

Computer Games Development

Project Report

Year IV

“An Investigation into the Implementation of a Voxel-Based Map Generator”

Alan Bolger

C00232036

[Date of Submission]

[Declaration form to be attached]

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# Acknowledgements

Meh.

# Project Abstract

*“An Investigation into the Implementation of a Voxel-Based Map Generator”*

*Alan Bolger*

This project aims to find out what the best practices are when building a voxel-based map generator, and what programming techniques can be used to improve the storage efficiency and overall performance. Research will have to be carried out on several different subjects to aid in this. These include:

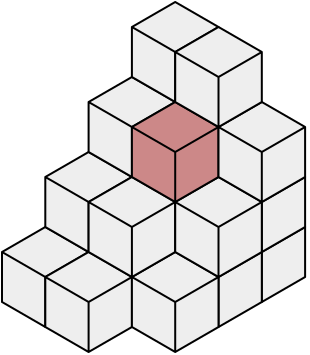
* Voxel Data Storage
* OpenGL (Graphics API)
* Raytracing (Experimental)
* Procedural Generation of Maps (Noise Maps)
* UI Implementation

# Literature Review

The following are literature subjects that were investigated during this project:

* **Voxels**

A voxel is a data point that is stored on a uniformly spaced 3D grid. The name came from a combination of the words ‘volume’ and ‘pixel’. A voxel is similar to a pixel in the sense that they do not usually have their position defined in their dataset. When rendering voxels, the position of a voxel is known by its position in relation to its surrounding voxels.

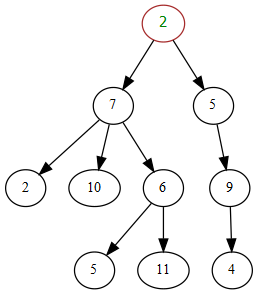


*A series of voxels in a stack, with a single voxel shaded.*

By Vossman; M. W. Toews - Own work; originally created in w:Adobe Illustrator, and later in a text editor, CC BY-SA 2.5, <https://commons.wikimedia.org/w/index.php?curid=1313585>

Voxels have been used in many games over the past several years, and are normally associated with blocky type games (such as Minecraft), but voxels don’t have to be cubes. Voxels are really only a point, and this point is only relative to the other voxels around it, which means it is up to the game renderer to decide the dimensions of the voxel and the space between each voxel.

* **Voxel Data Storage (Octrees)**



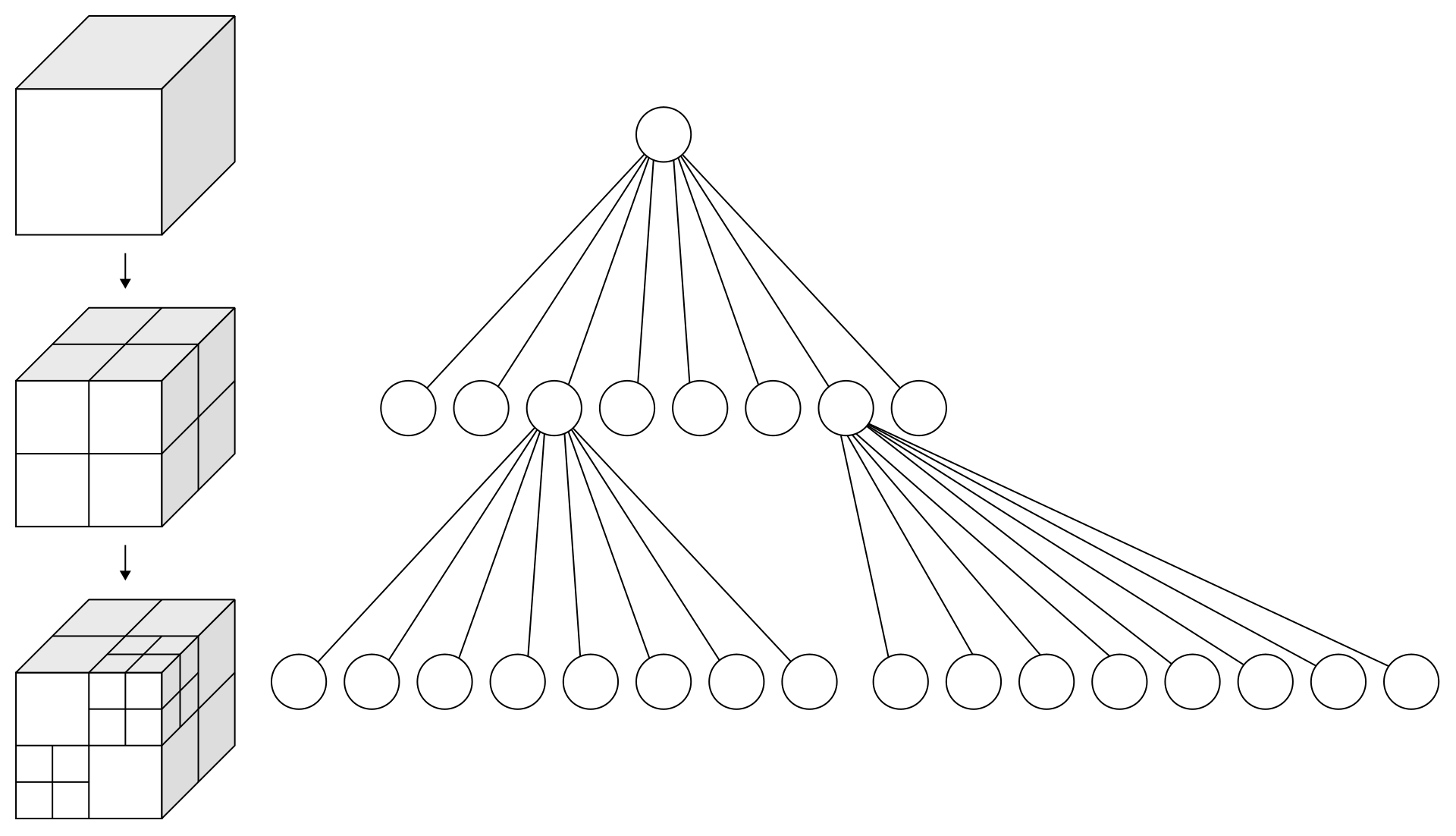
*A diagram of a tree data structure.*

By Paddy3118 - Own work, CC BY-SA 4.0,

<https://commons.wikimedia.org/w/index.php?curid=83223854>

Octrees are a type of tree data structure. A tree is a data structure that mimics a hierarchical tree structure (see diagram above) and has parent nodes with subtrees of children and a root value.

In an octree data structure, each internal node has eight children. Octrees are widely used as a way to divide 3D space into smaller sections by subdividing nodes recursively into eight octants.



*A diagram of the subdivision of an octree’s nodes.*

By WhiteTimberwolf, PNG version: Nü - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=9851485>

Point region octrees store a 3D point, or position, in each node. This point is the centre point for the subdivision of that node. Each of the eight children of a node represent a corner point, and these corner points make up the node’s bounding box. In matrix based octrees, it is the centre point of the area that the node represents which is used as the subdivision point.

At their lowest level, an Octree’s structure matches the uniformly sized cells that are needed to store a voxel world. They can also provide tight compression of sparsely populated areas. These particular octrees are called Sparse Voxel Octrees (or SVOs).

However, the time complexity of searching and inserting to an octree is O(log(N)) where N is the number of octree nodes.

* **Voxel Data Storage (Octree Alternative)**

An alternative to using an octree would be to use an array-based storage system. An array is a data structure that contains elements, with each element storing some data. In additional to being single dimensioned, arrays can also be stored and accessed as 2-dimensional arrays (x and y index positions) or 3-dimensional arrays (x, y and z index positions).

If a 3d array was used to store voxels, then the x, y and z index position of any element storing a voxel in the array would be the voxel’s world position. Also, arrays are extremely fast when accessing any given element, and the time complexity of accessing an element is O(1), which means no matter how big the array is in size, it will always take the same amount of time to access any element in that array.

Arrays tend to take up more memory than octrees, but this problem can be overcome with some good memory management.

* **Raytracing**
* **Procedural Generation of Maps**
* **GPU Compute Shader**
* **UI Implementation:**

# Evaluation and Discussion

Replace this text with Results and Discussion.

Describe the results using diagrams such as graphs etc. as appropriate, and discuss what the results mean.

Example: Results indicate that once the threshold gets over a certain point it significantly reduces player performance and player experience

Project Milestones

Key project milestone dates and measurement on schedule, was project schedule adhered to, effectively planned for delivery on-time or ahead of schedule if appropriate.

Major Technical Achievements

What are your major technical achievements?

Project Review

What went right? What went wrong? What (if anything) is still outstanding/missing (i.e., still left to do)? If starting again, how would you approach this project differently? What advice would you have for someone attempting a similar project in the future? Were your technology choices the right or wrong ones? If you chose the wrong technology, provide justifications for why you think this. What were the implications of your technology choices?

# Conclusions

summarise your work and findings.

Future Work

Indicate what might be some next steps to try (if a student next year was going to undertake a project in this area what might be an interesting thing for him/her to examine?).

# References

# Appendices

Replace this text with Appendices.

This might include ethics application and other relevant material e.g. copy of any questionnaires used.