Unit-5

Date
Page

VISUAL REALISM

Illumination and Shading Methods

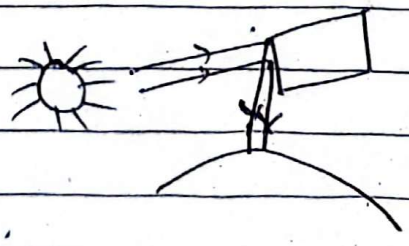
- Illumination model (Lighting Model) :- Describes how light interacts with surface to simulate realistic lighting effects.

→ It is used to calculate the intensity of light that we should see at a given point on the surface of an object.

(i) Ambient Illumination / Diffuse Illumination { surface orientation, independent viewer location

→ Assume there is some non-directional light in the environment (background light).
→ The amount of ambient light incident on each object is constant for all surface and overall directions.
→ It is very simple model, not very realistic
→ The reflected intensity I_{amb} of any point on the surface is:

$$I_{amb} = k_a I_a$$

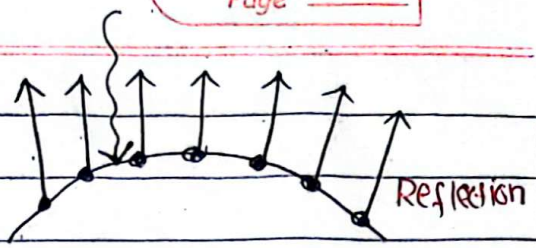


I_a → ambient light intensity,
$k_a \in [0,1]$ → surface ambient reflectivity

E.g: Think of walking into a room during the daytime with curtains drawn but no direct sunlight. The room is softly lit everywhere - that's ambient light.

Date
Page

(ii) Diffuse Reflection Model



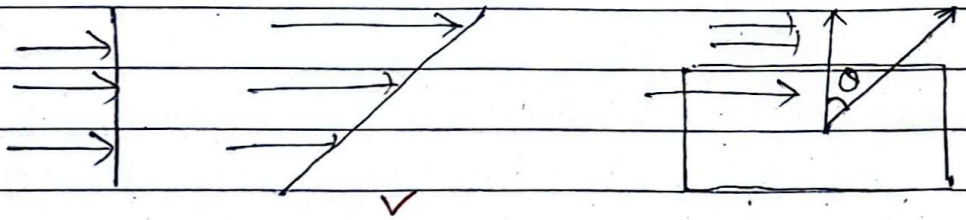
→ Object illuminated by only ambient light have equal intensity everywhere.

→ If there is a light source then different object should have different intensities based on distance and orientation w.r.t light source & viewer position.

→ A point on a diffuse surface appears equally bright from all viewing position because it reflects light equally in all directions.

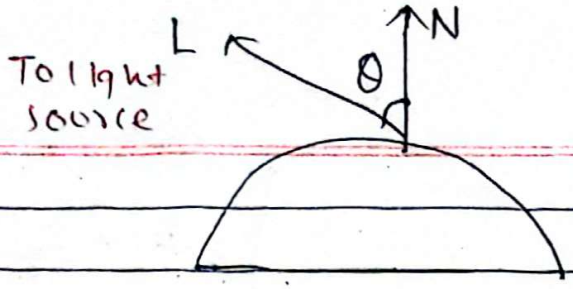
→ which means intensity is independent of position of viewing. The intensity of a point on a diffuse depend on the orientation of the surface w.r.t the light source and the distance to the light source.

→ Diffuse reflection model follows 'Lamberts cosine rule'.



- This Law states that when light falls obliquely on a surface, the illumination of the surface is directly proportional to the cosine of the angle θ between the direction of the incident light and the surface normal N.

i.e $I \propto \cos\theta$.



Angle of incidence between the unit light source direction vector L and the unit surface normal N

N → Unit normal vector to a surface
L → Unit direction to the point light source from a position on the surface.

- If I_L is the intensity of the point light source, then:

The diffuse reflection equation for a point on the surface can be written as:

$$I_{L,diff} = k_d I_L (O)\theta \qquad N \cdot L = |\vec{N}||\vec{L}| (O)\theta$$

(1) (2) unit vector

or

$$I_{L,diff} = k_d I_L (N \cdot L) \quad [\because (O)\theta = N \cdot L]$$

- If light source is at infinite distance from the object then L will be same for all points on the object, the light source becomes a directional light source.

$$\boxed{I_{diff} = k_a I_a + k_d I_L (N \cdot L)} \qquad k_a, k_d \in [0,1]$$

(iii) Specular Reflection Model / Phong-Specular - -

→ Whenever light surface produces highlights or bright spots, then the light effect is known as specular reflection.

→ Reflectance intensity changes with reflected angle.

→ An ideal specular surface is mirror which reflects light exclusively in one direction.

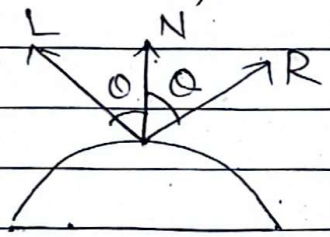
→ Specular reflection is the result of total or near total reflection of the incident light in a concentrated region around the specular reflection angle.

$$I_{sp} = I_s k_s (\cos\phi)^n$$

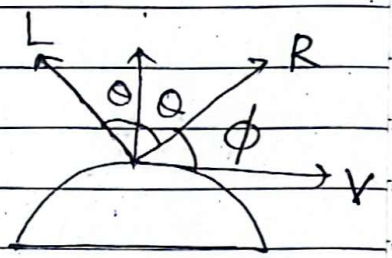
n → specific intensity

$\cos\phi = R \cdot V$

& $R = (2N \cdot L)N - L$



Ideal specular Surface



Non-Ideal specular Surface

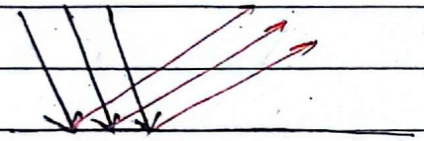
R → Unit vector in the direction of ideal specular reflection.

L → Unit vector directed towards the point light source

V → Unit vector pointing to the viewer from surface position.

ϕ → Viewing angle relative to specular reflection direction R.

4 (a)

Specular Reflection	Diffuse Reflection
(i) All the light travelling in one direction and reflection from the mirror is reflected in one direction.	(i) The rays incident at slightly different points on the surface are reflected in completely different direction.
(ii) Smooth, shiny surface.	(ii) Rough, dull surfaces.
 Smooth surface	 rough surface:
(iii) Visible only from certain angles, depending on the viewer's position.	(iii) Visible from all directions, regardless of the viewer's position.
(iv) ~~Provide~~ Produces bright spots or highlights.	(iv) Produce even, soft-lighting without bright spots.
(v) Highly dependent on the angle of incidence and reflection.	(v) Independent of specific angle of ~~re~~ incidence.
(vi) Eg: Mirror, polished metal, calm water surface.	(vi) paper, wall, cloth or a matte-painted surface.