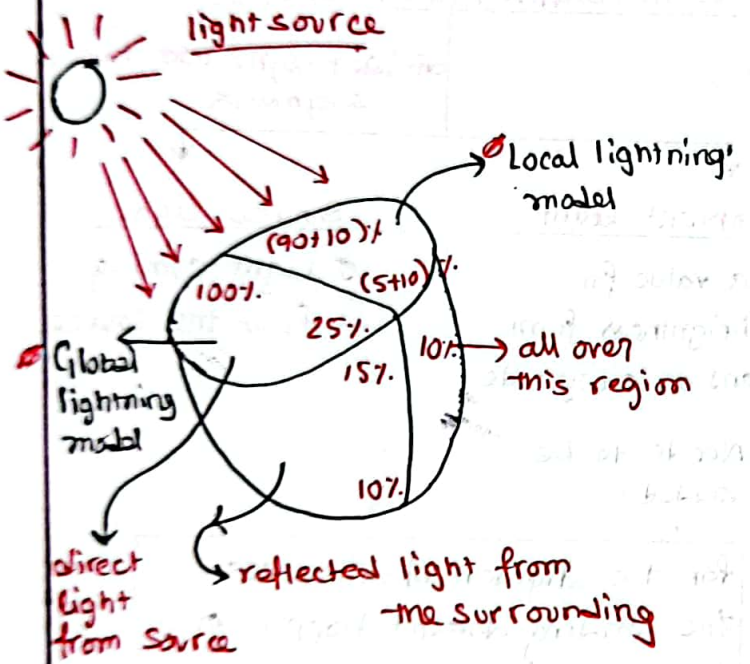
ILLUMINATION MODEL

LECTURE 14

- To observe the shape of an object, it is important to study how the light is being reflected off of it.



- The variation in the brightness of certain regions can occur due to to surface orientation, this phenomena is known as **shading**

(i) So the differences in brightness of certain regions in an object that can explain the shape is known as **shading**

(ii) But, light being blocked is called **shadow**

LIGHTNING MODELS

This model has no difference in source light, but in the light that comes from reflection.

GLOBAL LIGHTNING MODEL

- acknowledges all reflected light and their intensities, and then integrates them.
- light from source + light from reflection
- extremely complex calculation.

↓

(drawback)

LOCAL LIGHTNING MODEL

divides light into two segments.

Ambient light

- a value for brightness from and on every side
- Needs to be added.
- for the slightest of differences the shading doesn't happen, or isn't visually distinctive, hence it eventually fails to create shape.

↓

(drawback)

Source light

- light coming from the source

(PROS & CONS)

leads to higher per pixel accuracy

- only one source
- calculates multiple deflections to determine the brightness of a pixel.
- very slow, due to complex calculation
- high accuracy

Know as:

- Recursive Ray tracing Algorithm

- source is divided into two segments
- uses ambient lightning
- faster in terms of calculation, as it is less complex
- has lower accuracy and final result may be a little blant.

- Phong's lightning Model Algorithm.

LOCAL LIGHTNING MODEL

(1) **Ambient Light :** (a constant uniform light that illuminates the object at every point).

- I_a → Intensity of ambient light
- K_a → absorption coefficient (Ratio of reflected light vs incident light)
- I → Intensity of light reflecting from a point

(*) Higher K_a means brighter object. (more the intensity of reflected light, the brighter the point)

$$I = K_a I_a \quad \text{----- (i)}$$

$$K_a = I / I_a$$

Ex:

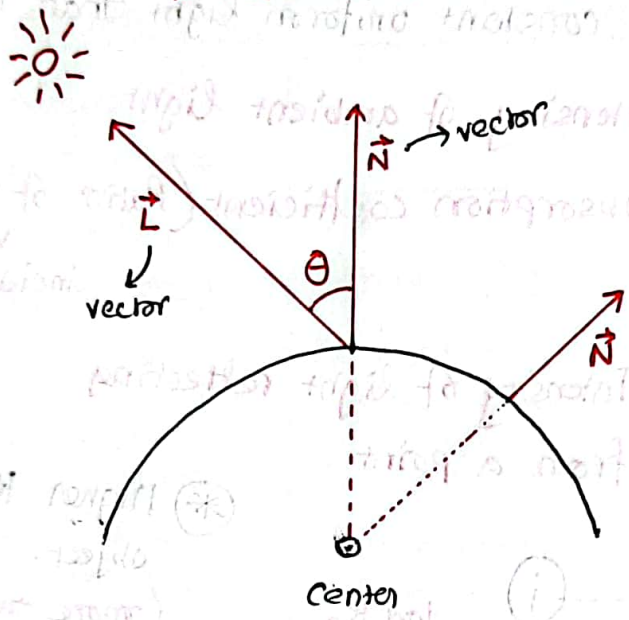
(2) **Source Light :** (Light coming directly from the source, and has a direction)

as stated it is divided into two segments

- Lamberts lightning model (Rough surface) / Diffuse Reflection
- Phong's lightning model (Even surface) / Specular Reflection.

① LAMBERT'S LIGHTNING MODEL (Diffuse Reflection)

Ø Reflection from rough surface.



$$I = K_d I_s \cos\theta \quad \text{---- (ii)}$$

$$= K_d I_s \cdot \hat{N} \cdot \hat{L} \quad \text{---- (iii)}$$

Normalised vectors.

I = Intensity of Reflected light

I_s = Intensity of Source light

K_d = Absorption coefficient of rough surface/object.

θ = the angle between surface normal & light source.

$\vec{N}$ = surface normal vector

$\vec{L}$ = light source vector.

Formula

$\vec{a}$ → vector a

$\vec{b}$ → vector b

How to find angle between the vectors? θ?

$$\vec{a} \cdot \vec{b} = |a| \cdot |b| \cos\theta$$

↓

dot product.

$$\vec{a} \cdot \vec{b} = (a_i \times b_i) + (a_j \times b_j) + (a_k + b_k)$$

$$|\vec{a}| = \sqrt{a_i^2 + a_j^2 + a_k^2}$$

Q In diffuse reflection given $\vec{N} = 2\hat{i} + 3\hat{j} + 5\hat{k}$ & $\vec{L} = \hat{i} + 2\hat{j} + \hat{k}$, find the angle between the vector $\vec{N}$ & $\vec{L}$?

Ans We know,

$$\vec{N} \cdot \vec{V} = |N| \cdot |V| \cdot \cos\theta$$

$$|N| = \sqrt{2^2 + 3^2 + 5^2} = \sqrt{38}$$

$$|L| = \sqrt{1^2 + 2^2 + 1^2} = \sqrt{6}$$

$$\vec{N} \cdot \vec{V} = (2 \times 1) + (3 \times 2) + (5 \times 1) = 13$$

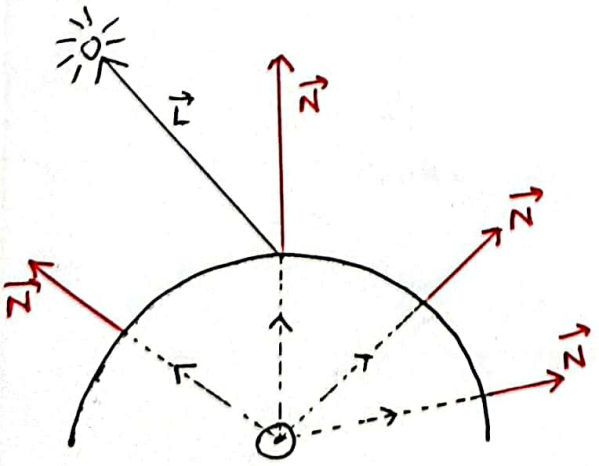
$$\therefore \cos\theta = \frac{13}{\sqrt{38} \times \sqrt{6}} = 0.861$$

$$\Rightarrow \theta = 30.58^\circ \text{ (Ans:)}$$

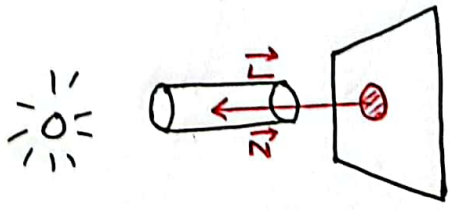
Ø $\vec{N}$ = direction of line from center to surface (for circles).

at $\theta = 0$, {the point is at maximum brightness}

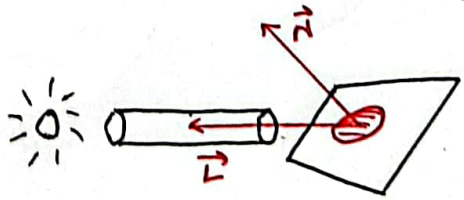
↳ as $\cos(0) = 1$,



(i)



$\theta = 0$,



θ has a value

Ø as the angle between $\vec{L}$ & $\vec{N}$ increases the intensity of light per unit decreases.