Generated Voxel World with Procedural Soundtrack

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# Overview

This application consists of an endlessly[[1]](#footnote-1) generated voxel world and a procedurally generated soundtrack.

# Outline

### How to use the application

|  |  |
| --- | --- |
| Action | Control |
| Move forward / backwards | W / S |
| Move left / right | A / D |
| Move up / down | E / Q |
| Change render distance | ImGui slider |
| Enable wireframe | ImGui tickbox |

### Notes on use

The application uses the standard wsadeq movement provided by the framework.  
Wireframe mode is also provided by the framework.  
An additional slider was added to control the “render distance”; the number of chunks away from the player in a square with side length of double this render distance (as the distance is the number of chunks past where the player is standing in each cardinal direction). This does not affect the camera’s “render distance” (far clipping plane) which remains unchanged at 1000 units no matter how the player sets this slider.

Note, it is not advised to set the render distance too high as it can significantly affect performance. The (admittedly not overly powerful) machine it was developed on can handle a render distance of three (36 chunks loaded) comfortably but begins to struggle when loading in chunks at higher render distances. The application is not designed to run at these higher settings, they are included only for demonstration.

The application may also take some time to load initially.

### General features

The application uses the directX-11 framework provided (Robertson, n.d.) and the instance cube shader that is a part of this. This shader combines a list of cube positions (“render queue”) into a single render call allowing for very efficient rendering of a large amount of geometry.

The soundtrack makes use of the SFML library (Gomila, a) to output the samples generated to speakers.

#### Terrain

The world is split up into 16x64x16 voxel “chunks”. These chunks can be loaded and unloaded to the render queue very efficiently, allowing for a player to walk about the world as it loads in and out around them in real time.

Chunks are cached in memory after generation, allowing for recently traversed areas to load in faster and more efficiently.

The chunks use fractional Brownian Perlin noise to generate a coherent yet varied terrain with large hills, and deep valleys.

The voxel’s texture is generated by blending between three textures based on the height of the voxel. Hills are covered in grass, which smoothly turns to silty sand, which turns to rock as the terrain gets to its deepest.

#### Soundtrack

The soundtrack generates note samples from a sine wave and passes these samples through a buffer to an object deriving from SFML’s sf::SoundStream (Gomila, b), which plays them.

Notes of a given pitch are created through modifying a standard 440hz A440 pitch (ISO, 1975) through 12-TET tuning to generate each note in an A Major scale.

The generated notes are combined into triads or seventh chords, in root, first, or second inversion, and randomly move through the octaves, to provide variation without changing the chord’s harmonic function.

The system uses a Markov chain with each chord being a state and moves between states through rules based on a functional harmonic progression (Hutchinson, 2020).

The system generates a melody through a system of rules. Randomly, either stepwise or “leaping” motion is chosen, to lead from the previous note. Stepwise will move the note one to two notes up or down in the scale, leaping motion will move to a random note within the scale, favouring notes from the more stable and more consonant pentatonic scale (which is a subset of the major scale) associated with the key (A Major pentatonic).

# Techniques Used

An in depth explanation of the procedural techniques used, and why they were chosen.

##### Terrain

## Perlin Noise

### Noise

A noise function is a pseudorandom function that is coherent. Such that, for a given input, a small delta will result in a small but unpredictable change in output value, and a large delta will result in a random output value. Perlin noise is a famous example of this (Perlin, 1999) using gradient noise.

### Ken Perlin’s Algorithm

The application uses an adaptation of ken Perlin’s original code (Perlin, 1997)

### Fractional Brownian Motion

## Chunk Multithreading

## Chunk Caching

## Texture Blending

## Markov Chains

## notes init, idk

## Generating sound eh

## Audio multithreading

## Music theory

# Architecture

# Critical Appraisal

Umm all those threads

Mimecft runs like ass anywas

# Reflection

# References

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Robertson, P., n.d. *Abertay directX-11 framework for education in various modules.* Dundee: Dr Paul Robertson.

* 12 tone even temperament
* Functional harmony
* Why major not minor (3 types of minor)

1. The world is split up into chunks whose coordinates are hashed as integers, so after a player walks a number of chunks past INT\_MAX, this would begin to repeat, so the limit is realistically 2.1 × 109 chunks, effectively endless to a casual player. [↑](#footnote-ref-1)