# GPU Accelerated Method for Constructing and Rendering Trees

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# Literature Review

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# 1 Introduction

The rendering of trees has advanced greatly from the early days of real-time applications. The earliest method of adding trees to an environement would be to simply load in a flat image of a tree and then have the image rotate to face the view point of the camera. This was acceptable for single placed trees but for areas with many trees the likely approach would be to repeat the image around the central axis of the tree to give a sense of volume.

Developments in graphics hardware allowed for more detailed models to be used in real-time applications. This would've started with more simple manually modelled trees with actual branches and leaves applied using bill-boarded textures or sometimes individually for games with less demanding environments.

Presently, trees are added to real time environments as fully developed realistic looking models. Trees are constructed and rendered using software and then loaded into a scene, with the exception of some that may be modelled manually if a specific shape or look is needed for the tree.

This project is a similar system, aiming to be able to produce realistic and varied looking trees in a real-time application to help bring life to an environment. The following section will provide a brief description of the project, the areas of knowledge required to complete the project and a general roadmap for the rest of the document.

## 1.1 Description

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

A key reason for wanting to include trees in computer generated environments is that trees, and other foliage, are what give life to that environment, a forest is not a forest without the trees and having an easy method of including trees in a landscape will mean that making that landscape more realistic and engaging becomes easier.

## 1.2 Knowledge

The key areas of knowledge required to complete this project are as follows:

- Branch Growth - The technical knowledge to produce natural looking branches will be most important to the success of this project, if the branches of the trees do not look naturally shaped then the final tree will not look realistic.

  The method used for naturally formed branches will be decided from researching multiple sources to find a suitable algorithm that can be implemented as efficiently as possible.

- Leaf Placement - Similarly to the issue of branch growth, the placement of leaves on the tree branches will also be important with respect to making the rendered trees look realistic.

  The method chosen will also similarly be researched from multiple sources to find the most appropriate algorithm for efficient implementation.

- Texturing - The textures applied to the trees after the geometry is finalised will not be as essential as the previous points but it will still play a key role in making the trees look realistic.

  A method will need to be used to correctly apply a bark texture to the trunk and branches of the tree without jarring edges being noticeable. The same attention will also need to be given to the leaf texture and the decision of whether to include some transparency in the leaves.

- Branch Pathing - This can be grouped with the branch growth section as a possible extension. The idea that an obstacle could be used to obstruct the growth of the tree's branches and the branch growth algorithm would take this into account and render the tree to look it has grown to avoid the obstacle.

  This would help the rendered trees properly integrate with the environment they're placed in and add a more realistic feel.

- Root System - A possible inclusion would be a ground level root system for the trees, not a fully rendered underground system as that would be pointless, but some of the roots of larger trees will be visible around the base of the tree.

  Some variation could be added to the trees by not having them magically sprout from the ground and instead showing some of the ground roots. A method would have to be chosen to model this, possibly using the sam method for the branches but reversed.

## 1.3 Roadmap

The following sections of this document will include: comparisons of material related to the project to be used to inform the direction that will be taken in design and development, following the material comparisons - a discussion of the key issues and themes related to the project and how some of the discovered materials can be used to understand these facets, and finally an evaluation of the document containing a critical review of the content presented throughout.

# 2 Comparisons of Related Material

This section will include a description of the methods used to find relevant materials to discuss around the project and a comparison of these materials where overlap is found.

## 2.1 Search Method

Relevant papers were found using google scholar and using search terms including "real-time", "rendering", "modeling" etc. effort had to be made to avoid papers referring to data structure related trees and focus was given to making sure that the chosen material was about real-time rendering in evironments and not just methods for generating premade models.

The different papers have varying focuses not all exactly about the rendering of trees, some were chosen to give some possibly needed background tht will be relevant to the project less directly such as talking about fast rendering of large environments including trees.

Papers where not excluded based on date of release as the methods discussed are mostly algorithmic and not necessarily dampened by advances in technology, most relevant papers have been released withing the last 20 years however due to that being when hardware became powerful enough to begin this form of research in earnest. The papers chosen were also checked to have around 20 and above citations which should show that they have acceptable credibility.

## 2.2

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

**Literature review**

| | | | | | |
|---|---|---|---|---|---|
| Introduction: brief description of project, areas of knowledge required, roadmap | First | 2.1 | 2.2 | 3 | Fail |
| Discovery of suitable quantity and quality of material | First | 2.1 | 2.2 | 3 | Fail |
| Description of key issues and themes relevant to the project | First | 2.1 | 2.2 | 3 | Fail |
| Evaluation, analysis and critical review | First | 2.1 | 2.2 | 3 | Fail |

**Quality of writing**

| | | | | | |
|---|---|---|---|---|---|
| Clarity, structure and correctness of writing | First | 2.1 | 2.2 | 3 | Fail |
| Presentation conforms to style (criteria similar to conference paper reviews) | First | 2.1 | 2.2 | 3 | Fail |
| References correctly presented, complete adequate (but no excessive) citations | First | 2.1 | 2.2 | 3 | Fail |

**Revised Workplan (if applicable)**

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|---|---|---|---|---|---|
| Measurable objectives : appropriate, realistic, timely | 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.