A5 Project Proposal
Title: Ray Tracing
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Final Project: Ray Tracing

Purpose :

Use ray tracing to generate an image for a simplistic scene on a central-island in the kitchen.

Statement :

Ray tracing is one of the first successful image synthesis method started from an idea from the physics natural[3]. In assignment 4, a basic ray tracer program is created. It includes primary ray, shadow ray, primitive geometry, hierarchical objects, point light, mesh and etc. The extra feature implemented for assignment 4 is anti-aliasing using super-sampling. Assignment 4 will be extended for the final project for CS 488 Introduction to Graphics.

A kitchen's counter top image will be synthesized using ray tracing. There will be an orange, empty glass cup, and cube hollowed glass sphere on the counter top. Custom primitive will be also shown on the counter. Counter top will be made of marble. Several computer graphic techniques will be implemented as discussed in the class, such as reflection, refraction, distributed ray tracing, texture mapping in my project. If time is allowed, I would also like to explore areas such as CSG and acceleration mechanism.

The following items will be learned:

1 Basic techniques to map texture to a 3D object.

2 Basic techniques for reflection/refraction.

3 Distributed ray tracing and its effects in synthesized image[1].

Technical Outline :

Two new primitive (Cone, Cylinder) will be implemented. They should be able to intersected by primary ray and shadow ray and integrated well in existing primitives.

Perlin noise[4] will be used to synthesize the texture for marble. If time allows, Texture mapping (UV mapping for a rectangle) will be implemented. Spherical or cubical environment texture mapping will be implemented. Perlin noise will be studied further in the project and will be used as a short technical report to fill graduate student requirement for the project.

Area light and point light will be used to light the scene. Soft shadow should be implemented using distributed ray tracing. At least uniformly distributed shadow rays[1] will be created for area light. If time allows, random or jittery distribution will be explored.

Reflection, Refraction[2] and Path Tracing should work with sphere primitive. If time allows, Schlick's approximation will be explored[5] for distribution between reflection and refraction.

Glossy Reflection and Glossy Refraction will be implemented with sphere and plane primitive.

Finally, a final scene will be presented along with a 5 second 30 FPS animation showing objects moving.

The following lua command will be added. Existing lua command for material will be modified for Glossy Reflection and Glossy transmission.

- **gr.cone**
- **gr.cylinder**
- **gr.texture**
- **gr.csgunion** (if CSG is implemented)
- **gr.csgintersection** (if CSG is implemented)
- **gr.csgdifference** (if CSG is implemented)
- **gr.arealight**

References

[1] Robert L Cook, Thomas Porter, and Loren Carpenter. Distributed ray tracing. In *ACM SIGGRAPH Computer Graphics*, volume 18, pages 137–145. ACM, 1984.

[2] Bram De Greve. Reflections and refractions in ray tracing, 2004.

[3] Andrew S Glassner. *An introduction to ray tracing*. Elsevier, 1989.

[4] Ken Perlin. An image synthesizer. *ACM Siggraph Computer Graphics*, 19(3):287–296, 1985.

[5] Christophe Schlick. An inexpensive brdf model for physically-based rendering. In *Computer graphics forum*, volume 13, pages 233–246. Wiley Online Library, 1994.

Objectives:

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___ 1: Custom Primitive [Cone, Cylinder]

___ 2: Path Tracing

___ 3: Reflection (primary ray)

___ 4: Refraction (primary ray)

___ 5: Soft shadow (distributed ray tracing - uniform distribution over area light)

___ 6: Glossy reflection (distributed ray tracing - normal distribution for reflected ray)

___ 7: Glossy transmission (distributed ray tracing - normal distribution for refracted ray)

___ 8: Perlin Noise

___ 9: Animation (Generate 150 ray tracing images with displaced objects to create 5 second animation)

___ 10: Final scene