An Overview of Ray Tracing

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1 Introduction

"**Ray tracing**" is defined as a rendering technique that ~~emulates~~[1] simulates the paths of rays of light to generate realistic images, calculating the way rays interact with surfaces to produce effects like reflections, refractions, and shadows. **whitted1979improved**

2 The Basics of Ray Tracing

It provides an improved illumination model for creating photorealistic images by tracing the rays of light as they bounce through a scene. Among many other mathematical calculations, we calculate next-pixel shifting vectors q_x, q_y and left bottom pixel center p_{1m} as shown in the equation:

$$\vec{q_x} = \frac{2g_x}{k-1}\vec{b_n}, \vec{q_y} = \frac{2g_y}{m-1}\vec{v_n}, \vec{p_{1m}} = \vec{t_n}d - g_x\vec{b_n} - g_y\vec{v_n}$$

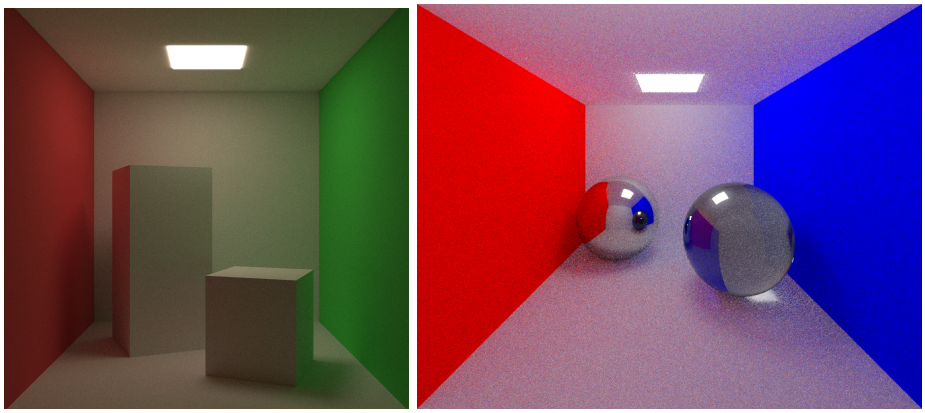
3 Some Algorithms

Table 1 presents two ray tracing algorithms and Fig 1 gives examples.

Table 1: Comparison of Ray Tracing Algorithms

Algorithm	Image Quality	Description
Whitted Ray Tracing	High	Computational complexity is proportional to the number ofrays and objects in the scene, roughly $\mathcal{O}(n^2)$
Path Tracing	Very High	Complexity grows as more raysare traced for realistic global illumination, approximately $\mathcal{O}(n^3)$

[1] Done for LaTeX evaluation



(a) Green wall! (b) Blue wall!

Figure 1: Examples of Raytracing

4 Optimizations in Ray Tracing

1. **Spatial Data Structures:**
   - *Bounding Volume Hierarchies (BVH):* BVH is a widely-used method to reduce the number of ray-primitive intersection tests by organizing objects into hierarchical structures.
   - Kd-trees are also popular for partitioning 3D space to improve intersection tests, particularly for static scenes.
2. **Acceleration Techniques:**

Ray Coherence: Using coherent rays helps in improving performance by ensuring similar rays follow the same code paths, enhancing cache efficiency.

Adaptive Sampling: Regions with high detail may use adaptive sampling to concentrate more rays in critical areas, while flat regions use fewer rays, thereby reducing computation.