Real-Time Rendering of Heterogeneous Translucent Materials with Dynamic Programming

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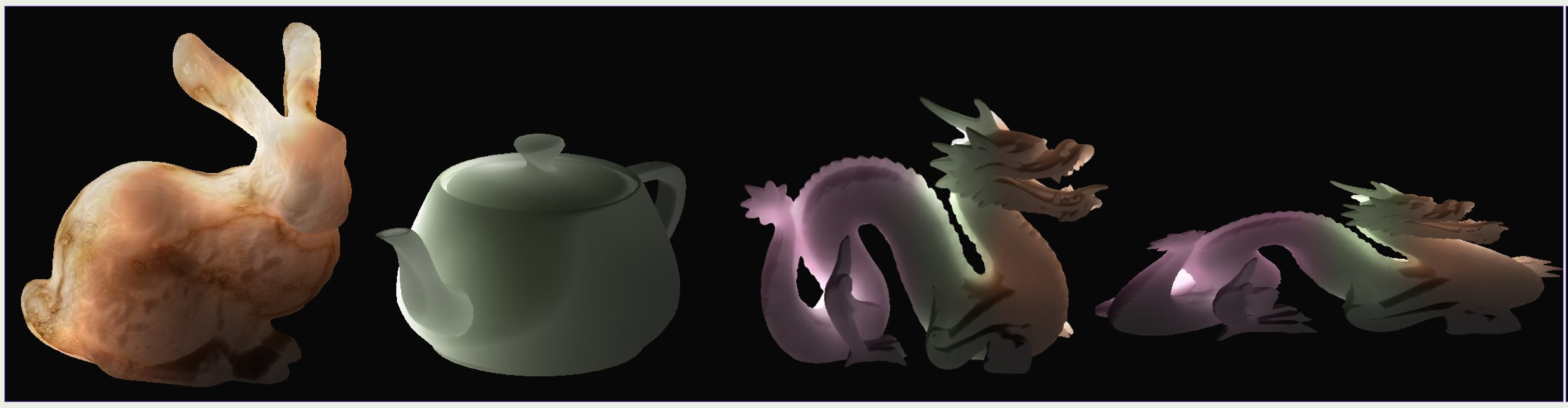
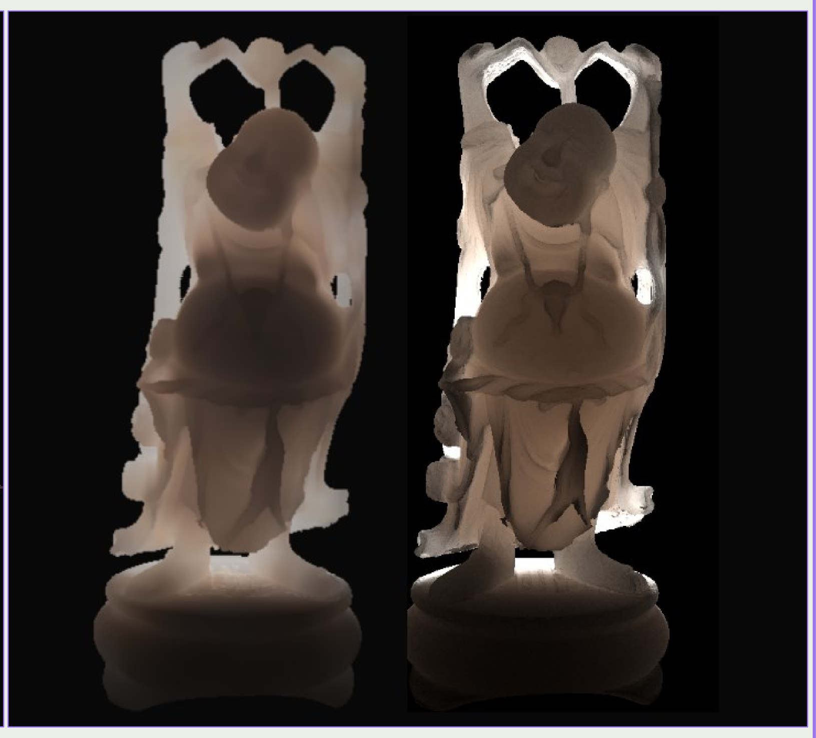
Eurographics

WASEDA University

Rendering of many materials



Bunny (143fps) Teapot (165fps) Deformable Dragon (167fps)

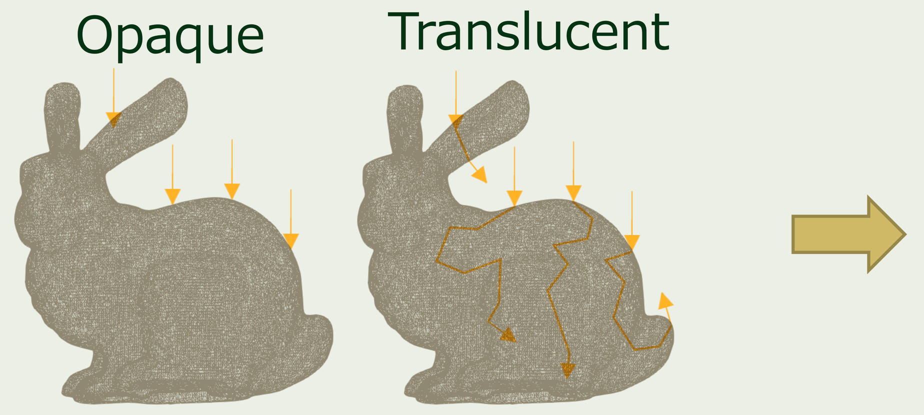


Our result Ground truth

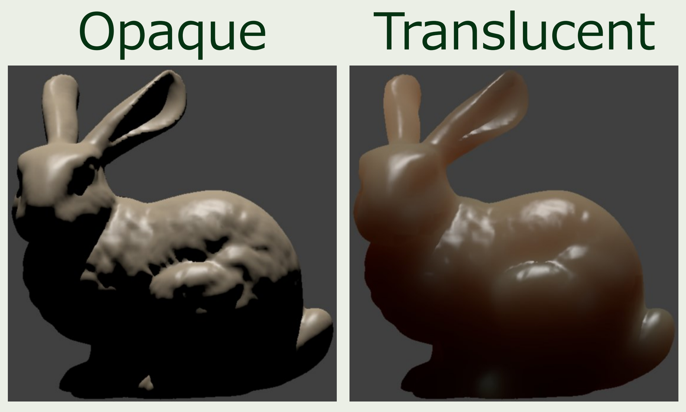
Motivation

Rendering translucent materials in real-time is challenging task.

Subsurface scattering (SSS)



Difference of the behavior of light transport



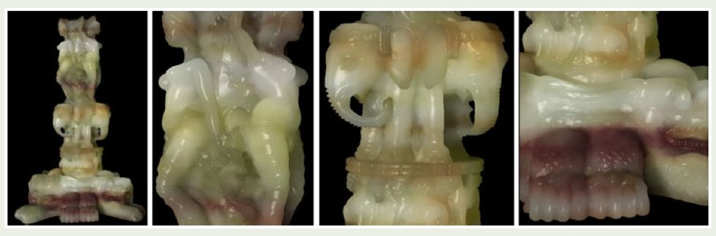
Difference of the appearance

Considering only **"The most important optical path"**.

Related work

Rendering heterogeneous translucent objects at high speed

Volumetric approach

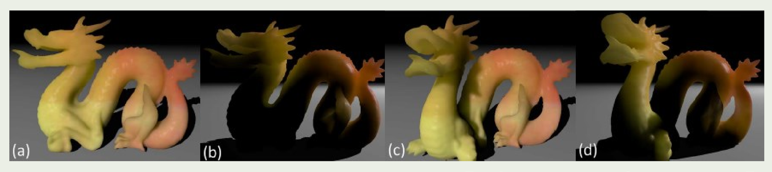


[Wang et al. ,2010]

Solve the diffusion equation in tetrahedron units.

- Find it difficult to handle the deformation with change of the topology like destruction

Real-time rendering



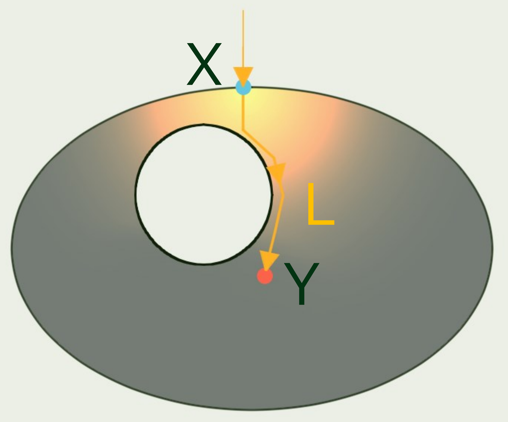
[Chen et al. ,2012]

Multiresolution splatting using several splatting buffer.

- It is necessary to sample many points to synthesize high- quality images.

Our method

The most important optical path

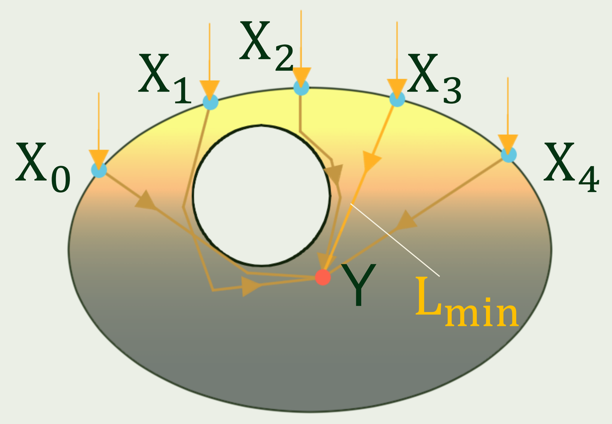


Translucent object illuminated by only single spotlight which irradiation area is microscopic (Narrow beam).

Radiance at X is determined by the distance between incident point X and Y.

Radiance is determined the shortest optical path L.

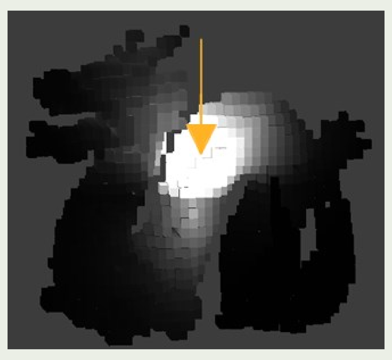
⇒ Radiance can be calculated using Dijkstra Algorithm.

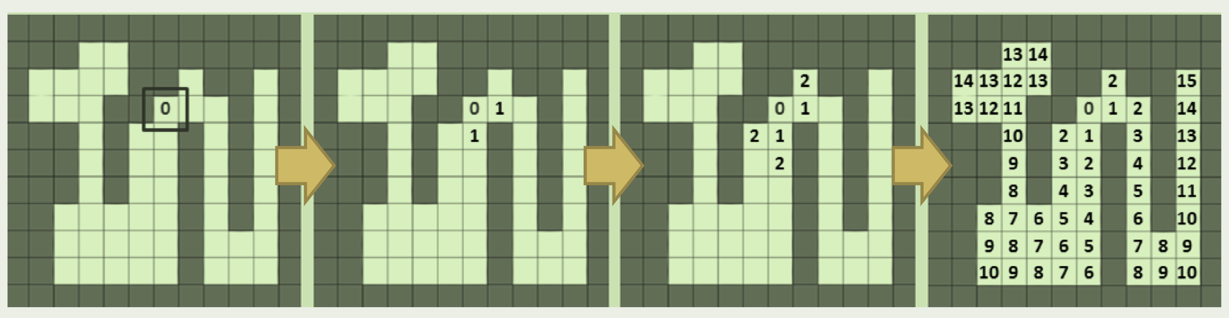


Parallel light source is regarded as a correction of single spotlights.

Radiance is determined the distance between X_3 to Y, the shortest path to the incident points L_{min}.

Dijkstra Algorithm





Create the graph updating value repeatedly.

Radiance Calculation

$$dL(x,\boldsymbol{\omega}) = -(\sigma_a(x) + \sigma_s(x))L(x,\boldsymbol{\omega}) + \sigma_s(x)\int_\Omega (p(\boldsymbol{\omega},\boldsymbol{\omega}',x)L(x,\boldsymbol{\omega})d\boldsymbol{\omega}')\ ds$$

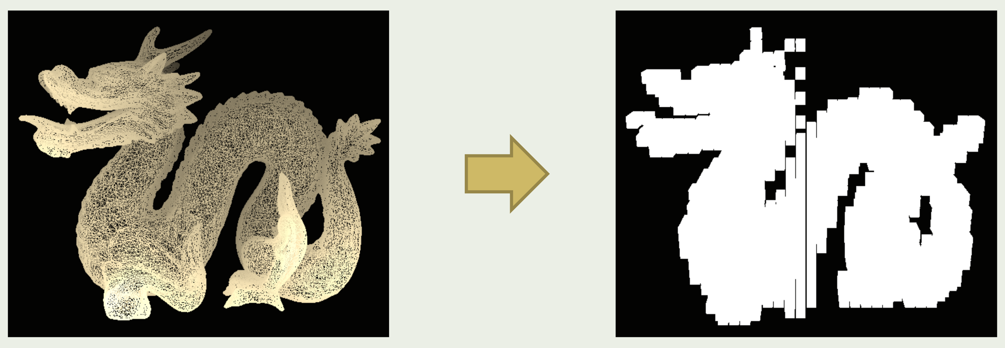
- ✓ Focusing on out-scattering and absorption.
- ✓ Dealing isotropic scattering.

$$\boldsymbol{dL(x) = -(\sigma_a(x) + \sigma_s(x))L(x)\ ds}$$

$L(x,\boldsymbol{\omega})$	:	Radiance
$\sigma_a(x)$	:	Absorption coherent
$\sigma_s(x)$	:	Scattering coherent
$p(\boldsymbol{\omega},\boldsymbol{\omega}',x)$	:	Phase function
$\boldsymbol{\omega}$	:	Incoming light direction
$\boldsymbol{\omega}'$	:	Outgoing light direction
x	:	Position

Implementation

Creation and Initialization of the graph



Graph is created using solid voxelization. Voxels represent nodes and edge is created relative to the adjacent 26 voxels.

A pixel on RSM represents a single small light source.

We apply "*Reflective Shadow Map*" (RSM) to decide the amount of light each voxel receives.

Interpolation of the radiance

We use 3D texture as the same resolution of voxels to interpolate the radiance.