Group Name: Defenders of Metropolis
Intro to DAS - CAP3027
Fall 2017

Metropolis Light Transport

Group Presentation Script Draft 1.0

Title Slide

Introduction Header Slide

- Group introductions, member names.

The Light Transport Problem Slide

- Explaining traditional Light Transport problems and traditional methods used to solve/render
- Bidirectional Tracing
- Path Tracing
- Traditional methods only efficient for small set of scene lighting scenarios
- A need for an efficient Light Transport algorithm to handle complex lighting situations and scenes

Monte Carlo Algorithms

- Considerations of Monte Carlo algorithms that make it applicable to problems of Light Transport (Introduce Veach and Guibas' considerations)

Metropolis Sampling Method: Computational Physics

- Look to the Metropolis sampling method in Computational Physics that is used to solve problems
- Method overview
  - Equations, nomenclature, and domain
- Algorithm Overview
  - Explained
  - DISPLAYED Pseudocode

Metropolis Light Transport Header Slide

Method and Algorithm Overview Slide

- Sample paths from light source to lens
- Each path has a sequence of points on scene surface
- *f* image contribution function, representing the power flowing from light source to image plane along set of paths
- Sample paths with an acceptance probability proportional to *f*
- Generate sequence of paths based on random mutations that can be accepted or rejected (determined by Metropolis Framework)

- Based on path sampled, update 2D array of pixel values of scene

Bidirectional Path Sampling Slide

- Initialization phase to estimate overall brightness of the image

Mutation Strategies Slide

- Metropolis phase to determine relative pixel intensity across the image
- Designing mutation strategy
    - Bidirectional mutations
    - Perturbations
    - Lens Subpath mutations

Perturbations and Other Considerations Slide

- Lens Perturbations
- Caustic Perturbations

Advantages and Disadvantages Slide

- Path space explored locally.
- Comparison Images

Question and Discussion

MLT

Useful Info Below

About

- Inspired by the Metropolis sampling method
- First introduced by Veach and Guibas in 1997
- Tried to solve the general global illumination problem
- New Monte Carlo method (relies on random sampling to gather better information)
- Reduces noise within rendering
- Used by multiple different Renderers (Iray for example)

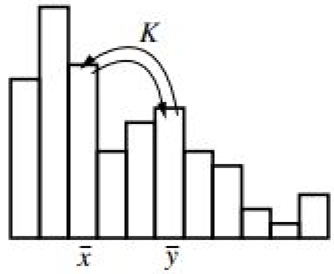
Advantages

- Algorithm is unbiased, handles general geometric and scattering models, uses little storage, and can be orders of magnitude more efficient than previous unbiased approaches
- Key advantage of the Metropolis approach is that the path space is explored locally
- Competitive with previous unbiased algorithms even for relatively simple scenes
- The main strength of MLT lies in its ability to explore local portions of the space of light paths in an unbiased way
- Contains less noise standard path tracing (more paths = more information for renderer)

Method

1. Creates sampling distribution proportional to a function (f)
    - Uses an idea called detailed balance to create a distribution proportional to f
    - This distribution of samples is called the *stationary distribution*
2. Makes a histogram based off those samples
    - The histogram represents points and the frequency of those points
    - 2 sets of points (x,y) constantly oscillates on their current frequency (new x, then new y, then new x, etc) at any given time as we trace each path (see further explanation)

    - These points, are what dictate the MLT subpath generation (explained

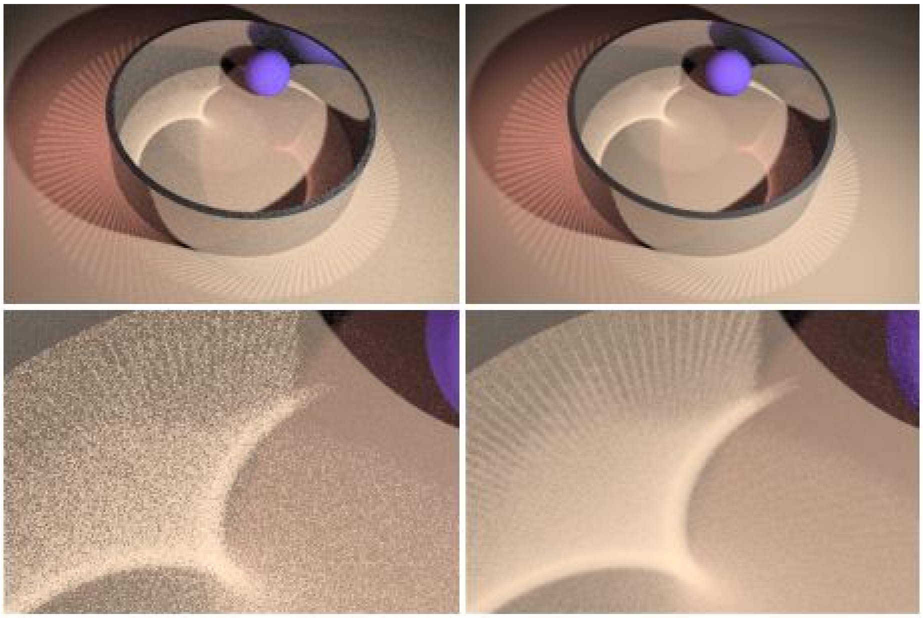


further later on)
  - The equation on how this is accomplished is called the transition equation

$$a(\bar{y}|\bar{x}) = min\left\{1, \frac{f(\bar{y})T(\bar{x}|\bar{y})}{f(\bar{x})T(\bar{y}|\bar{x})}\right\}$$

3. Scales the histogram to approximate the function (f)
4. Histogram is then scaled to approximate (f)
5. Uses histogram to create subpaths on the original light path that extend out at specified random directions/angles and maintain same power density.
6. These light subpaths can be thought of as stochastic (originating from a random variable) migration of the original light source
7. Light subpaths are separated into direct and indirect (explicit/implicit) light paths.
   - Implicit used for reflective surfaces and explicit being used on surfaces like lambertian.
8. The light subpaths are connected with subpaths originating from the viewer. (bidirectional path tracing) to complete all of the paths and brighten the image accordingly based off these paths
9. Each point in the path has a power value that is used when rendering the image (brightness)

Images



Bidirectional tracing (right) vs MLT (left)

Tentative Outline:

Slide:

1. Title Page
2. Introduction
    a.
3. Traditional Light Transport Algorithms
    a. Path Tracing
    b. Bidirectional Tracing
4. Monte Carlo based algorithms
    a. It's applicability to Light Transport
    b. Other Info on Monte Carlo
5. Metropolis Sampling Method in Computational Physics
    a. Overview
    b. More Info
    c. Pseudo Code(s)
6. Metropolis Light Transport Method

a. Algorithm Overview
b. Mutations
c. Perturbations
d. Comparisons
e. Advantages/Disadvantages