31. Ray Tracing-4: Witted Ray Tracing

11 April 2024 22:50

Source: 1. Ray Tracing Essentials, Part-1 to 7
By Nefi Alarcon, NVIDIA

2. 3D Computer Graphics Primer: Ray-Tracing as an Example

From <https://www.scratchapixel.com/lessons/3d-basic-rendering/introduction-to-ray-tracing/implementing-the-raytracing-algorithm.html>

In 1980,

Conventional Models uses Phong's model,

$$I = \underbrace{k_a I_a}_{\text{ambient}} + \underbrace{k_d I_e (L.N)}_{\text{diffuse}} + \underbrace{K_s I_e (R.V)^n}_{\text{specular reflection}}$$

⇒ This model does not account for objects within the scene acting as a light source or for light reflected from object to object

⇒ ambient ✓ diffuse ✓ hurts the quality of specular reflections

Witted Ray-Tracing :-

Different types of rays into a scene :-

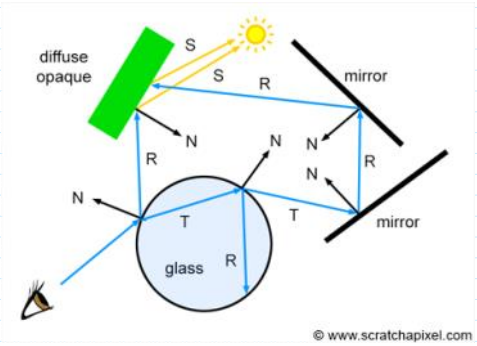
Primary Rays / Camera Rays :- Rays which origin from the camera and passes through the centers of the pixels.
If primary ray hits any geometry in the scene we compute the color of the object at the intersection point and assign this color to the pixel.

Secondary Rays :- Rays generated from primary rays at the ray's intersection point. The direction of these secondary rays depends on :

① Ray is in the direction of light → Shadow

② Ray is in the direction of reflection → Reflection

⑧ Ray is in the refraction direction → Refraction.



Case 2:- Opaque and diffuse → Phong Model

Also cast a ray in the direction of each light source to find if the point is in shadow. (Shadow rays).

Case 2:- Mirror-like surface

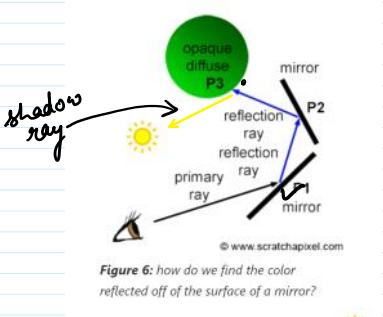


Figure 6: how do we find the color reflected off of the surface of a mirror?

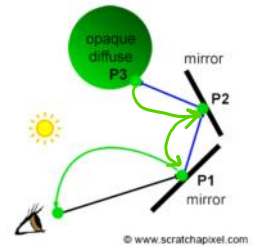


Figure 6: how do we find the color reflected off of the surface of a mirror?

$$I = \underbrace{k_a I_a}_{\text{ambient}} + \underbrace{k_d I_c (L \cdot N)}_{\text{diffuse}} + \text{"Fresnel Reflection Law"}$$

Case 3:- Transparent surface

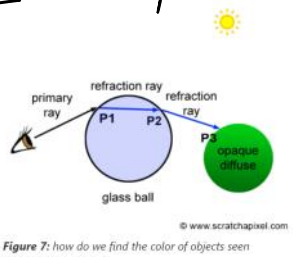


Figure 7: how do we find the color of objects seen through a glass ball?

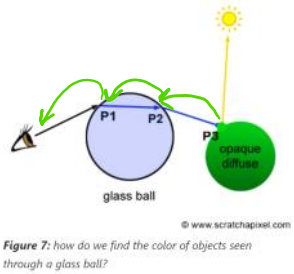


Figure 7: how do we find the color of objects seen through a glass ball?

$$I = \underbrace{k_a I_a}_{} + \underbrace{k_d I_c (L \cdot N)}_{} + \text{"Snell's law"}$$

ambient diffuse

Recursivity :-

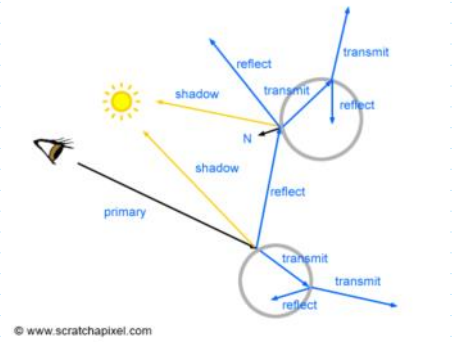


Figure 8: *Whitted algorithm is recursive.*

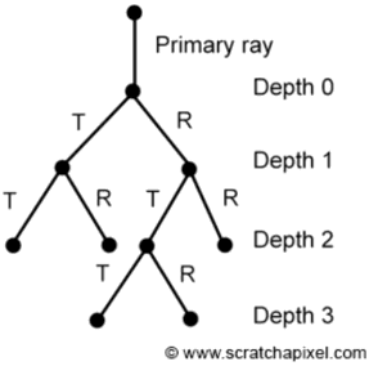


Figure 9: *a tree of rays.*

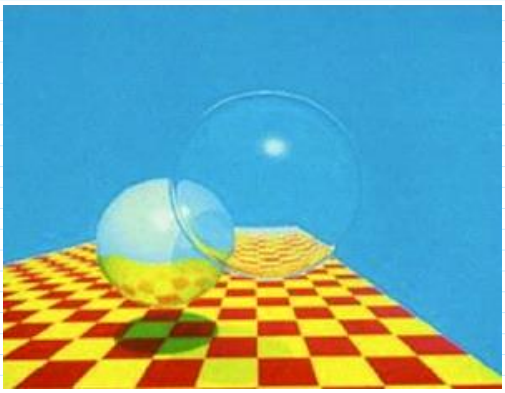
PAPER-1 :-

Graphics and Image Processing — J.D. Foley Editor

An Improved Illumination Model for Shaded Display

Turner Whitted
Bell Laboratories
Holmdel, New Jersey

To accurately render a two-dimensional image of a three-dimensional scene, global illumination information that affects the intensity of each pixel of the image must be known at the time the intensity is calculated. In a simplified form, this information is stored in a tree of "rays" extending from the viewer to the first surface encountered and from there to other surfaces and to the light sources. A visible surface algorithm creates



480 x 640
74 minutes on VAX-11/780

Facts :-

(1) Turner owned a numerical analysis company. While doing simulation for a nuclear power industry tracing photons.

(2) Published in 1980, took 20 more years before ray tracing started to get used for anything else than just research projects, due to high computational cost.