examples for this problem are architecture, mechanical parts design, electrical circuit design and a paint program.

1.11 A 1024 x 1280 display has a 4 to 5 aspect ratio. Hence, if the diagonal is 50 cm and we want square pixels, the screen must be approximately 31 cm x 39 mm. Each pixel is then about 0.3 mm on each side. A smooth display will require about 3 triads for each pixel, and thus the triads are about 0.1 mm apart. Finally if the shadow mask is halfway between the screen and electron guns, the shadow mask spacing is half the triad spacing.