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Engineering • Technology • Creativity

Computer Graphics

Illumination Models
(Surface Rendering)

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Chapter Description

- Aims
  - Basic of Computer Graphics.

- Expected Outcomes
  - Understand the basic concept of computer graphics. (CO1: Knowledge)
  - Ability to use the computer graphics technology. (CO1: Knowledge)

- References

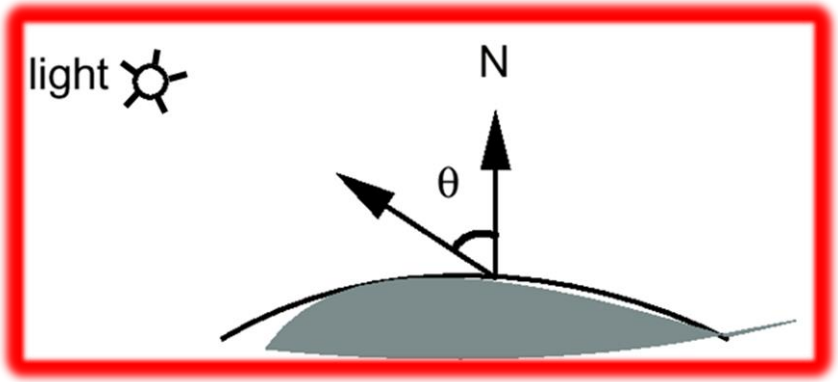
  - Donald Hearn & M. Pauline Baker, Computer Graphics with OpenGL, 4th Edition, Boston : Addison Wesley, 2011.
  - Computer Graphics by Zhigang Xiang, Schaum's Outlines.

Illumination Model

- An illumination model
  - ✓calculate the **intensity of light** that we should see at a given point on the surface of an object.
    - Done by simulating some light attributes
- Can be
  - Local illumination
  - Global illumination

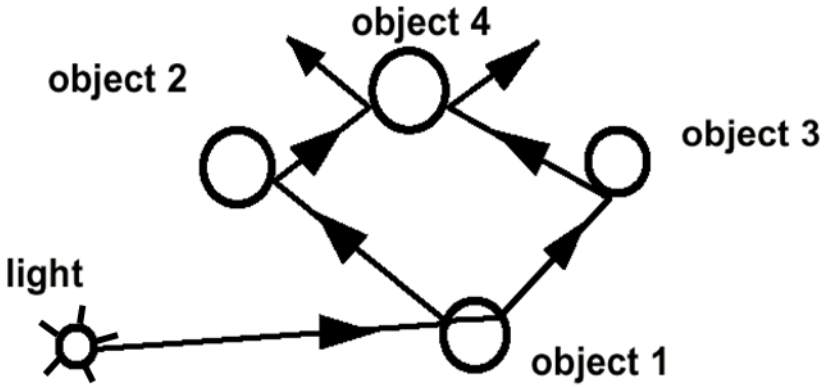
Illumination Model

- Local illumination
  - Models only the direct illumination from the source
  - Based on the light, the observer position, and the properties of the object material



Illumination Model

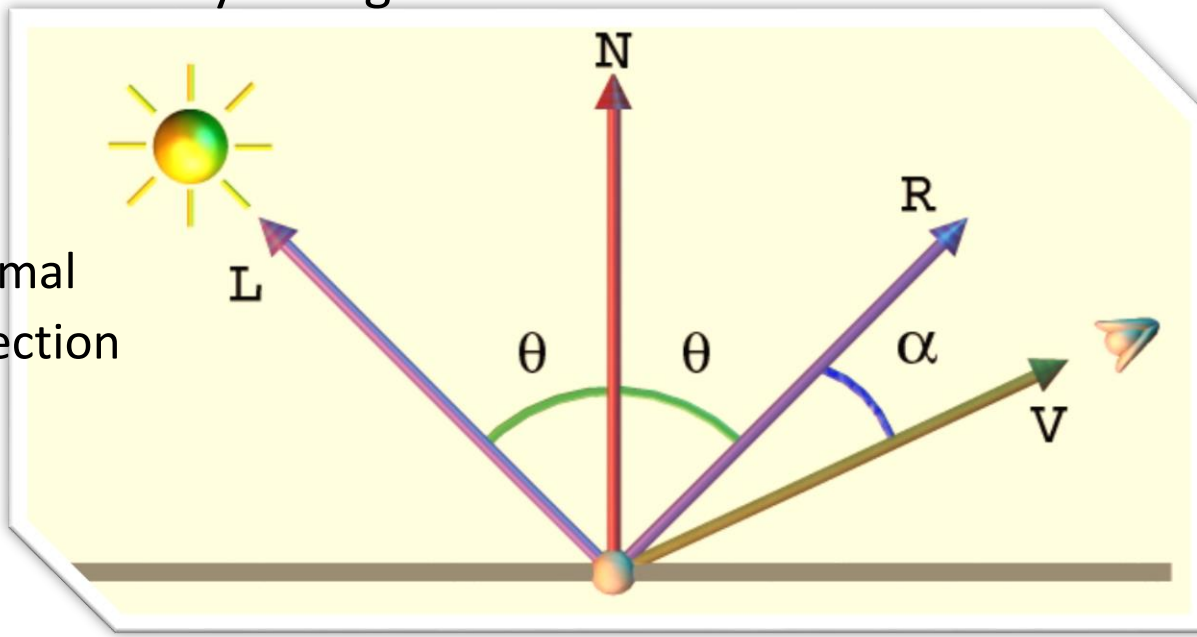
- Global illumination
  - take into account the interaction of light from the bouncing of the another objects
  - consider all the surfaces in the scene



Model functions

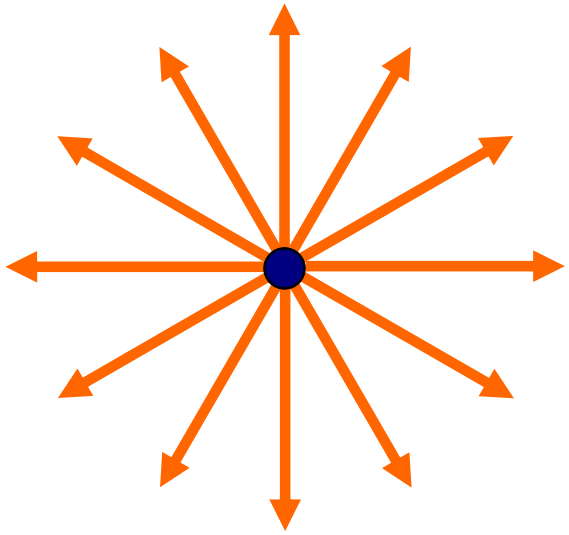
- Light sources
  - Determine the color, intensity, lines through space
- Reflection of light
  - How much the reflection angle
    - How are color and intensity changed

L: direction to light
N: normal vector
R: reflection of light about normal
V: direction to viewer (i.e. reflection direction of interest)



Point Light Sources

- Simplest model
- Emits equal intensity in all direction

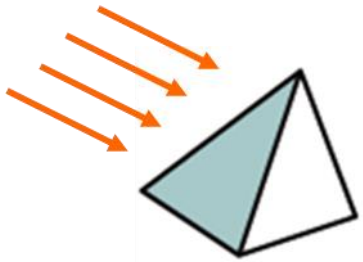


Directional Light Sources

- Infinitely distant light source, like the sun, can be modelled as a point light source
- Consider directional effect of all light rays because these rays seems parallel for its distance.

Definied by:

- direction (x,y,z)
- intensity (r,g,b)



L = -direction

Intensity Attenuation

- Intensity diminished for light because of the distance of the light source

- Intensity diminished by a factor of $1/d^2$ where distance *d*

Intensity Attenuation

$$f_{\substack{\text{radial}\\ \text{attenuation}}}(d) = \begin{cases} 1.0, & \text{source at infinity} \\ \dfrac{1}{a_0 + a_1 d + a_2 d^2}, & \text{local source} \end{cases}.$$

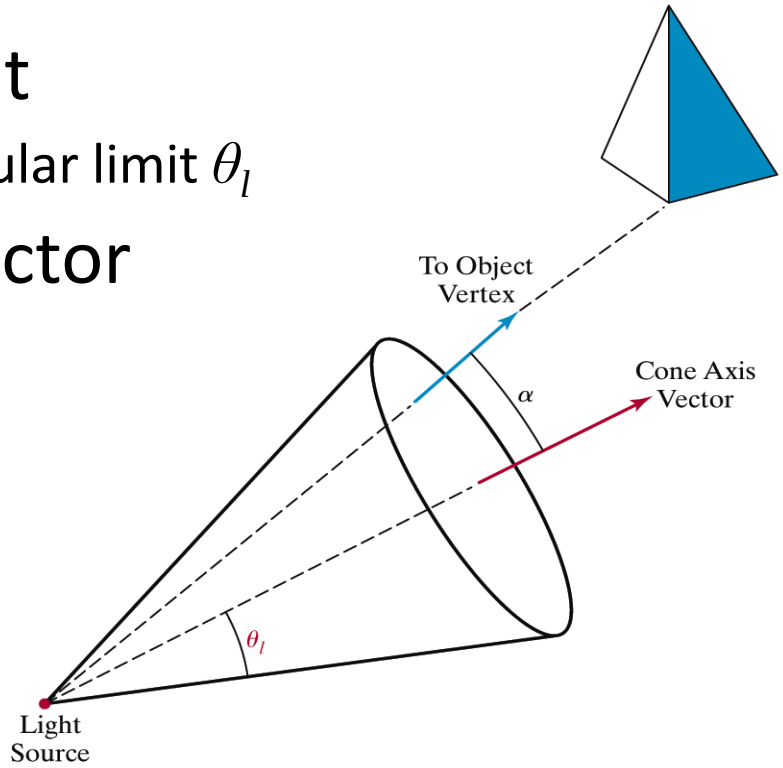
- A user can adjust the coefficients a_o, a_1, and a_2 , to obtain a variety of lighting effects
- If *d* is very small then constant term, a_o need to be adjusted to prevent *f(d)* become too large.

Spotlights

- Point light source to a spotlight
  - ✓add a vector direction and an angular limit θ_l
- If V_{light} and V_{obj} are the unit vector

Then

$$V_{obj} \cdot V_{light} = \cos\alpha$$

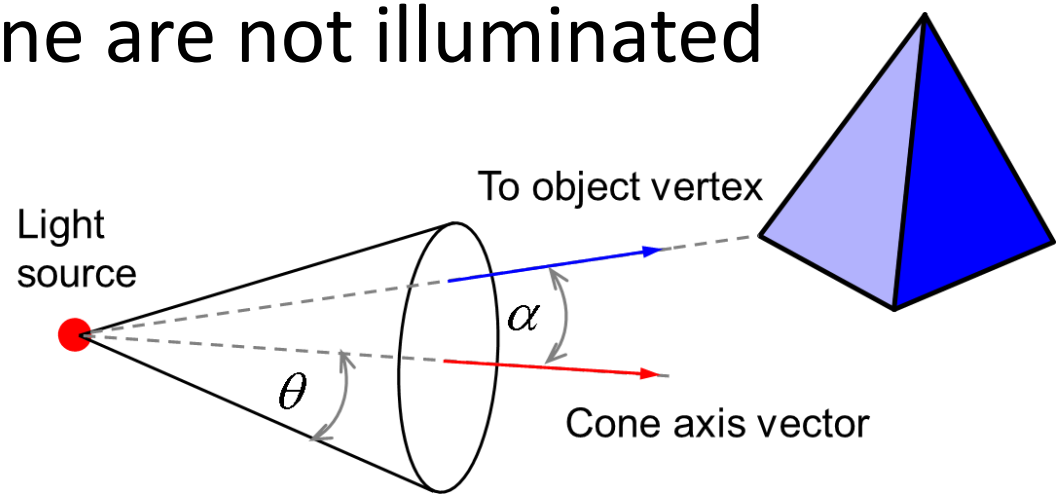


Reference: Donald Hearn & M. Pauline Baker, Computer Graphics with OpenGL

- If this angle is restricted with the θ_l , then the object is within the spotlight.

Spotlights - Angular Intensity Attenuation

- Points outside the cone are not illuminated (stay in dark).



$$f_{\substack{\text{angular}\\\text{attenuation}}}(\alpha) = \begin{cases} 1.0, & \text{source not a spotlight} \\ 0.0, & \mathbf{V}_{\text{obj}} \cdot \mathbf{V}_{\text{light}} = \cos\alpha < \cos\theta \\ \left(\mathbf{V}_{\text{obj}} \cdot \mathbf{V}_{\text{light}}\right)^{a}, & \text{otherwise} \end{cases}$$

where a is a constant