Review

CSC321 Computer Graphics

19 December 2016

1. What kinds of objects can we store in a scene graph?

2. (a) Distinguish between additive and subtractive colors.

   (b) Distinguish between RGB and HSL (or HSV) colors.

   (c) What is the CIE diagram?

   (d) How is an understanding of human physiology relevant to an understanding of color in computer graphics?

3. Here is a parametric representation of a line.

$$x(t) = (1-t)x_0 + tx_1$$
$$y(t) = (1-t)y_0 + ty_1$$

   (a) Where does the point $(x(0.25),\quad y(0.25))$ lie relative to the points $(x_0,\ y_0)$ and $(x_1,\ y_1)$?

   (b) Where does the point $(x(-1.0),\quad y(-1.0))$ lie relative to the points $(x_0,\ y_0)$ and $(x_1,\ y_1)$?

   (c) Where does the point $(x(2.0),\quad y(2.0))$ lie relative to the points $(x_0,\ y_0)$ and $(x_1,\ y_1)$?

4. Here is the development of a parametric representation of a curve.

$$\vec{p_0} = (x_0, y_0)$$
$$\vec{p_1} = (x_1, y_1)$$
$$\vec{p_2} = (x_2, y_2)$$
$$\vec{p_3} = (x_3, y_3)$$

$$x_{01}(t) = (1-t)x_0 + tx_1$$
$$y_{01}(t) = (1-t)y_0 + ty_1$$

$$x_{12}(t) = (1-t)x_1 + tx_2$$
$$y_{12}(t) = (1-t)y_1 + ty_2$$

$$x_{23}(t) = (1-t)x_2 + tx_3$$
$$y_{23}(t) = (1-t)y_2 + ty_3$$

$$x_{02}(t) = (1-t)x_{01}(t) + tx_{12}(t)$$
$$y_{02}(t) = (1-t)y_{01}(t) + ty_{12}(t)$$

$$x_{13}(t) = (1-t)x_{12}(t) + tx_{23}(t)$$
$$y_{13}(t) = (1-t)y12(t) + ty_{23}(t)$$

$$x_{03}(t) = (1-t)x_{02}(t) + tx_{13}(t)$$
$$y_{03}(t) = (1-t)y_{02}(t) + ty_{13}(t)$$

(a) What is the name of the kind of curve that the functions $x_{03}(t)$ and $y_{03}(t)$ describe?

(b) The curve is described by a polynomial function of what degree?

(c) What are the values of $x_{03}(t)$ and $y_{03}(t)$ at $t = 0$ and $t = 1$?

(d) Describe the tangents of the curve at $t = 0$ and $t = 1$.

(e) For $0 \leq t \leq 1$ the points $(x_{03}(t), y_{03}(t))$ lie within what part of the plane?

5. What is the inverse of the matrix M?

$$\begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

6. Let $\vec{p_0}$, $\vec{p_1}$, and $\vec{p_1}$ be vectors the specify the locations of three distinct and non-colinear points. These three points define a triangle.

   Give an expression whose value is a vector that is normal (perpendicular) to the triangle and that has a length (magnitude) of one.

7. Just as we can raise a number to a power, we can raise a matrix to a power.

$$\begin{aligned} \mathbf{M}^2 &= \mathbf{M} \times \mathbf{M} \\ \mathbf{M}^3 &= \mathbf{M} \times \mathbf{M} \times \mathbf{M} \\ \vdots &= \vdots \\ \mathbf{M}^n &= \mathbf{M} \times \mathbf{M} \times \mathbf{M} \times \ldots \times \mathbf{M} \quad \text{(n times)} \end{aligned}$$

   What is the value of $\mathbf{R}^{30}$?

$$\mathbf{R} = \begin{bmatrix} \cos(\frac{2\pi}{360}) & -\sin(\frac{2\pi}{360}) & 0 & 0 \\ \sin(\frac{2\pi}{360}) & \cos(\frac{2\pi}{360}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

8. Here is a parametric representation of a surface. What kind of surface is it?

$$f(u, v) = (v \cos(u2\pi), v \sin(u2\pi), v)$$

9. Here are some vectors that we can use in calculating the amount of illumination on some small part of a surface.

   - $\vec{N}$ is the normal vector. It specifies the orientation of the surface.
   - $\vec{L}$ is the illumination vector. It points at the source of light.
   - $\vec{R}$ specifies the direction of a reflected ray.

- $\vec{V}$ points at the viewer's eye.

(a) Which of these vectors is relevant in our calculation of how much ambient lighting contributes to the brightness of a small part of a surface?

(b) Which of these vectors is relevant to our calculation of how much diffuse lighting contributes to the brightness of a small part of a surface?

(c) Which of these vectors is relevant to our calculation of how much specular reflection contributes to the brightness of a small part of a surface?

10. (a) Write code to test the following code.

    (b) What does this JavaScript function do?

```
var f = function( mean ) {
    var result = function() {
        return -mean * Math.log( Math.random() );
    }; // result()

    return result;
}; // f()
```

11. We represented curved surfaces by dividing the surface into small pieces and approximating each piece with a triangle.

    If we divided the surface into very many pieces, the surface appeared to be smoothly curved. Viewers did not see a mesh of triangles because the triangles were too small.

    We also learned that we could get a good representation of a curved surface with fewer triangles by choosing an appropriate shading algorithm.

    Explain.

12. We can produce more realistic images by specifying the shapes of objects in our virtual worlds in greater detail. However, we might also achieve realism with less intricate geometry if we use texture maps.

    Explain.