Proposal: Implement a 3-D Scanner Using Triangulation

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Abstract

We will implement a three-dimensional scanner that will generate a point cloud using triangulation. These data points will be used by a software application, which we will also implement, to transform the data points into a polygonal mesh using mathematical formulas. This polygonal mesh will represent the scanned object and be available for use in 3-D modeling software applications.

1 Introduction

Our group was planning on studying graphics tessellation for a GPU, including both hardware and software elements. After discussing it in the summer and deciding to pursue it in our first meeting in the fall, we took the idea to our desired advisor, Dr. Wolff for input. However, Dr. Wolff presented us with a very intriguing project idea: implementing a 3-D scanner. It did not take long for all three of us to decide to transition to this project. We had wanted to do something in 3-D graphics and this provided a more concrete and defined idea with both hardware and software elements.

This project is important to our group as we all have an interest in graphics and this project provides us with a real-world application that not only allows us to work on an interesting project but also provides us with additional experience that we can potentially utilize in future career opportunities. In addition, 3-D scanners have many practical uses in both the sciences and entertainment fields, ranging from medical diagnoses to architectural design to computer generated imagery in movies and games.

Through this project, we hope to further develop our software engineering skills and gain graphics knowledge while also implementing a distinct hardware element through a camera, laser, and motor. It will also challenge us to apply mathematics concepts within the realm of computer science, particularly in the graphics field.

We have already performed some preliminary research both in the general schema of the project idea as well as required hardware pieces. Dr. Wolff has provided us with a

SIGGRAPH (a leading graphics conference) course website that provides us with a starting point from which we can begin our implementation.

2 Goals

2.1 Functional

- Implement a 3-D scanner (hardware) which sends its data to a software application.
- Generate a set of data points using optical triangulation and image processing.
- Write a software application that will transform the set of data points into a polygonal mesh that represents the scanned object which can be manipulated in a 3-D modeling application (e.g. Blender, Maya).
- Further implement the software application to apply a texture map defining the colors found on the scanned object.

2.2 Educational

- Achieve successful implementation of a medium-scale software application with a hardware component.
- Further develop our software engineering skills, including coding and working in a team environment.
- Learn more about computer graphics, including associated mathematics.

In order to be successful, we will have a functional 3-D scanner that will produce a set of points from the cameras pixels which will then be transformed into a polygonal mesh that portrays the scanned object.

3 Predicted Requirements

For our project, the primary requirements will be hardware-based. These include:

- Laser line generator ($15-25), Laser mount ($20), Laser AC adapter ($20)
OR
Pocket Projector ($100-150)
- Webcam/Camera (already have)
- Stepper motor kit ($60-100)Possibly
- White tag board ($5)
- Books, etc. (library, online)

- Java/C++ (no cost)
- Matlab (no cost: PLU computers)
- Blender/Maya (no cost/student license)

We will also need a workroom and request to use MCLT 212A. Spatial requirements will be sufficient in this room for implementation of the scanner environment.

4 Predicted Challenges

The demands of implementing this project are substantial start-to-finish. We must make sure to break things up into stages and substages. Some of the predicted challenges we face include:

- Engineering the motor mechanism for rotation of the object to be scanned.
- Properly arranging hardware elements to work as a group.
- Calibrating the projector and calibrating/programming the camera
- Capturing and storing data points from image/video.
- Performing correct mathematical calculations to properly assemble data points into correct coordinate positions for a polygonal mesh.
- Obtaining and applying color data to the polygonal vertices.

In order to maintain a proper efficiency rate to prevent us from getting off track, we must make sure to not try and do too much at one time, set limits on features and do not go past them until prior features are fully implemented, ensure we have sufficient research before delving too deep into implementation, ensure not to lose too much steam over J-Term, and do the best we can to maintain and adhere to a schedule. A rough schedule is found in the next section.

5 Timeline

September: Research
October: Research/Design
November: Design
December: Finish design, begin assembly and calibration
January: Implementation of Hardware Pieces
February: Implementation of Hardware/Initial Implementation of Software
March: Implementation of Software
April: Finish Implementation/Testing
May: Testing, Presentation, Finish Final Document

Note: Documentation will occur throughout implementation.