GPU Accelerated Method for Constructing and Rendering Trees

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Project Proposal First Draft

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1 Introduction

Generating natural environments can be costly. Creating and rendering realistic models of trees can be challenging. The aim of this project is to investigate approaches for creating and rendering trees to be used in a real-time graphics application.

2 Description of Project

2.1 Aims

The aim of this project is to create an OpenGL module for constructing and rendering trees for use in 3D environments such as games. The trees that are constructed should look relatively realistic and the rendering process should make effective use of the GPU to be as efficient as possible.

2.2 Motivation

The motivation for creating this project is to make the addition of trees into a 3D environment easier to allow for the creation of better looking environments without needing to spend as much time modeling certain assets.
The natural growth patterns of trees can be represented quite well algorithmically so I would argue that using an algorithm to produce tree models will also result in a more realistic looking model than one created manually while taking less time and effort.

3 Market Analysis

As part of analysing this project I have researched some similar software solutions that are already available on the market.

3.1 SpeedTree 3D Vegetation Modeling

SpeedTree IDV Inc. (2017) is an advanced software suite that is used for large projects in the game and film industry. It allows for extremely detailed foliage generation, not limited to trees, and allows for very minute detail manipulation for the generated plants. This includes factors such as tree bark colour and texture, and the size, shape and scattering of leaves across branches.

3.2 The Grove 3D Tree Growing Software

The Grove F12 (2014) is a detailed simulated method of constructing trees with a multitude of factors that come into play with the growth of the tree. The Grove uses a different method than might be assumed for typical construction of trees. Rather than construct trees in one state, by that I mean that you construct the tree as you would want to display it, The Grove gives you a set of many parameters that you can tweak and you then grow a tree, by adding years to its life and tweaking the parameters you construct the tree you want. This includes modifying the weight of branches, the flow of sugar and hormones within the tree, growing towards light sources, growing around or avoiding buildings and many others.

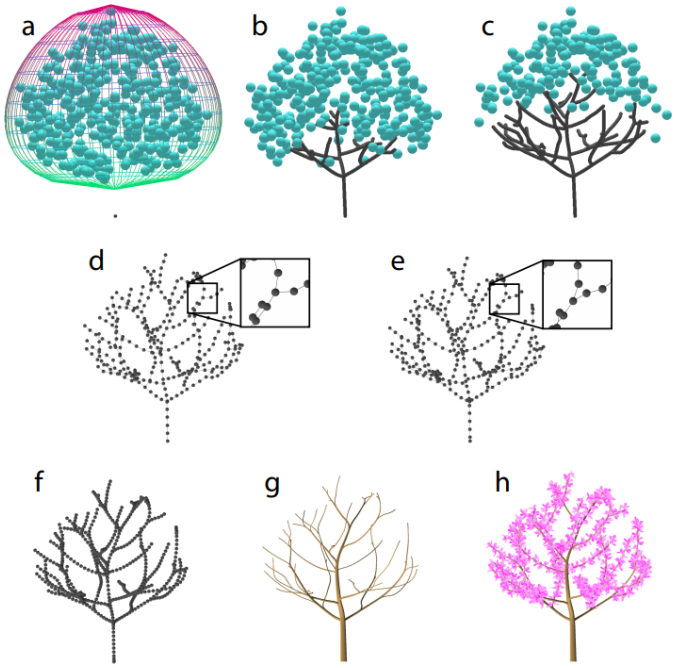
4 Method Analysis

I have also researched some existing methods used to construct trees and how they relate to the scope of this project. I have also included research into general GPU accelerated rendering as I believe that will also be useful information.

4.1 Modeling Trees with a Space Colonization Algorithm

The paper Adam et al. (2007) is a wealth of knowledge on the construction of trees. It includes a well written and explained method for constructing trees and provides many links to other relevant papers that relate to various aspects of the tree construction. The main method they describe involves creating a three-dimensional *envelope* of the tree crown that you want to produce. You then give a set of *attraction points* which the paper states as user inputted but I think could be randomly generated using a noise algorithm. The tree *skeleton* then grows, from a given root point, into the envelope and towards the attraction points which produces branches within the given space. Once the skeleton is produced it can be used as a base to apply thickness to the trunk and branches.

Figure 1: Key steps of the proposed method

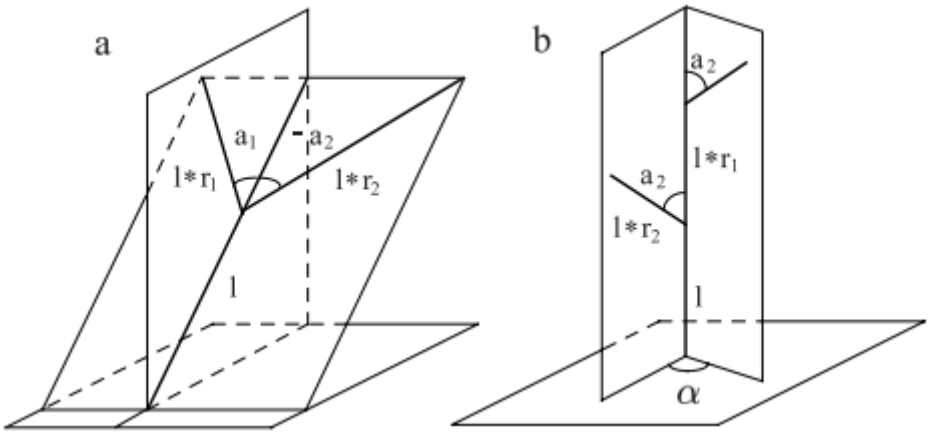


This is a very basic overview of course and I will research further into this method once I am sure of the scope and aim of the project. Whether I use this method or not however, I believe that this paper and it's references will be of great use moving forward.

4.2 The Algorithmic Beauty of Plants

This book Przemysław and Aristid (1990) provides many insights into the algorithmic construction of plants. After a brief look through it seems that the most relevant section will be chapter 2 "Modeling of trees" which puts forward a method of generating branches through a *mother branch* having two *daughter branches* that split off from it. These daughter branches are shortened using constant ratios with repect to the mother branch and are angled from the mother branch using constant *branching angles*. The mother branch and daughter branches are contained in the same *branch plane*.

Figure 2: Proposed tree geometry



This book was co-authored by Przemysław Prusinkiewicz who was also a co-author of the space colonization paper I referenced previously. It seems that his research into the 3D construction of plants will be useful while researching for this project. Once I am sure of the direction I'm taking the project I will read into this book more closely to glean more details that could aid my progress.

References

Adam, R., Brendan, L., and Przemyslaw, P. (2007). Modeling trees with a space colonization algorithm. *http://algorithmicbotany.org/papers/colonization.egwnp2007.large.pdf*.

F12 (2014). 3d tree growing software - the grove. *https://www.thegrove3d.com/*.

IDV Inc. (2017). Speedtree – 3d vegetation modeling and middleware. *https://store.speedtree.com/*.

Przemysław, P. and Aristid, L. (1990). The algorithmic beauty of plants. *http://algorithmicbotany.org/papers/#abop*.

CMP - 6013Y **Student registration number:100203952**

Project proposal

Description of project: aims, motivation, understanding of issues, problems	First	2.1	2.2	3	Fail
Resources, references: evidence of preliminary work to identify key resources, initial reading	First	2.1	2.2	3	Fail
Proposed approaches: relevance, suitability, appropriateness	First	2.1	2.2	3	Fail
Risks: identification, suitable contingency planning	First	2.1	2.2	3	Fail

Quality of writing

Clarity, structure correctness of writing	First	2.1	2.2	3	Fail
Presentation conforms to style	First	2.1	2.2	3	Fail

Workplan

Measurable objectives : appropriate, realistic, timely	First	2.1	2.2	3	Fail
Gantt chart: legibility, clarity, feasibility of schedule	First	2.1	2.2	3	Fail

Comments

Supervisor: Dr. Stephen Laycock

Markers should circle the appropriate level of performance in each section. Report and evaluation sheet should be collected by the student from the supervisor.