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2021

GPU Accelerated Method for Constructing and Rendering Trees

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Abstract

This project aims to convert and extend the Lindenmayer-system based tree construction method presented by (Prusinkiewicz et al., 1996) to be used as an independent OpenGL module. The module should allow the addition of trees to a real-time environment with minimal user interaction, avoiding the difficulties and expenses of manually producing tree models.

Acknowledgements

I'd like to thank my supervisor, Stephen Laycock for his brilliant help and support throughout this project. Thank you to George Smith and Harry Tucker for their interest in my work and their support during the COVID-19 lockdowns.

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1 Introduction

1.1 Context

Creating and rendering realistic models of trees manually requires advanced expertise with modelling software packages. This limits the ability to produce convincing 3D scenes for small developers with restricted resources.

The purpose of including trees in a natural environment is to provide realism. Trees are common natural structures present in even simple environments throughout the history of computer graphics and have seen many iterations as technology has advanced allowing for more detailed and realistic approaches.

The aim of this project is to provide a method for creating and rendering trees to be used in a real-time graphics application. This method should be simple to use and implement into an existing OpenGL project.

1.2 Related Work

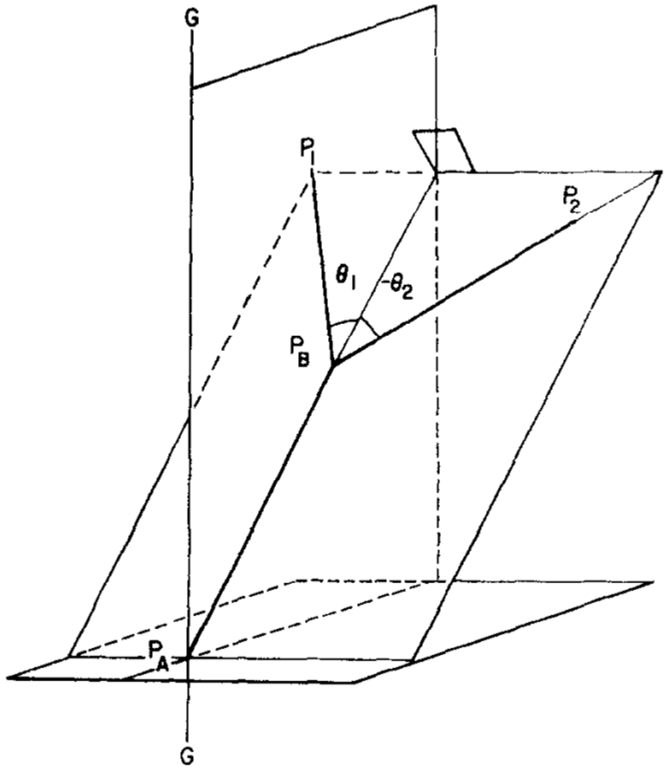
In this section various related works will be discussed with respect to how they contribute to the main knowledge required for this project. These areas of main knowledge are the branching structure, branch thickness and leaf placement of the constructed trees.

A paper by Lindenmayer (1968) proposes a theory for the development of organisms using a cells current state and being combined with input that the cell receives from its neighbour. Two new cells are produced from this development to replace the existing cell and the cycle repeats for the two new cells.

This process of generating new outputs recursively to produce larger structures became “Lindenmayer systems” or the abbreviated “L-systems” which became important tools in pattern generation for future applications. L-systems became a common approach for the generation of branching patterns in flora which is where the aim of this project is concerned.

Another early paper that is referenced by many later studies of the subject is by Honda (1971) where he presented one of the earliest algorithmic methods for creating a branching structure. This was done by starting with a parent branch which then bifurcates into two child branches and rotating them by given angles about the termination point of the parent branch, an example of which can be seen in Figure 1. By continuing this method they treated each child branch as another parent and bifuracted them to expand the branching structure which would be continued until a desired result is reached.

Figure 1: Example diagram of parent branch P_AP_B bifurcating into child branches P_BP_1 with a rotation of θ_1 and P_BP_2 with a rotation of $-\theta_2$



This paper does not include any information relating to branch thickness or leaf placement as its focus was only on the branching structure. However, this paper provides a groundwork for many later studies that will be discussed in this project.

References

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