

Light

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Apr. 15, 2013

1 Administrivia

Announcements

Assignment

Read 5.4–5.6.

From Last Time

RoomView lab.

Outline

1. Real world lighting.
2. A lighting model.
3. Types of shading.
4. The Phong reflection model.

Coming Up

More light on light.

2 Lighting in the Real World

1. Viewer, lights, objects.
2. Light properties?
3. Material properties: Translucence, reflectance (specularity), scattering (diffusion). Examples? Color of an object.
4. How do lights and materials interact?
5. The rendering equation. Calculation for each point in a scene.
6. Need a balance between accuracy and efficiency.
7. Local vs. global lighting. The graphics pipeline.

3 A Lighting Model

1. General illumination function for a light source: $I(x, y, z, \theta, \phi, \lambda)$.
2. Types of modeled light sources:
 - (a) Ambient light
 - (b) Point sources
 - (c) Spotlights
 - (d) Distant light sources

3.1 Color Sources

1. Illumination function is a continuous function of wavelength.
2. Complex computation, vision model.
3. Luminance function:

$$\mathbf{I} = \begin{bmatrix} I_r \\ I_g \\ I_b \end{bmatrix}$$

3.2 Ambient Light

1. Uniform light — “background” light.
2. Model:

$$\mathbf{I}_a = \begin{bmatrix} I_{ar} \\ I_{ag} \\ I_{ab} \end{bmatrix}$$

3.3 Point Sources

1. Emits light equally in all directions.
2. Assume point source at \mathbf{p}_0 . Color vector:

$$\mathbf{I}(\mathbf{p}_0) = \begin{bmatrix} I_r(\mathbf{p}_0) \\ I_g(\mathbf{p}_0) \\ I_b(\mathbf{p}_0) \end{bmatrix}$$

3. Illumination at \mathbf{p} due to \mathbf{p}_0 ? Depends upon square of distance:

$$\mathbf{I}(\mathbf{p}, \mathbf{p}_0) = \frac{1}{\|\mathbf{p} - \mathbf{p}_0\|^2} \mathbf{I}(\mathbf{p}_0)$$

4. High contrast harshness due to shadow effects: umbra, penumbra.
5. In practice, replace inverse square term with

$$a + bd + cd^2$$

where d is the distance and a , b , and c are constants chosen to soften.

3.4 Spotlights

1. Simple spotlight: point source with light emitted only through narrow range of angles.
2. Consider the source at \mathbf{p}_s to be restricted by the cone described by \mathbf{l}_s and θ .
3. For accuracy, distribution within the cone is modeled by $\cos^e\phi$.

3.5 Distant Light Sources

1. Re-calculating the $\mathbf{p}_0-\mathbf{p}$ vector.
2. If the distance is “large” how much does the vector change?
3. Replace source location with source direction:

(a) Near source: $\mathbf{p}_0 = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$ (a point)

(b) Far source: $\mathbf{p}_0 = \begin{bmatrix} x \\ y \\ z \\ 0 \end{bmatrix}$ (a vector)

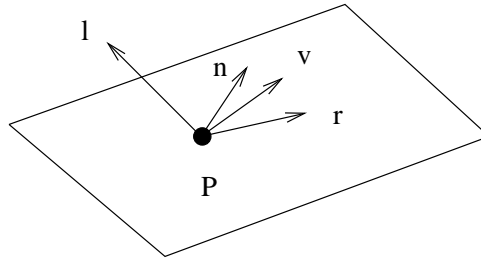
4 Shading

1. Flat shading: each point on a polygon assigned same color.
2. Gouraud (smooth) shading: assign colors individually to vertices, interpolate.

5 The Phong Reflection Model

1. Consider an object point, \mathbf{p} and a light source \mathbf{p}_i .

2. Important vectors:



(a) l : vector to light source.

(b) n : surface normal.

(c) v : vector to COP.

(d) r : reflection vector.

3. The light from source to object can be described by:

$$\mathbf{L}_i = \begin{bmatrix} L_{ira} & L_{iga} & L_{iba} \\ L_{ird} & L_{igd} & L_{ibd} \\ L_{irs} & L_{igs} & L_{ibs} \end{bmatrix}$$

(theoretically wrong but, in practice, right)

4. Using material properties, distance from viewer, orientation of surface and direction of source a reflection matrix can be constructed:

$$\mathbf{R}_i = \begin{bmatrix} R_{ira} & R_{iga} & R_{iba} \\ R_{ird} & R_{igd} & R_{ibd} \\ R_{irs} & R_{igs} & R_{ibs} \end{bmatrix}$$

5. (Simplified) Illumination at \mathbf{p} :

$$I = I_a + I_d + I_s = L_a R_a + L_d R_d + L_s R_s$$

A global ambient term may be “thrown” in.