Shading

3D Pipeline

Object Representation
First Stage

Local co-ordinates

Local to world co-ordinate.

Scan conversion / Device to screen co-ordinate
5th Stage.

Modeling Transformation
(2nd Stage)

→ World co-ordinate.

Viewing Transf.

Lighting (3rd stage)

World co-ordinate to View co-ordinate.

Clipping

Hidden Surface Elimination.

Projection Transformation.

Viewing Pipeline
4th Stage

Window to View Port Transformation

→ Lighting models actually compute color of various intensity values. (real nos)

(continuous values)

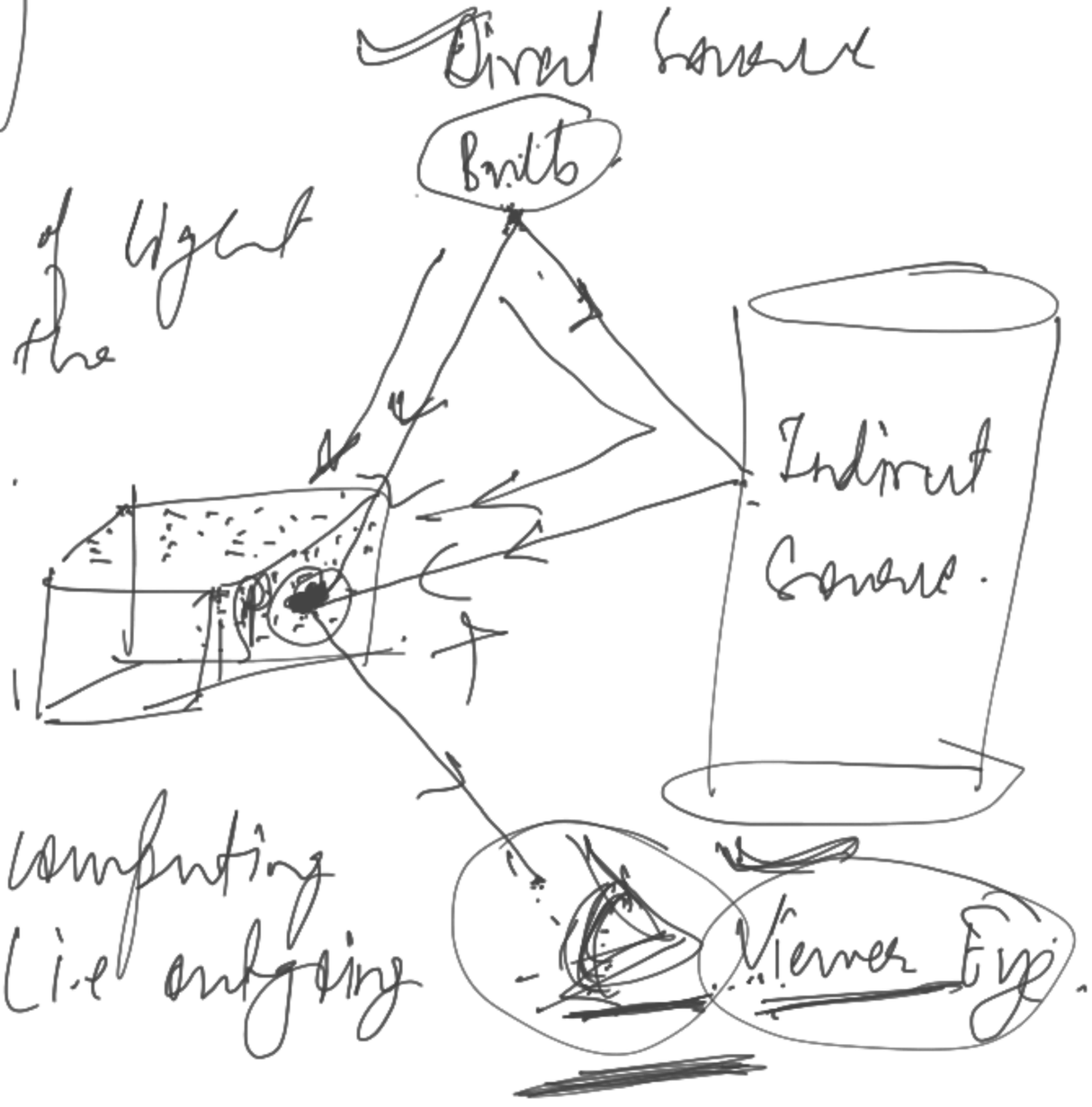
→ ① computing intensity values based on lighting model

② mapping continuous values to some discrete representation.

Idea of Color

Illumination :- Transfort of light energy from source to the point is called illumination.

Lighting :- The process of computing the luminous intensity (i.e outgoing light) at a point.



Shading :- (Interference Rendering) → assigning colors to pixel.

[Lighting & Shading] both are same.

→ Both are refering to the process of computing outgoing light (the color) at a point.

Difference :- Different ways of computing colors at a point.

Lighting :- It refers to color computation of a point

- Light source
- Surface properties

→ Complex computation

→ Time taking

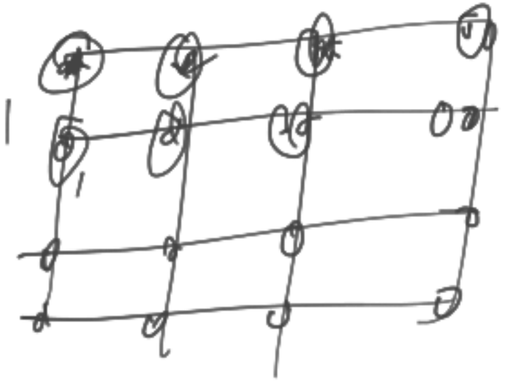


Fig.

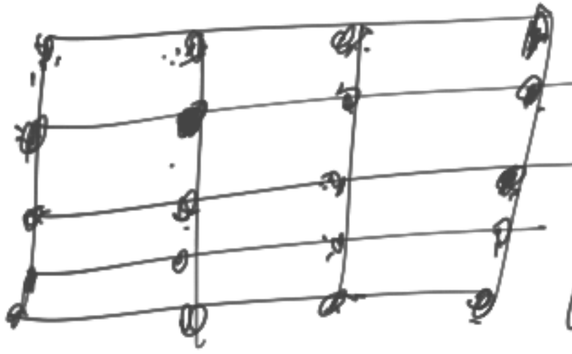
Ub

① We are going to map the surface points to pixel

② Then use lighting model to compute color for a selected no of pixels (surface points).

→ Interpolation of colors for remaining pixels.

→ Less computationally expensive.



16 rays

1/2 or 2 pixels.

→ Shading :- Interpolation based process of pixel coloring.

- What affects color

① Properties of light source

② Surface Prop.

- Point Light Source
- Spot Light / Directional Source
- Ambient Light

Simple Lighting Model :-

- Compute colors at the surface points.
- Light reflected from the point is a result of two incident lights.
  - One coming from source (Direct Source)
  - Another one coming from cylinder (Ambient Light)

Reflected Light Intensity = Sum of intensities of ambient & direct reflection.

→ Reflection:- (1) Diffuse Reflection
(2) Specular Reflection.
(3) Ambient Reflection

Diffuse Reflection

Equal reflect

due to direct light → DIFFUSE (Lighter shade)

due to ambient light → AMBIENT (Darker shade)

Specular Reflection

- Specific direction
- Shiny (smooth surface)
- Direct light

Intensity Calculation :- Intensity at the surface point is calculated as sum of three intensities -

$$I_p = I_{amb} + I_{diff} + I_{spl}.$$

→ Reflected light intensity is function of

incident light intensity

Surface property → Reflection coefficient or Reflectivity.

- Diffuse reflectn coefficient for ambient light = k_a
  " " " " direct light = k_d
  Specular " " " direct light = k_s

It can vary from (0.0 to 1.0)

0.0 → Representing dull surface with no reflection

1.0 → " shiny surface that reflects almost all the incident light.

- Ambient Light Model :-

$I_{amb} = k_a \cdot I_a$

I_a → Incident light.

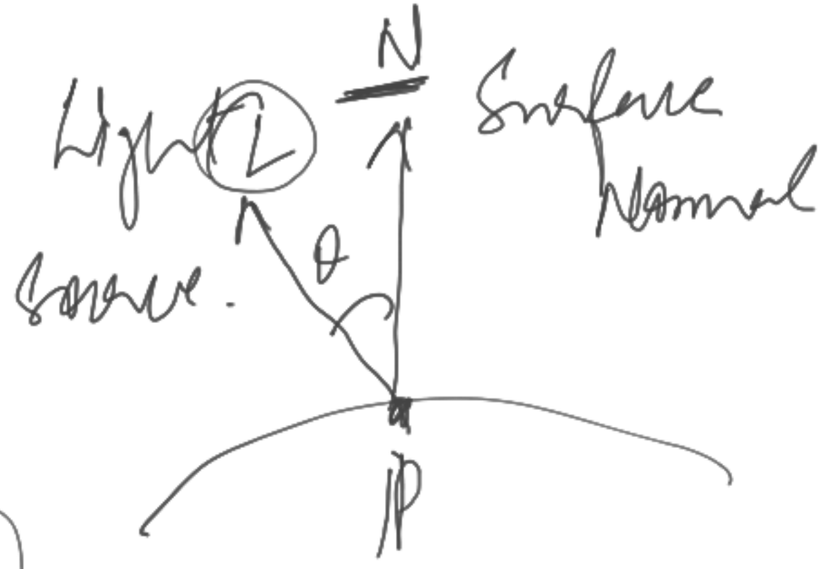
↓

I_{eff}.

$$I_{amb} = k_a \cdot I_a$$

- Diffuse Reflection Model :-

Lambert's Law :-



$$I_{diff} = k_d \cdot I_{light}$$

$$I_{diff} = k_d \cdot I_s \cos\theta$$

$$I_{diff} = \begin{cases} k_d \cdot I_s (\hat{N} \cdot \hat{L}) & \text{if } \hat{N} \cdot \hat{L} > 0 \\ 0 & \hat{N} \cdot \hat{L} \leq 0 \end{cases}$$

- Specular Reflection Model :- Phong Reflection model.
  - $I_{spec} \propto I_s \cos^{n_s}\phi$ $(0 < \phi < 90^\circ)$
  - n_s → Specular reflection coeff.
    - → Generate different effect

> 100 → shiny surface effect

1 generate rough surface effect.

$I_{spec} \propto I_s . \cos^{n_s} \phi$

$$I_{spec} = K_s . I_s . \cos^{n_s} \phi .$$