Interactive Refractions with Total Internal Reflection

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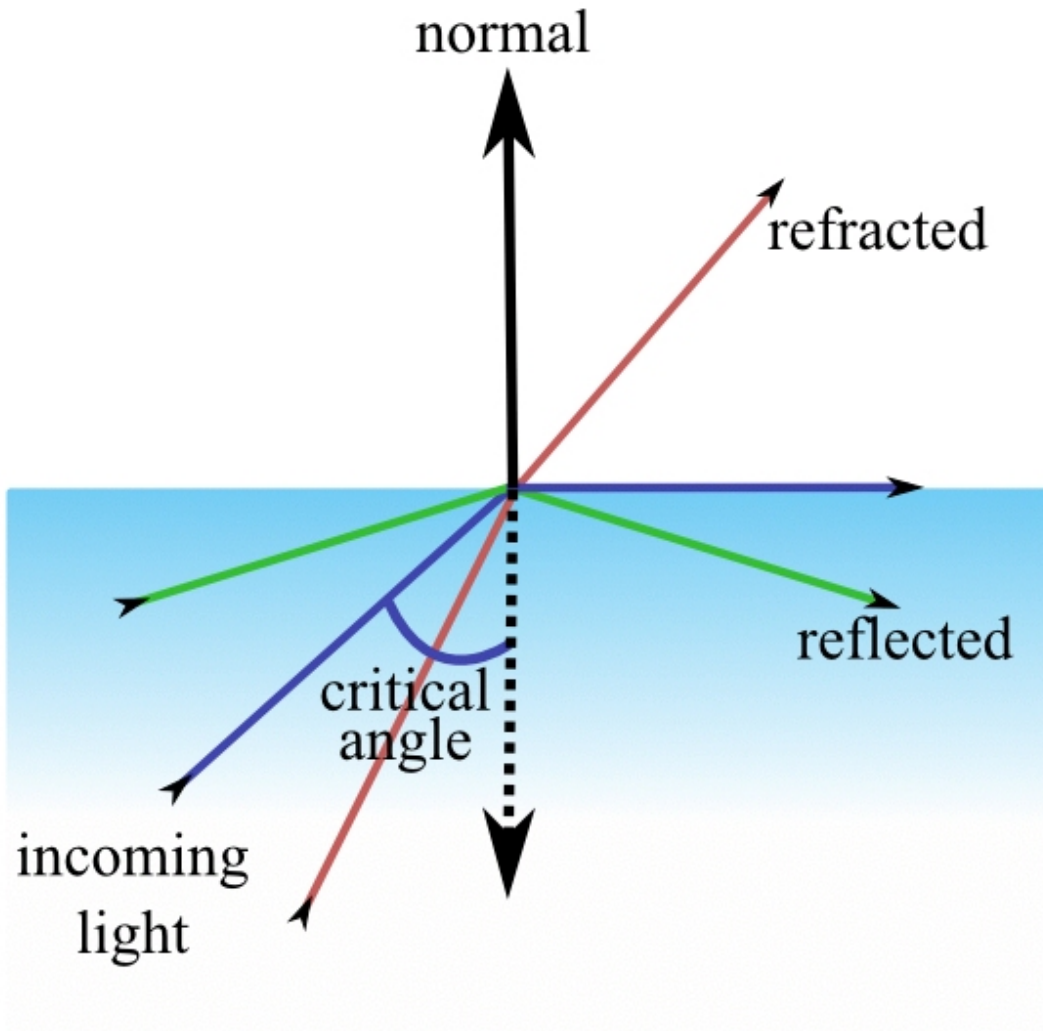
Department of Computer Science

Motivation

- Interactive applications forgo realism

- Dielectric materials

- Refraction

- Total internal reflection (TIR)

# Total internal reflection

Background

- Planar Refraction [Diefenbach97]

- Texture index perturbation [Kay79] [Oliveira00] [Lindholm01] [Wyman05]

- Ray-height field intersection [Policarpo05] [Baboud06]

- Intersect depth textures for refraction [Szirmay-Kalos05] [Kruger06] [Hu07]

- Hybrid ray tracing and GPU [Hakura01] [Ohbuchi03] [Chan05] [Genevaux06]
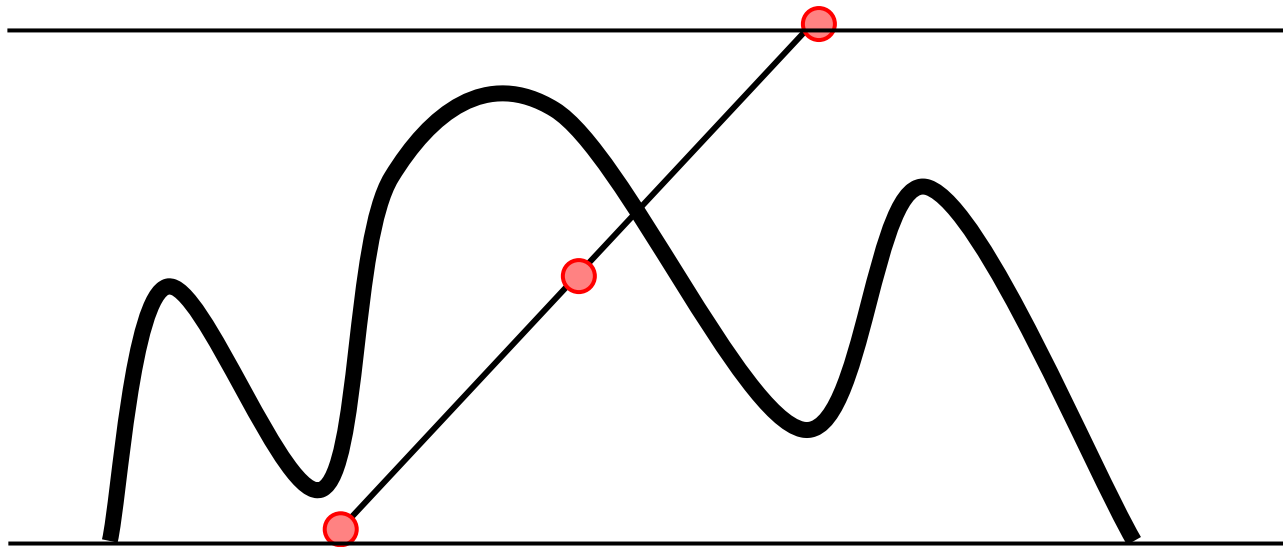
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Algorithm Overview

- Intersect depth maps with binary search

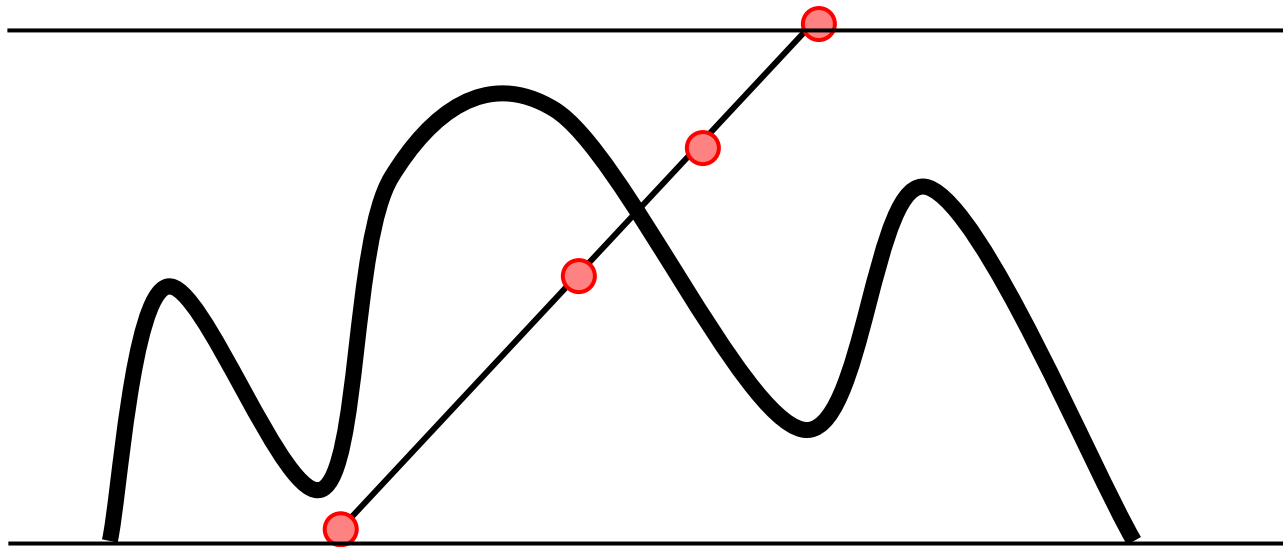- Bounce internally while undergoing TIR

- Intersect scene
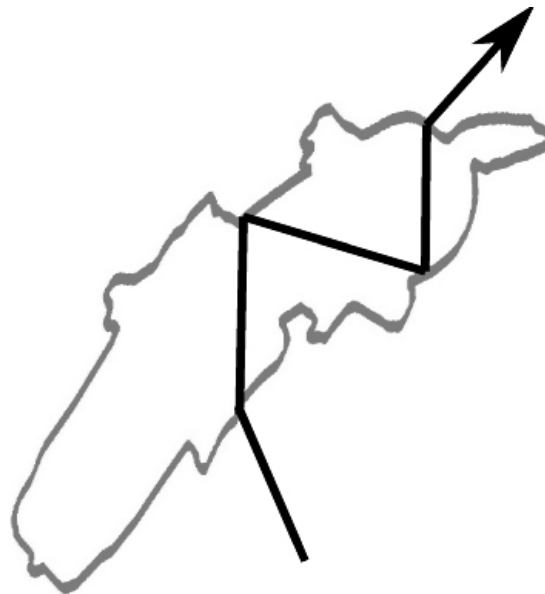
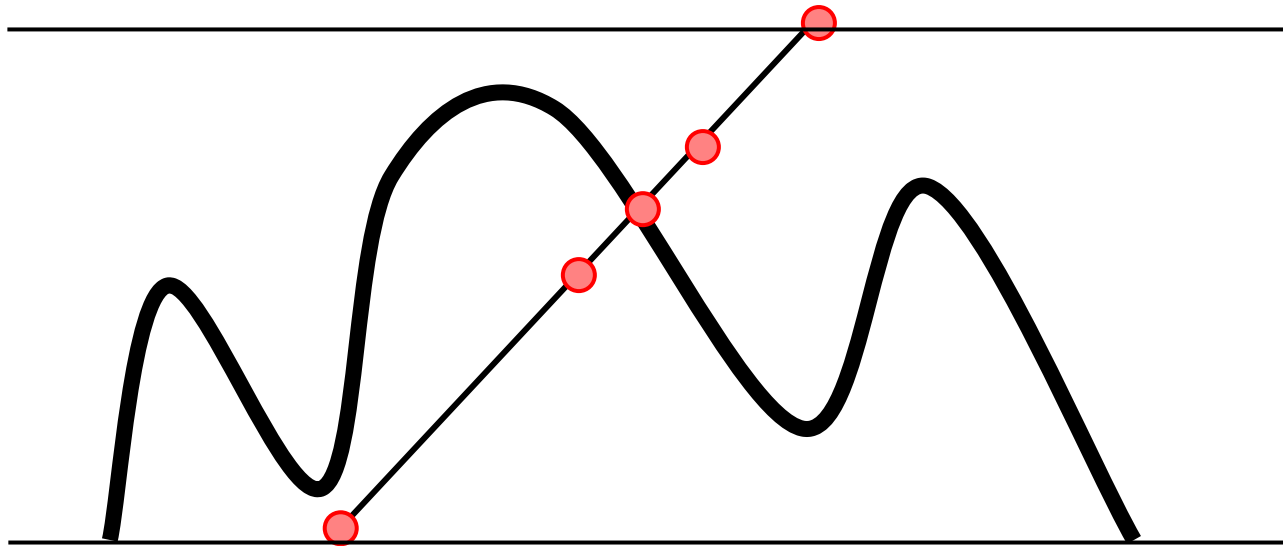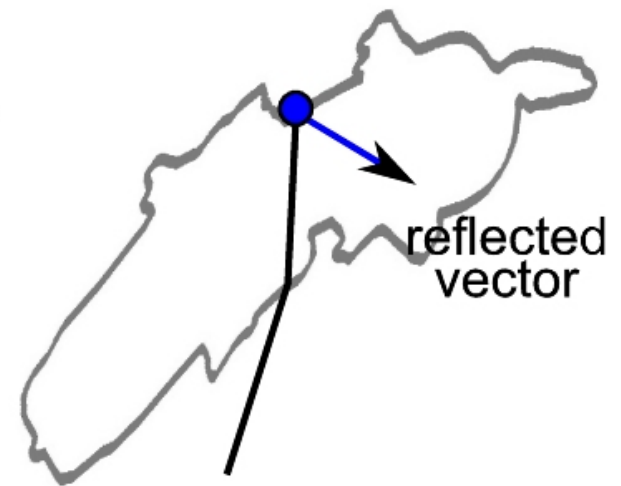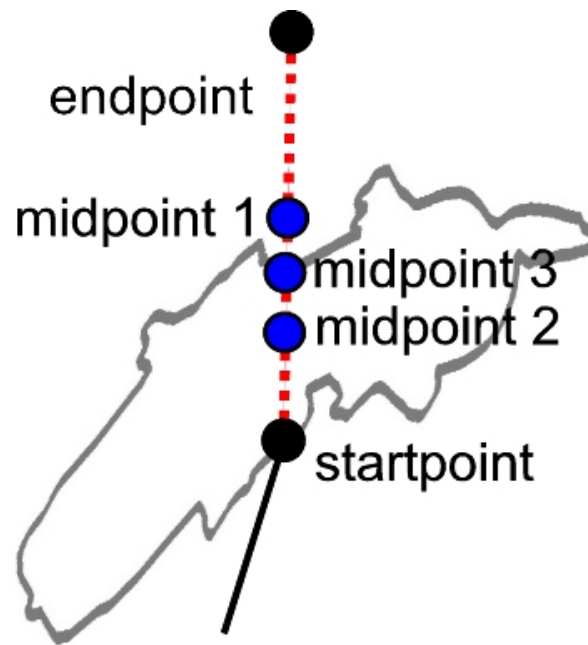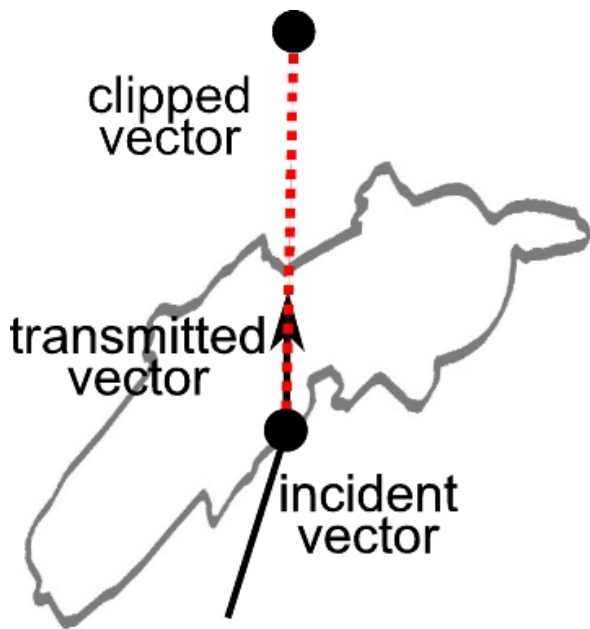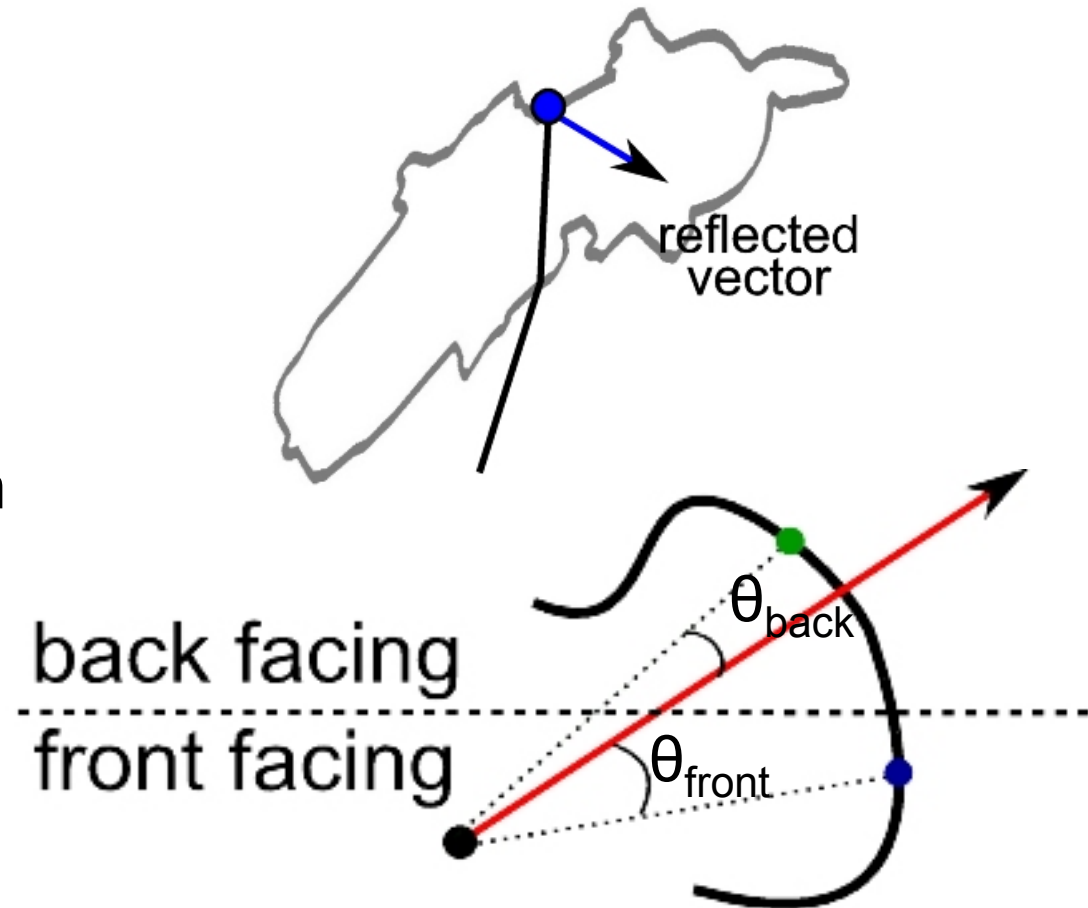# Binary search on a height field
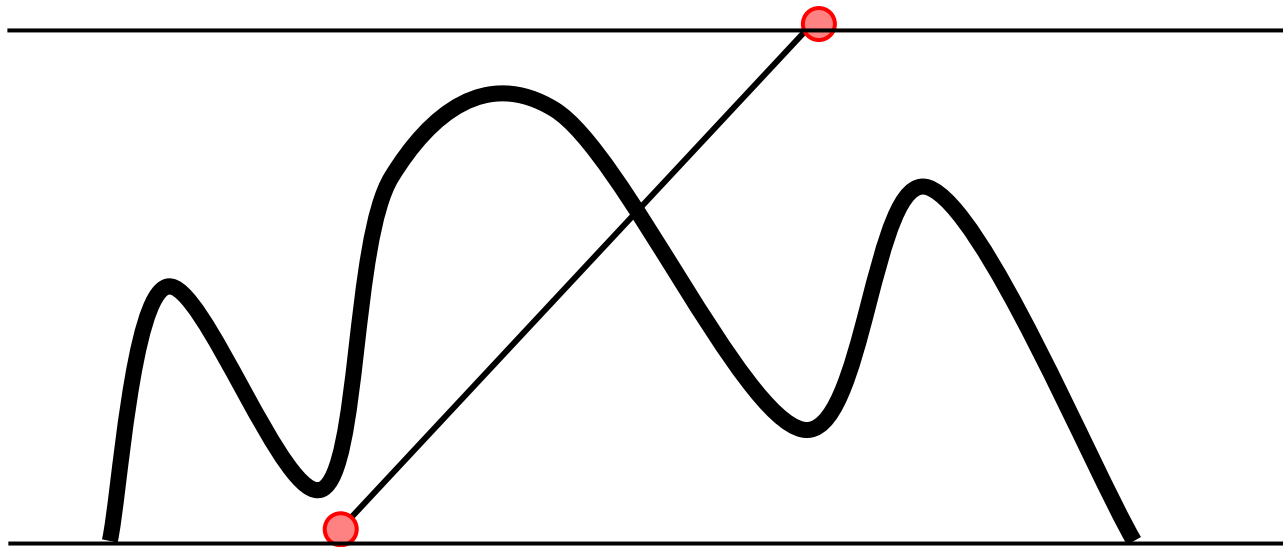
Binary search on a height field

Binary search on a height field

Binary search on a height field

Binary search

clipped
vector

transmitted
vector

incident
vector

endpoint

midpoint 1

midpoint 3

midpoint 2

startpoint

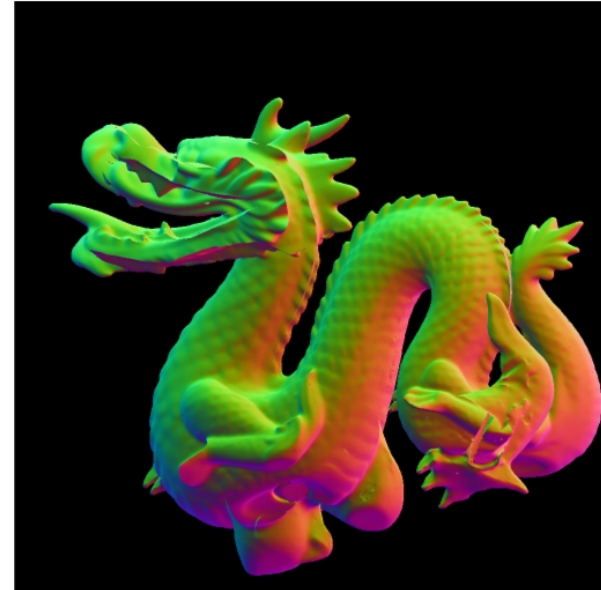reflected
vector

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Determine front or back

- Represent geometry with depth maps

- Ray could intersect either side

- Perform binary search on both depth maps

- Take smaller of θ_{back} and θ_{front}

reflected vector

θ_{back}

back facing

front facing

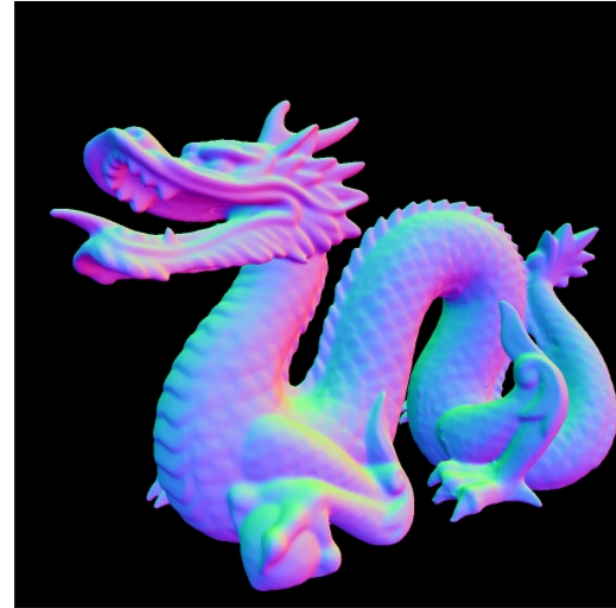θ_{front}

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Step 1

- Render *back* facing refractive geometry depths and normals

Step 2

- Render *front* facing refractive geometry depths and normals
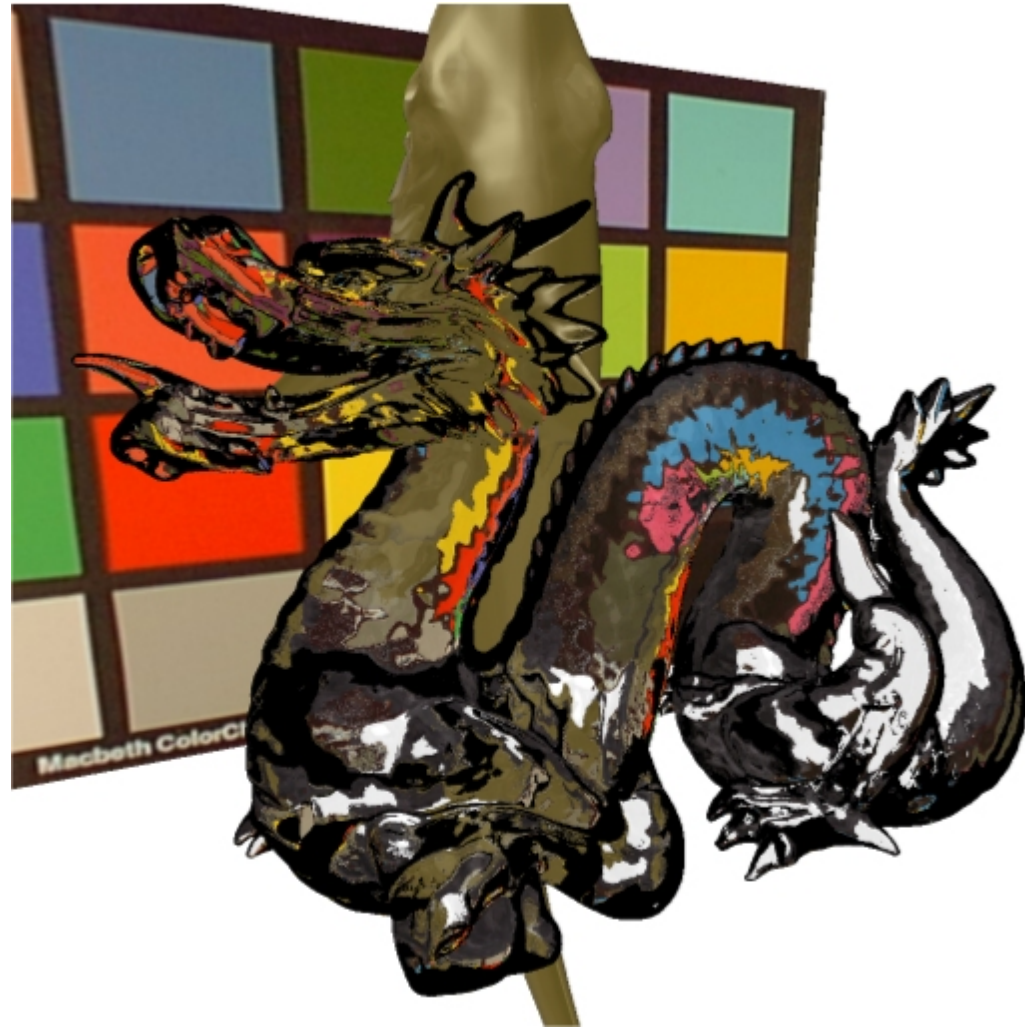
Step 3

- Render background geometry depth and color
- Used for intersection later

Step 4

- While bouncing
  - Intersect refractive geometry
  - Compute next ray

Adding bounces

No TIR bounces 38 fps   1 TIR bounce 31 fps   2 TIR bounces 26 fps
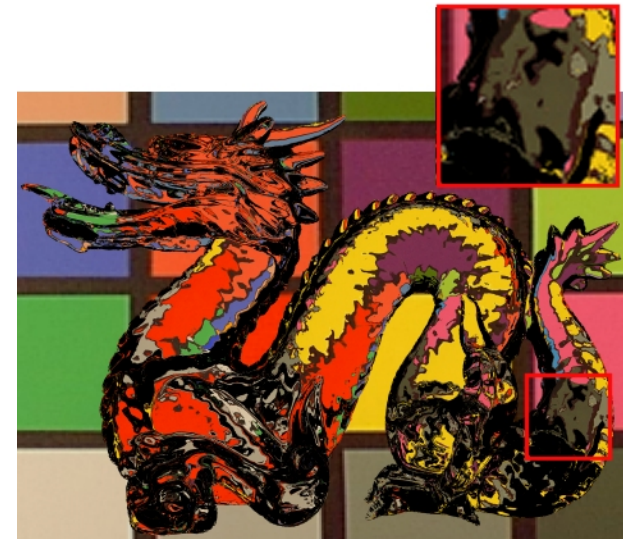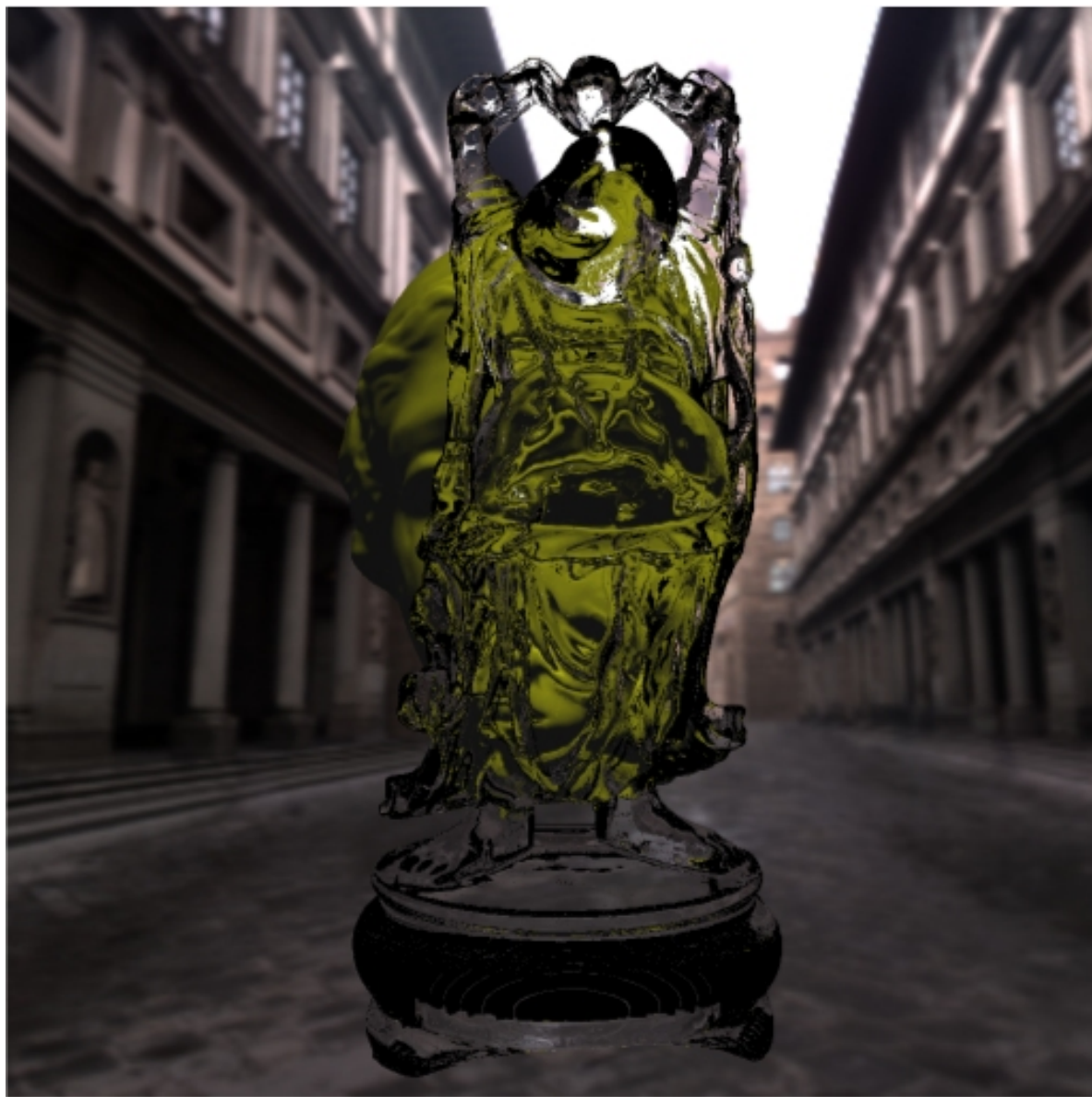

Ray traced with 10 TIR bounces

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Comparison

Our approach

22 fps

Two sided

38 fps

Ray tracing

8 seconds

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2 TIR bounces @ 15 fps

Video demo

- nVidia 8800 GTX GPU

- Pentium 4 Dual Core CPU

1 bounce	75 fps
2 bounces	60 fps
3 bounces	51 fps
4 bounces	44 fps

Discussion

- Problems
  - Binary search can miss intersections
    - More thorough search
  - Searching both front and back is costly

- Conclusions
  - Interactive
  - Plausible TIR
  - Adds to realism

Questions?