CPSC 290 Proposal: Introduction to Raytracers

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Objective

To learn the fundamentals of 2D/3D computer graphics, with an emphasis on static rendering. The independent study will be structured around building a raytracer, and then modifying the raytracer in increments to allow for the handling of gradually more complex geometries, materials, and light paths. The driving goal is to work towards creating a raytracer that produces realistic images.

Incorporation of CPSC 478 materials

Because this CPSC 290 is set up as an introductory course to computer graphics, some material from CPSC 478 will be borrowed. Lecture notes and homework assignments will come from CPSC 478. The main topics to be covered by these additional materials are imaging, rendering, geometric modeling, and animation.

Project: Raytracing

Raytracing is a way to render a 3D scene by simulating how photons of light bounce through a scene, determining the color for each pixel in the final image. The focus of this CPSC 290 will be to first build a simple raytracer, and augment the raytracer by adding features of arbitrary complexity. In order to start, however, some

fundamentals about how computers create 3D geometries and scenes must be covered. Core concepts about geometries will be pulled from CPSC 478 materials and readings.

The building of a preliminary raytracer will follow the steps laid out in the following open source project: http://www.macwright.org/literate-raytracer/
In the link above, the author explains how to make a simple raytracer. He explains how to set up a scene, camera, lights, objects, and how to cast rays, detect collisions, account for the reflectivity of surface materials, and how to render the scene. Following his explanations, I will use a sample scene and build a simple raytracer that can render it. I will likely build the raytracer in JavaScript in order to effectively compare results with the author. Using this simple raytracer as a base, I will have options for augmenting it throughout the rest of the semester.

Areas of augmentation include:

- Exploring complex geometries – I plan to use a single sphere initially, but I would like to set up scenes that involve more interesting shapes and complicated object setups.
- Exploring materials – I would like to explore materials of different reflectivity; opaque, translucent, and transparent materials; subsurface scattering; solids vs. liquids.
- Exploring light paths – I would like to explore results by changing the number of allowed light bounces, and by exploring how recursive ray casting can allow for more accurate creation of refraction, reflection, and shadows.
- Exploring camera effects – I would like to give the artist control over the camera aperture and depth of field for an image.

- Aside: exploring “alternative physics” – While the above suggestions for additional exploration focus on the production of realistic images, it would also be interesting to produce images that are not bound to physical behavior of photons. I would like to experiment with various rules that might produce other types of interesting images.

My goal for the end of the term is to be able to build a more elaborate raytracer, and to test it by building and rendering a series of interesting scenes. I will create 3D objects to place in my scenes. I am aiming to treat materials as accurately as possible, and to produce images that are as realistic as possible.

Additional Notes

A potentially helpful course is probably CIS 277 (Introduction to Computer Graphics), offered at University of Pennsylvania. If needed, I can supplement my independent study with material from CIS 277.

Professor Rushmeier will provide readings about rendering and raytracing. I will also meet with her weekly to keep track of my progress.