Real-time Application of LTC for Shadow Rendering

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Overview

1. Analytic solution of rendering equation
    a. Linearly Transformed Cosines(LTCs) revisited
2. Limitations of LTC: Global illumination
    a. Why is GI so critical?
3. Project Scope: Shadow
4. Our Idea
5. Project Plan & Roles

Analytically Solving Rendering Eq

- Spherical Integrals are common in rendering
  - Rendering equation

$$L(\omega_o) = L_e(\omega_o) + \int_\Omega L(\omega_i) f_r(\omega_i, \omega_o) \cos\theta_i d\omega_i$$

- Exact integration are not common

- Numerical integration is slow
  - Stochastic methods suffer from noise

Analytically Solving Rendering Eq

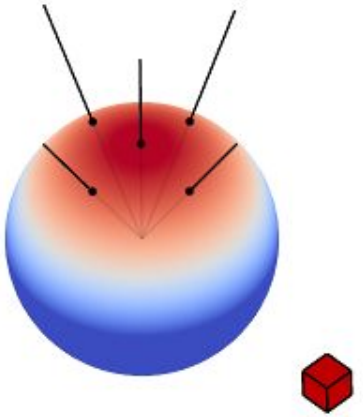
- **Real-time rendering**
  - **Sampling is not practical**
  - **Need efficiency, allows approximate**
  - **Trade correctness for efficiency**

- **Analytical solutions are welcome**

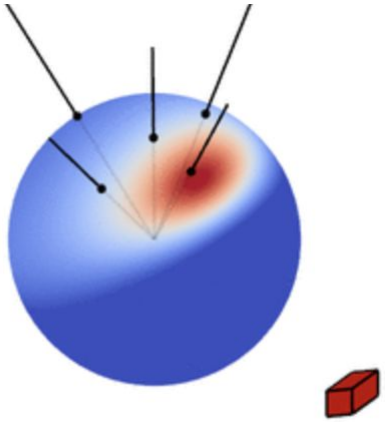
$$L(\omega_o) = L_e(\omega_o) + \int_\Omega L(\omega_i) f_r(\omega_i, \omega_o) \cos\theta_i d\omega_i$$

LTC Revisited

- Cosine
  - Easy to compute the integral



- Linearly Transformed Cosine (LTC)
  - Approximate BRDFs

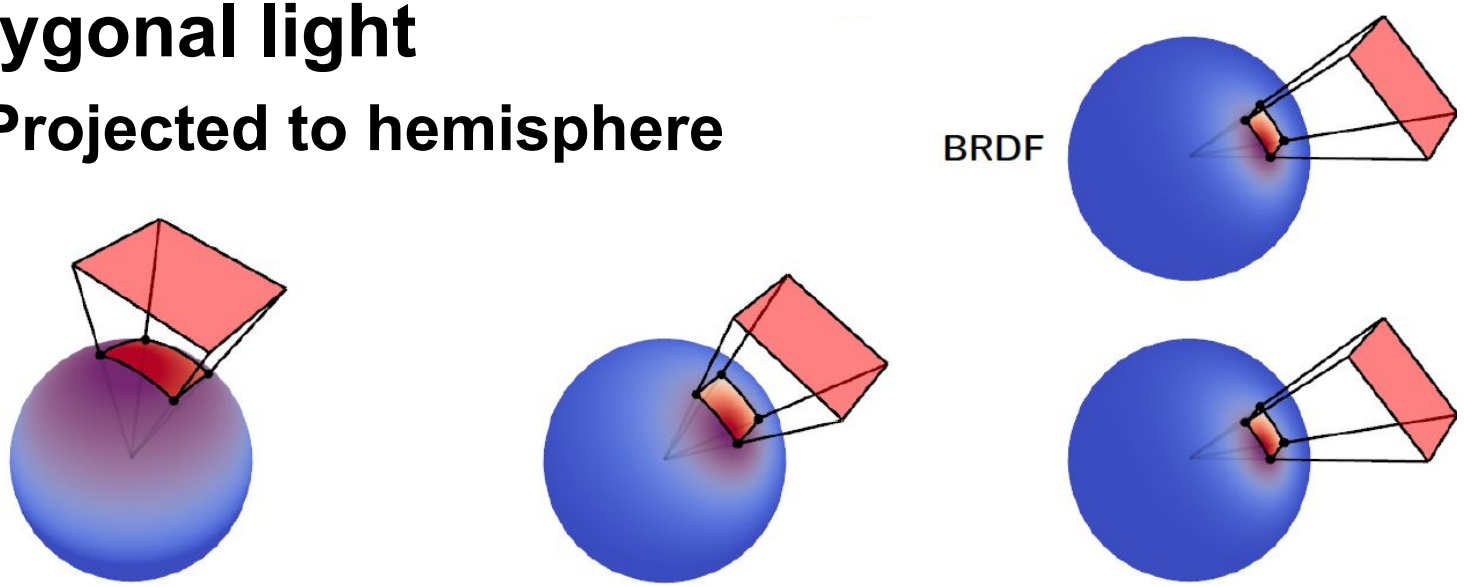


[Heitz2016]

LTC Revisited

- Change of variables
  - Connect LTC with plain cosine
  - Easy integration for LTC too
- Polygonal light
  - Projected to hemisphere

[Heitz2016]



LTC Revisited

- **Fine quality real-time rendering**
  - **With a very simple idea**

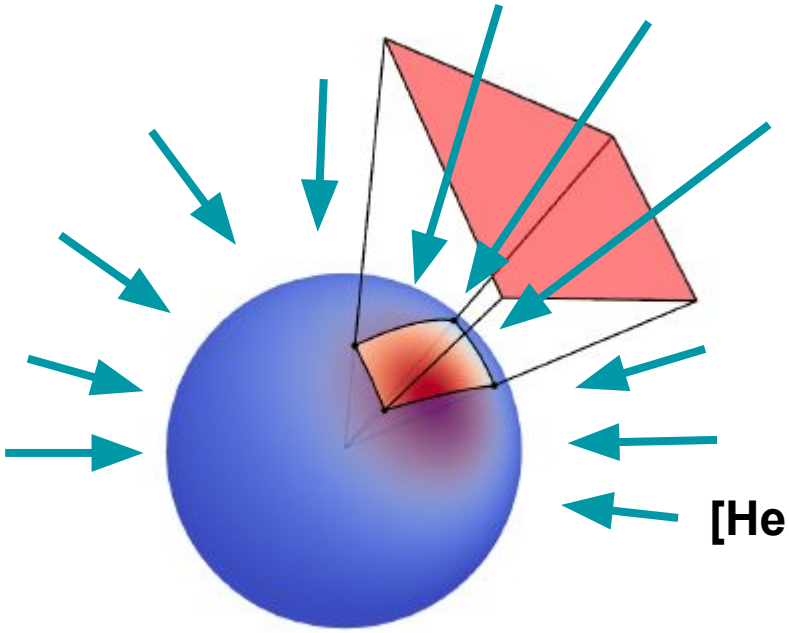
[Heitz2016]

There Are Always Pros & Cons!

- **What are the drawbacks/ limitations of LTC in the paper?**

Limitations of LTC (1)

- No indirect light

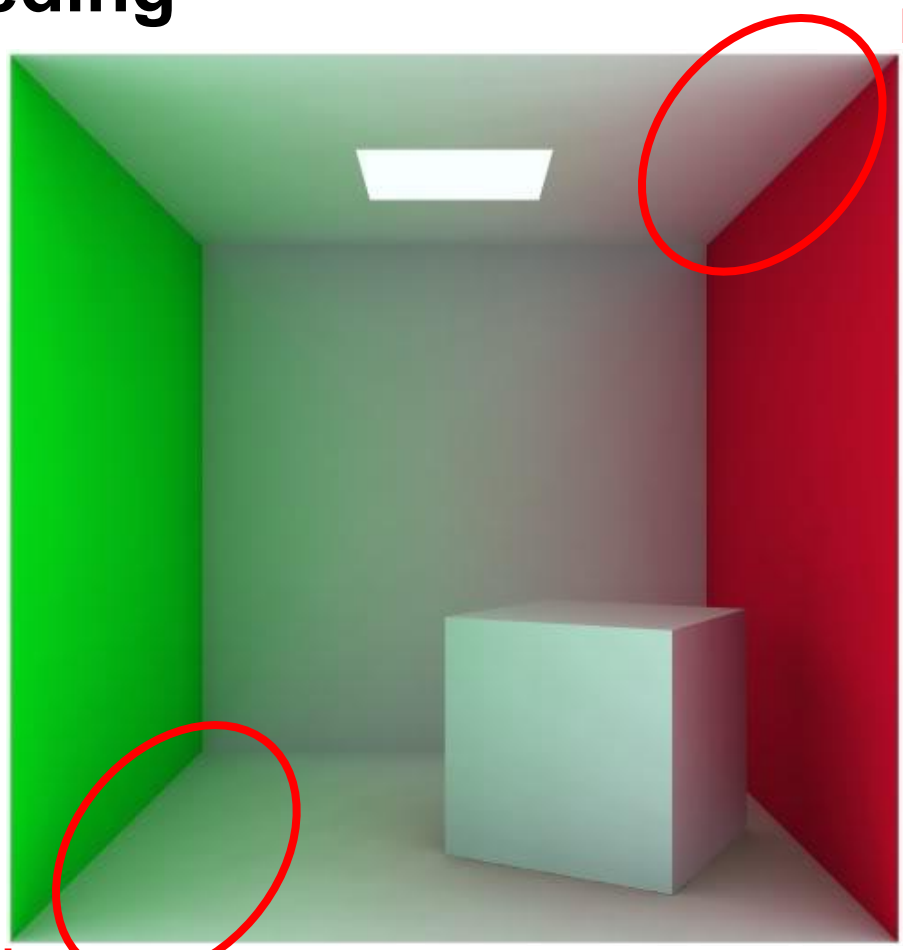


[Heitz2016]

- Because, indirect illumination needs global interaction
  - Means, time-consuming
  - Radiosity, MC ray tracing

Indirect Light

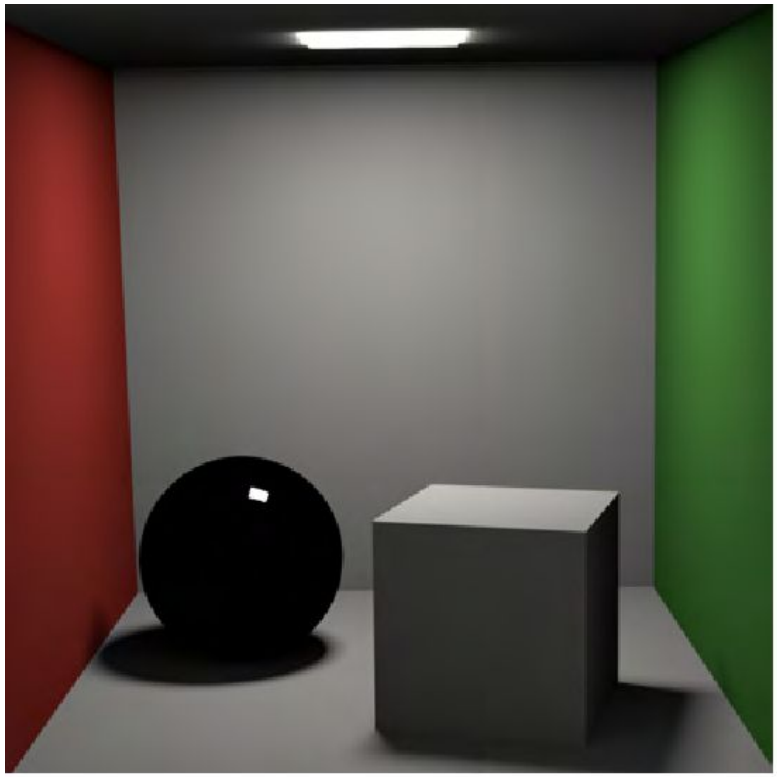
- Color bleeding



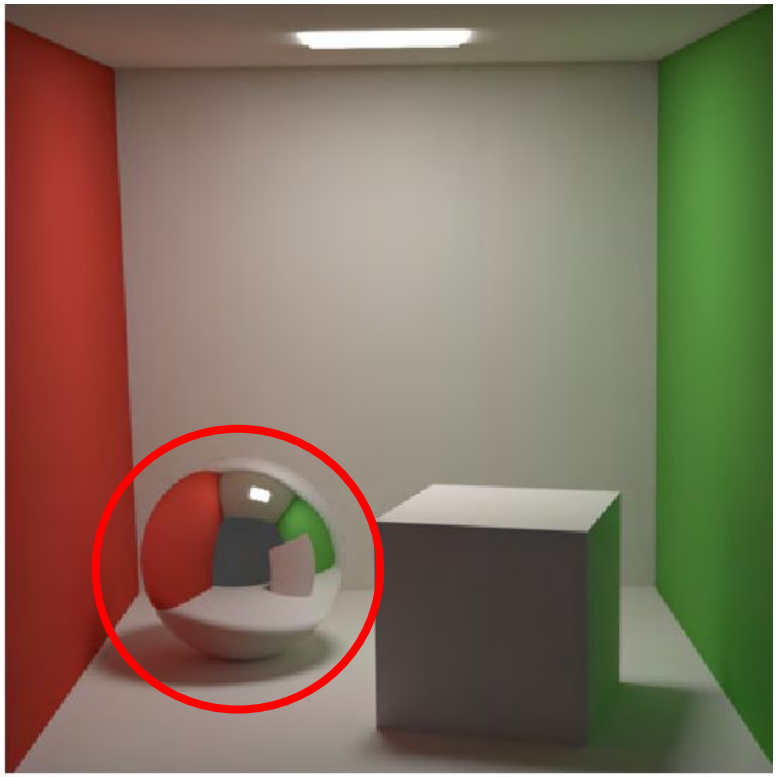
[source: LightUp forum]

Indirect Light

- **Specular materials**



(a) Local Illumination



(b) Global Illumination

[Arnebäck2017]

Limitations of LTC (2)

- **No shadows**
  - **Not considered a visibility term (V = 1)**
  - **No obstacles between light and material**

$$\int_{\Omega} Light \times BRDF \times Visibility$$

[Heitz2016]

Shadow

- **Shadow**

[source: LightWave documentation]

Limitations of LTC: Summary

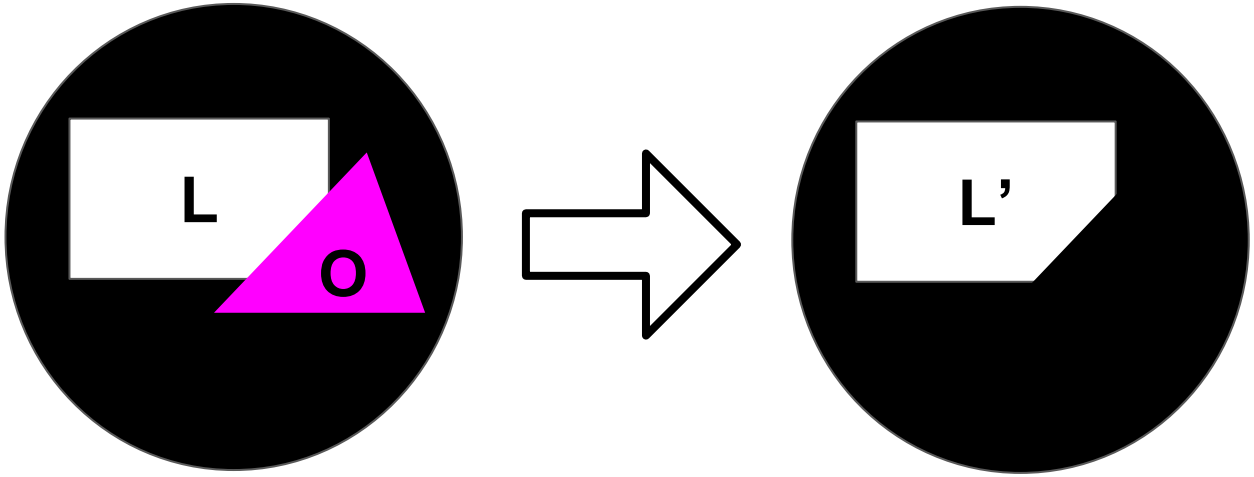
- No global illumination
  - No indirect lights
  - No shadows

Our Project Scope

“Efficient Shadow Rendering Using LTC”

Our Idea: Projected Visible Light

- Visible part of projected light is also polygon
- Use it as our integration domain



- Further optimization: approximate with simpler polygons, parametrization for avoiding redundant computation

Project Plan

- Understand LTC demo code
  - Currently, scene is limited to very simple scene
- Render general scene with LTC (baseline)
  - Learn OpenGL pipeline, scene representation
- Projected visible light
  - Optimization: vertex reduction (simplification)
- Check results

The Roles of Each Member

- **Eun Hyouk Shin (focus: scene geometry)**
  - **Learn scene representation**
  - **Implement projected visible light**
  - **(Optional) vertex reduction**
- **In Young Cho (focus: image production)**
  - **Learn OpenGL pipeline**
  - **Implement LTC integration for general scene**

Summary

- Why is LTC useful?
  - Analytic method is good for real time rendering
- Limitations of LTC
  - Lack of global illumination
- Problem (Project Scope)
  - Shadow rendering
- Why is it important?
  - GI adds more realistic lighting to 3D scenes
- Our idea
  - Projected visible light