

Transparency and Shadows

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Illustration Models and Surface Rendering Methods

➤ Transparency

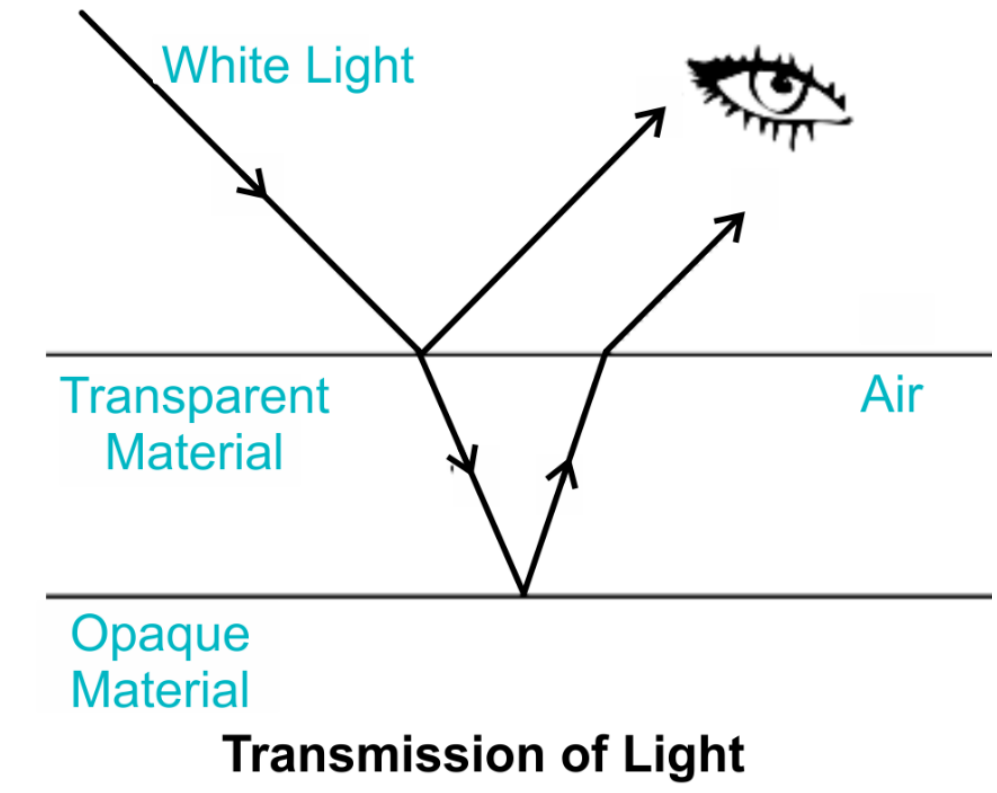
➤ Shadows

Transparency

- Transparency refers to the property of an object or an image that allows it to appear partially see-through or let light to pass through certain areas.
- When an object or pixel is transparent, the background behind it becomes visible, creating the illusion of blending or compositing with other elements in the scene.

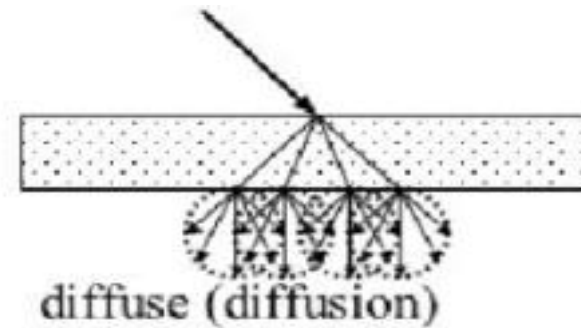
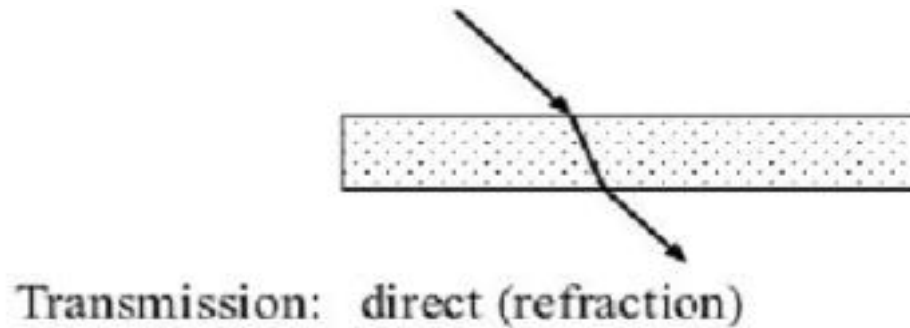
Reflected and Transmitted Light Through Transparent Surface

- A transparent surface produces both reflected and transmitted light
- The contribution of transmitted light depends on:
 1. Degree of transparency .
 2. Presence of light sources or illuminated surfaces behind the transparent object .



Intensity equation for transparent surfaces

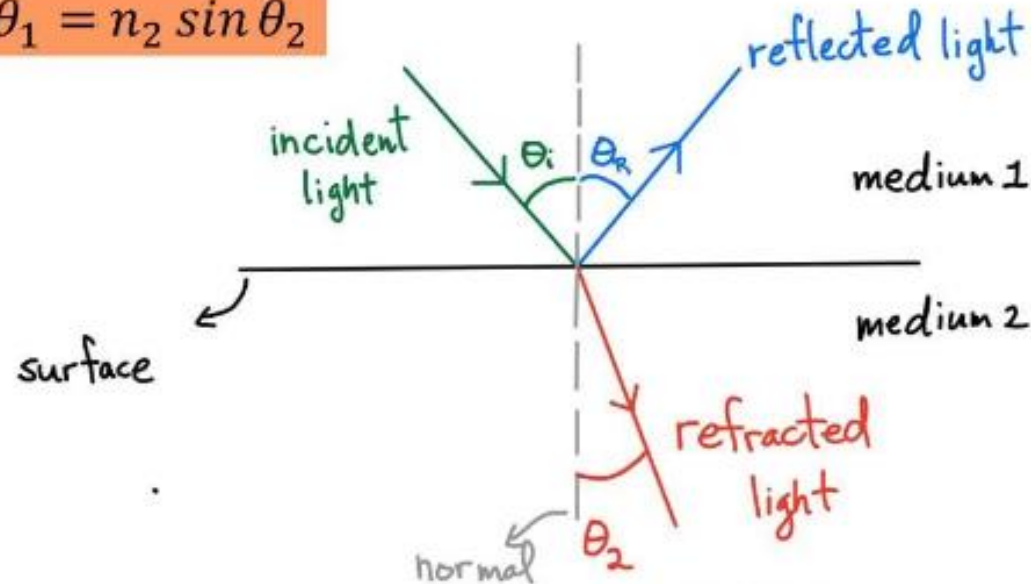
- Intensity equations include contributions from light passing through surfaces.
- Both specular and diffuse transmission can take place at the surface of the transparent object.



Intensity equation for transparent surfaces(cont)

- Realistic transparency effects are modeled by using the refraction of light.
- According to Snell's law:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$



Intensity equation for transparent surfaces(cont)

- Since the calculation of trigonometric functions in Snell's law is time consuming , we can obtain the unit transmission vector T in the refraction direction Q_r as:

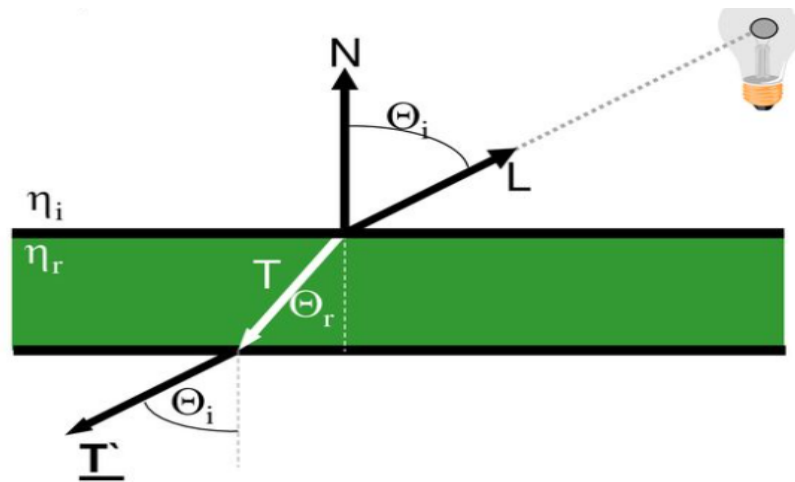
$$T = \left(\frac{\eta_i}{\eta_r} \cos \Theta_i - \cos \Theta_r \right) N - \frac{\eta_i}{\eta_r} L$$

- Where N is the unit surface normal
 - Where L is the unit vector in direction of light source
- Transmission vector \underline{T} can be used to locate intersections of the refraction path with objects behind the transparent surface. Including refraction effects in a scene can produce highly realistic displays by using Ray Tracing Algorithms.

Intensity equation for transparent surfaces(cont)

- Ray Tracing Algorithm

- A simpler procedure for modeling transparent objects by ignoring the path shifts altogether.
- This approach assumes there is no change in the index of refraction from one material to another, so that the angle of refraction is always the same as the angle of incidence. This method speeds up the calculation of intensities and can produce reasonable transparency effects.



$$T' \cong -L$$

The path is **shifted**

Intensity equation for transparent surfaces(cont)

- Transparency Simplifying Refraction:

- Assuming that there is no shift , we still have to account for
 - Reflection off transparent object
 - Partial light absorption by transparent object
- Let K_t be transparency factor then $(1-K_t)$ is the opacity factor

$$I = (1-k_t)I_{refl} + k_t I_{trans}$$

- Here , Total Surface Intensity(I) is calculated using above formula.

Implementing Transparency Effects

- Depth-Sorting Algorithms

- To handle transparency
- Combining reflected intensity with visible and opaque surfaces

- A-Buffer Algorithm

- For accurate transparency
- Sorting surface patches in depth order
- Combining intensities for overlapping surfaces

Uses of Transparency:

- Layering
- Textures and Patterns
- User Interface Design

Examples In Computer Graphics:

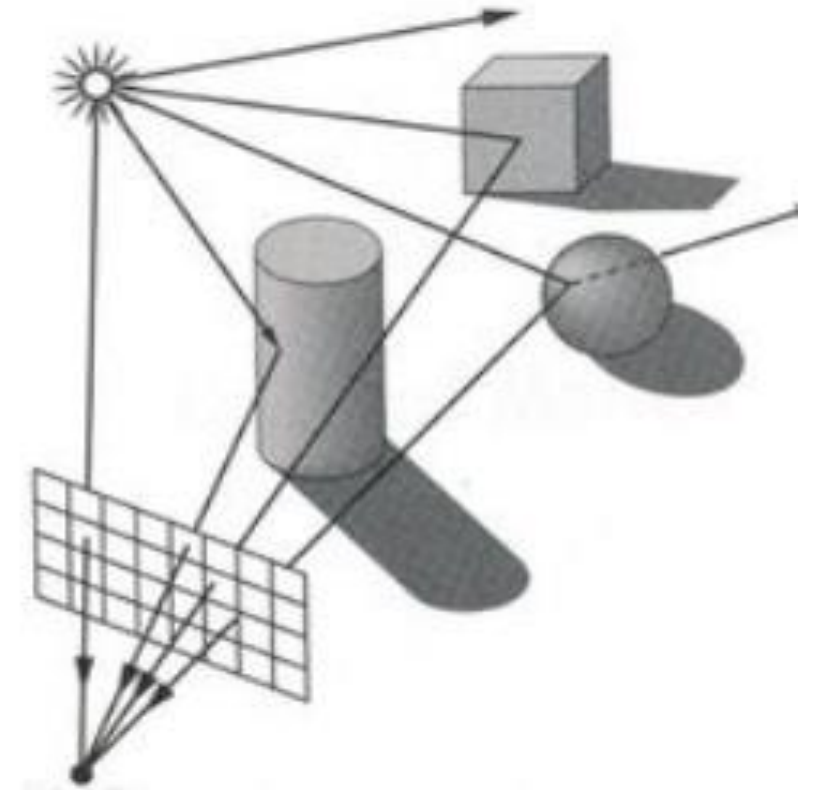
- Glass and Reflection
- Water Simulation

Shadow

- A shadow is a dark shape that is formed when an object blocks a source of light.
- Shadow is different from Shading.
- We apply hidden surface method to locate areas where light source at view position produces shadows.

Hidden Surface Method

- Shadowed Surface(Surface cannot be seen from light source).
- By applying a hidden-surface method with a light source at the view position, we can determine which surface sections cannot be "seen" from the light source.



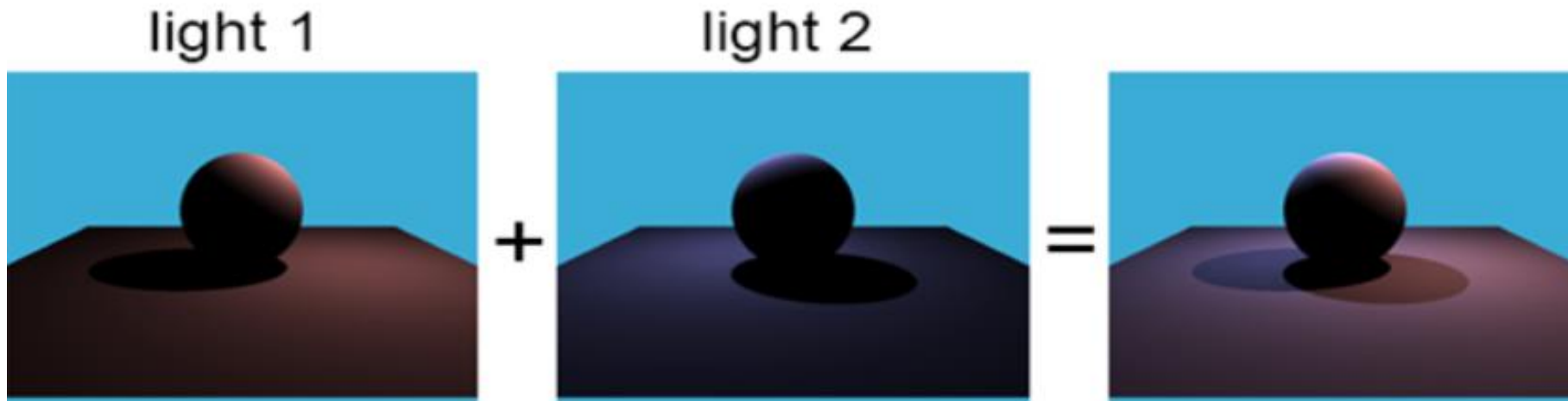
Effect of Light Source On Shadow

- Single Light Source

- Sharpness and Directionality
- Consistency
- Length and Intensity

- Multiple Light Source

- Softness and Blending
- Varying Intensities
- Color Mixing
- Multiple Shadows



Ambient Light for Shadows

- Displaying shadow areas with ambient-light intensity only or combining them with specified surface textures involves utilizing different lighting models and rendering techniques.
- By applying these methods, artists and designers can control the look and feel of shadowed areas in their visual projects, contributing to the overall aesthetics and realism of the final renderings.

Sources:

- Computer Graphics by Donald D. Hearn And Pauline Baker.
- Numerade , Pinterest for Images.
- ChatGPT for ideas and fulfilling information.
- Google was also used for this and that.

Thank you!!!