LTE $I_j = \int_\Omega f_j(\bar{x})\, d\mu(\bar{x})$

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Distance Aware Ray Tracing for Curves

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Problem

- The “curves” primitive utilized for fur and hair. Ray tracing for this primitive is possible, however, many samples are required to reduce aliasing for thin curves.

Related Works

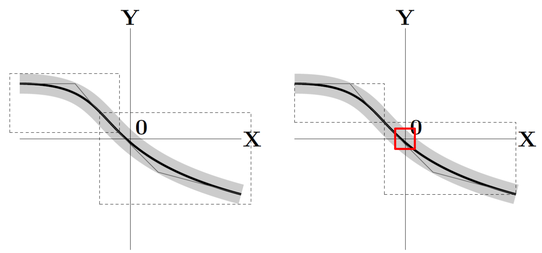
- Ray Tracing for Curves Primitive
  [Nakamaru, Ohno 2002]
- Tracing Ray Differentials
  [Igehy 1999]
- Ray Tracing Animated Scenes Using Coherent Grid Traversal
  [Wald, Ize, Kensler, Knoll, Parker 2006]
- A Framework For Rendering Complex Scattering Effects on Hair
  [Xuan Yu, Yang, Hensley, Harada, Jingyi Yu 2012]

Our Approach

- We extend the ray-curve intersection algorithm so that it can return not only a real intersection point but also a “pseudo” intersection point, i.e., a closest point to the curve. With this information and ray differentials at that point, we approximate the coverage of the curve.
- We extend the grid traversal algorithm to track ray differentials’ changes. A grid is traversed as in the slice-based packet traversal.
- Real/pseudo intersection points are gathered to form a list. The list is then sorted and utilized to accumulate colors for these points – thus we performs a sort of the A-buffer algorithm for each ray. We also carefully track alpha and coverage values to avoid redundant computation for intersection points that doesn’t contribute much to the final image.

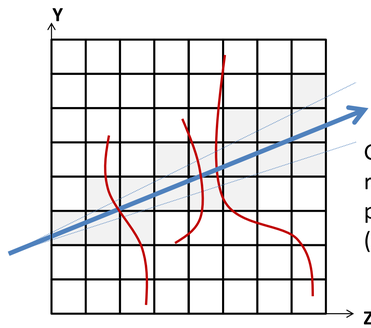
Distance of Curves

- A square centered at O is utilized to cull sub curves resulting in subdivision – a sub curve can be culled if its bounding box doesn’t overlap the square. Originally the half width of the ribbon was utilized to form the square. We instead use the sizes of ray differentials.
- After fully subdivided, a distance to the survived sub curve is determined and its coverage is approximated by considering ray differentials at that point.



Slice-based Traversal with Ray Differentials.

- It is necessary to traverse not only cells that a ray intersects but also those within ray differentials.
- We track ray differentials projected onto the plane perpendicular to the major traversal axis. With this information, we can form a “slice” for the current ray position in the grid and can change it through the traversal as in [Wald et al 2006].



Gray cells are determined according to ray differentials projected onto the plane perpendicular to the major traversal axis (x-y planes in this case).

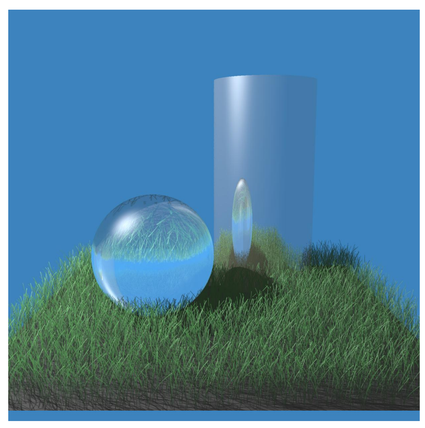
Accumulating Colors of Intersection Points

- Each intersection point coverage is approximated by considering the distance and the ray differentials.
- Intersection points with coverage values are then sorted in front-to-back order.
- For each intersection point, its final contribution to the image is calculated from the coverage value and the alpha at that point. The color of each intersection point is accumulated according to this contribution.
- The same process is performed for shadow, reflection, and refraction rays.

Results

Our approach
(1 sample/pixel, 6 min.)

Traditional approach
(16x16 samples/pixel, 47 min.)



Reflection and refraction are handled in the same manner.