Parallel Ray Tracer
TJHSST Senior Research Project Proposal
Computer Systems Lab 2009-2010

Stuart Maier

October 23, 2009

Abstract

Computer graphics rendering is important for generating realistic pictures. However, realistic rendering methods can often take long periods of time. This project aims to develop a realistic ray tracer that operates on many computers in order to create faster rendering times.

1 Introduction

Images that have been rendered using computer graphics have been important in many different fields. The ability to generate a high quality image that is extremely realistic is a goal in the field of computer rendering. However, the latest algorithms that generate high quality images are also exceedingly slow. There has been some research onto how to render the images on many computers at once, in order to generate the images more quickly. If a rendering image can be efficiently parsed out onto different computers that have little contact with each other, the cost of creating a highly realistic rendered image will go down. Additionally, conventional rendering techniques are designed for generating visible images and cannot work with different parts of the electromagnetic spectrum, such as infrared and ultraviolet. New rendering techniques, on the other hand, can deal with this.

2 Background

There has been much prior research on the subject of computer rendering. One important paper has been Illumination for Computer Generated Pictures, by Bui Tuong Phong.[2] This paper is a description of the Phong shading algorithm, a system for shading objects that was based off of how light actually hits surfaces. It is used in many ray tracers, including the current project.

A good overview paper is An Introduction to Parallel Rendering by Thomas Crockett.[1]

This paper provides a snapshot on the current state of computer rendering techniques and the methods of parallelization.

An important project is the Cornell Box. This was developed at Cornell University and is information on a precisely described scene. The scene was photographed, with the scene information and reference image freely published. Using this information, the accuracy of rendering schemes can be evaluated by comparing the output render to the actual image.

3 Goal

The goal of this project is to create a rendering system that runs on many computers at once and is able to quickly create high quality computer generated images. The goal can fluctuate based on the progress of the project. The quicker the project advances, the more will be contained in the goal. In a very optimistic scenerio, the renderer can be taken off of the conventional RGB rendering colors and moved to a more realistic simulation of the entire EM spectrum. Additionally, the project will be able to run on many independent computers that have no contact with each other, and lose as little speed as possible to parallelization inefficiencies.

4 Design Criteria

The most important criteria that this project needs to achieve is the parallelization. Specifically, the program must be able to run on many computers at once, with the computers having little to no communication with each other. The computers must achieve the rendering process with little computer time lost to parallelization processes. This is important because the projected target of this project is a network of personal computers which may be connected over a local area network, or even simply over the wider Internet. Thus, the computers cannot constantly be checking up on each other. They must be able to finish their task, and then send the final result as a single large communication. This criterion was chosen because it is the parallelization model used for BOINC, on the most famous parallel cmoputing projects.

5 Procedure

The first part of this project, which is currently going on, is the development of the originial ray tracer. It uses standard ray tracing algorithms, including the Phong shading model. Another important part which is currently happening is the parallelization. This is being taken care of by splitting the ray tracing screen up into different sections, and assigning those sections to different computers. Further phases of the project will experiment with more advanced parallelization techniques and more advanced rendering algorithms. Additionally, more advanced techniques, such as spectral rendering, may be attempted. If that part is successful, it will allow for realistic rendering of more advanced objects, such as light sources and illuminate at a single wavelength, such as a laser. While current rendering techniques work well for most images, they fail at generating colors that fall outside of the RGB spectrum.

6 Scope

The scope of this project is first, to develop a parallel ray tracer. After this is complete, further features will take place. More advanced parallelization is one possible alternative. Another is working on developing more advanced render features, such as photon mapping and photon tracing, as well as spectral rendering. These would take advantage of the new speed in the parallelized system and would not present problematic parallelization hurdles, as each of these designs are easy to parallelize. In parallel with that work, test runs will be done. Different scenes will be developed, and the renderer will be tested with each of them in order to look into its efficiency.

7 Expected Results

I expect to gain a parallel rendering system that is able to create high quality images at high speed. In terms of results, there will be many rendered images. They can be compared to standard reference images in order to check the accuracy of the renderer. Different scenes can be renderer in order to show different effects caused by varying scenes. I would hope that the final project can be run on computers spaced across the world from each other, and still maintain high efficiencies.

References

[1] Thomas W. Crockett, "An Introduction of Parallel Rendering", *Parallel Computing*, July 1997.

[2] Bui Tuong Phong, "Illumination for Computer Generated Pictures", *Communications of the ACM*, June 1975.