

Introduction/Background

The primary goal of this project is the modification of the underlying 3D graphics implementation of WebWinds. WebWinds (<http://webwinds.jpl.nasa.gov/>) is an interactive visualization tool written primarily in Java, with several underlying components that make use of the JNI² to provide access to OpenGL. OpenGL is a cross platform 3D graphics application programming interface (API) used by WebWinds to provide native 3D graphics. These modifications will be done in an effort to increase the performance of volumetric and 3D visualization tools.

WebWinds abstracts its 3D graphics implementation in such a manner that it will be possible to modify this layer without a need for modification of already existing volumetric rendering applications and 3D visualization tools.

The team of developers working on WebWinds found that the existing volumetric rendering application's performance was inadequate for user's needs. Volumetric rendering tends to be very resource intensive. A more robust 3D graphics layer would be beneficial to the evolution of WebWinds.

Objectives

The objective of this project is specifically to increase the performance of volumetric rendering applications, through the modification of the underlying WebWinds structure, in order to realize an increase in performance in all 3D applications. Optimization will be made through the use of culling (the removal of unseen data), simplification (reducing the number of graphics primitives being rendered), and LOD (Level Of Detail) management (not rendering more pixels than can be displayed). Some investigation into the parallelization (breaking up computation so it can take advantage of multiple processors) of the underlying OpenGL structure will also be performed.

¹ **Volumetric Rendering**-A method for analyzing 3D data sets.

² **JNI**- (Java Native Interface) Platform specific code (native) may be added to Java via the JNI. JNI is a component of the Java Development Kit (JDK).

Approach

The current WebWinds 3D graphics package will be modified to provide methods of optimization that can be implemented directly without any further modification to individual packages making use of 3D graphics.

For computers with single processors, three methods of optimization will be implemented:

- Simplification (Decimation³): The volume visualization tools currently employ a method of decimation to increase rendering performance. However, the method is rather primitive and each application has its own decimation routines. By creating a general decimation routine for all OpenGL applications, performance can be maintained while graphic accuracy is not heavily affected.
- Occlusion culling (hidden surface removal): In 3D graphics, oftentimes a great deal of the image being processed is rendered but not visible. By using this method, performance is increased by not rendering what is not viewable.
- LOD Management: Oftentimes, especially in volumetric rendering, more data points are plotted than are viewable at certain resolutions. By not rendering all of these points, computation is decreased, thereby freeing up resources.

For computers with multiple processors, the ability to take advantage of multiprocessing will be added to the graphics core. This will be accomplished through the threading⁴ of the 3D graphics engine.

My knowledge of programming in C, C++, Java and OpenGL in C will be of the utmost importance during this project. Another key factor towards this project's success is that I enjoy computer graphics work, making my success all the more tangible. My ability to work well individually and with a team will definitely be of great use this summer, as I will find myself working alone and calling on the knowledgeable WebWinds team for aid. It is my hope that my efforts can make a contribution to this powerful 3D graphics package.

Expected Outcome

The main goal of this project is the optimization of the volumetric rendering tool of the WebWinds 3D scientific visualization tool. Through the techniques described above, this will be accomplished and in addition, the performance of the WebWinds package as a whole may be enhanced as I plan to modify the "graphics backbone."

³ **Decimation-**

⁴ **Threading-** The breaking up of routines into segments that can be computed independently.

Texts to be used

Advanced Animation and Rendering Techniques: Theory and Practice
By Alan H. Watt and Mark Watt

Computer Graphics Using OpenGL
By F. S. Hill, Jr.

Introduction to Algorithms
By Thomas H. Cormen, Charles E. Leiserson and Ronald L. Rivest

Real-Time Rendering
By Tomas Möller and Eric Haines

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