CS4533 Lecture 8.2
Slides/Notes

Shading and Illumination (Notes, Ch 14)

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Shading and Illumination

We need light-material interactions to produce realistic-looking images.
(photo-realistic images)

Color Cube : R.G.B color mode.

Green (0,1,0)   (1,1,0) Yellow
(0,1,1)   (1,1,1) white
cyan
(0,0,0) Black
(1,0,0)
B   Red   (0.5, 0.5, 0.5) : gray
(0,0,1) (1,0,1)   (0.7, 0.8, 0.2) ?
Blue   Magenta = (0.2, 0.2, 0.2) + (0.5, 0.6, 0)
                    brightness   Yellowish

✳ 3 Types of surfaces:

1. specular surfaces: shiny
   most reflected lights are
   scattered in a narrow range of
   angles. eg. Mirrors, metals.

2. Diffuse Surfaces : reflected
   lights are scattered in all
   directions.
   eg. Walls with flat paint.

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3. <u>Translucent Surfaces</u> : allow some lights to penetrate.
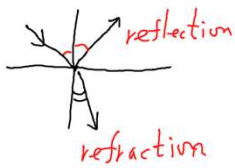
(refraction of lights)

reflection

refraction

eg. glass, water

* 4 Types of Light Sources

- Describe a light source with a 3-component intensity function.

$$I = \begin{bmatrix} I_r \\ I_g \\ I_b \end{bmatrix}$$ I_r, I_g, I_b : intensity of <u>independent</u> red, green, blue

components.

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1. <u>Ambient Light</u> : uniform lighting (eg. classroom background lighting)

$$I_a = \begin{bmatrix} I_{ar} \\ I_{ag} \\ I_{ab} \end{bmatrix}$$ <u>I_a is identical</u> at <u>every point in the scene.</u>

2. <u>Distant Light Source</u> : light source is far away from the surface.

parallel light rays from the light source.

Specify the parallel ray vector V.

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3. <u>Point Source</u>: emits light rays equally in all directions

Let P_0 be the location of the point source.

$$I(P_0) = \begin{bmatrix} I_r(P_0) \\ I_g(P_0) \\ I_b(P_0) \end{bmatrix}$$
Intensity at point P: $I(P, P_0) = \dfrac{1}{|P-P_0|^2} I(P_0)$

Intensity $\propto \dfrac{\#\ rays}{area}$

$\dfrac{k\ rays}{4\pi d^2}$ (fixed k)

$\propto \dfrac{1}{d^2}$

Total: emitting k rays in all directions. Total sphere area $= 4\pi d^2$.

* <u>Define</u>: $|P - P_0| = d$.
$I(P, P_0) = \dfrac{1}{d^2} I(P_0)$

* $\dfrac{1}{d^2}$ gives very <u>high contrast</u>. (bright or dark)

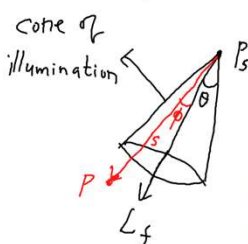* In real world, sources are larger $\Rightarrow$ softer scenes.

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* In real world, light sources are larger $\Rightarrow$ softer scenes.

$\Rightarrow$ usually we replace $\dfrac{1}{d^2}$ by $\dfrac{1}{a + bd + cd^2}$ where a, b, c are constants. We can adjust a, b, c to get more realistic effect.

$\left(\dfrac{1}{d^2} \text{ is a special case with } a=b=0, c=1 \right)$

4. <u>Spotlights</u>: The light has a narrow range of angles thru which the light is emitted.

cone of illumination

P_s: spotlight position
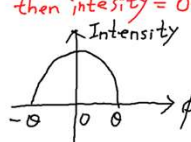L_f: focus direction
θ: cutoff angle $\in (0, 90°]$

P: position of pt P being lit.
$S = P - P_s$: vector from P_s to P.

Intensity is attenuated by $(\cos\phi)^e$ $(e > 1)$ when $\phi \le \theta$
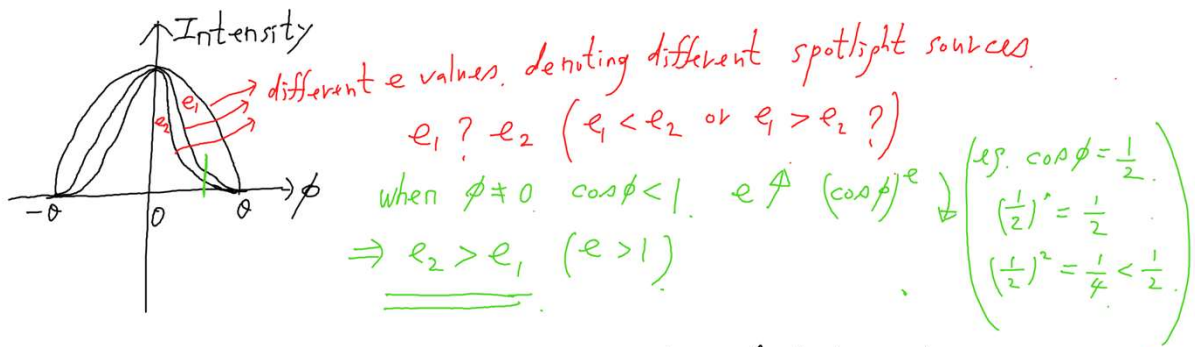
If $\phi > \theta$ then intensity $= 0$

e: spotlight exponent. describes how quickly the intensity drops off
ϕ: if $|L_f| = |S| = 1$
$L_f \cdot S = \cos\phi$.

↑ Intensity

→ different e values, denoting different spotlight sources.

e_1 ? e_2 ($e_1 < e_2$ or $e_1 > e_2$?)

when $\phi \neq 0$ $\cos\phi < 1$, $e \uparrow (\cos\phi)^e \downarrow$

$\Rightarrow e_2 > e_1$ ($e > 1$)

(e.g. $\cos\phi = \frac{1}{2}$

$(\frac{1}{2})^1 = \frac{1}{2}$

$(\frac{1}{2})^2 = \frac{1}{4} < \frac{1}{2}$)

$-\theta$ 0 θ → ϕ

__Phong Reflection Model__ : describes material-light interactions.

3 types of { material-light interactions / reflections } :
1. ambient reflection
2. diffuse "
3. specular "

3 components of the model (to be added together)

(Next class)

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