"GROWTH": DRONE MUSIC PROGRAMMING VIA JUCE AND DIFFUSION-LIMITED AGGREGATION ALGORITHM

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ABSTRACT

This is a audio programming project about the process of random growth, aimed to explore the interactions among music, programming, environment, and physics. The author build a drone piece of music, use "diffusion-limited aggregation" algorithm to simulate the process of random motion of molecules, and use the latter to control the parameters of the former, which show how the music will grow up if music itself has its own life. The author also incorporated a visualization and a user interaction system, allowing users to freely watch and control the growth direction, rate, and other aspects of the Brownian tree.

1. INTRODUCTION

Interactive music design is not merely about creating a visualization of the music; rather, it requires abstracting elements from other modalities and using these parameters to control the changes in the music. From this perspective, this work attempts to explore the vitality of music itself through algorithms. At the same time, the growth of all things in the world is silent and gradual. We usually cannot observe drastic changes in the growth of life over a short period, but as time progresses, we suddenly realize that life has grown to almost take on a new form. Therefore, the author attempts to use algorithms to control the slow evolution of the music and visualizes it, allowing the audience to clearly see how the Brownian tree and the music grow together. Visually, this work resembles a tree growing according to a certain random rule, and as the tree's growth direction and rate change, the music undergoes corresponding transformations. All the sound elements are related to the theme of growth. The project mainly consists of five parts: the Brownian tree, rich sound, pluck sound, gain, and panning.

2. METHOD

2.1 Brownian Tree

The diffusion-limited aggregation model, also known as the Brownian tree, is an algorithm based on Brownian motion. Initially, there is a stationary molecule at the center of the screen, while other molecules approach from all sides, moving in a random, unpatterned manner. Once these molecules reach the vicinity of the stationary molecule, they too become fixed in place, and new molecules continue to arrive. This process repeats, and eventually, the molecules that have been fixed will form a strangely shaped structure, also referred to as a Brownian tree. The author set four outputs which reflect how much the tree grows in each direction, and use these four outputs to modulate some important values.

2.2 Rich Sound

In this project, the author generated two sound groups: one consisting of sawtooth wave sounds and the other of square wave sounds. Each group contains multiple notes, with adjustable frequencies and quantities. Within each group, individual notes can have several sub-oscillators, each with tunable detuning parameters, enabling the creation of a rich and complex sound texture. Additionally, the author introduced a small amount of white noise to further warm the sound. A sine wave low-frequency oscillator (LFO) was applied to modulate the filter's cutoff frequency, and the unidirectional growth of a tree structure was utilized to control this sine LFO. As the tree gradually grows over time, the modulation range of the filter's cutoff frequency progressively expands, resulting in a dynamic evolution of the sound.

2.3 Pluck Sound

An envelope with "ADSR" is made in this part through refining the modulator class. The author designed an envelope class that inherits from the phasor class. In addition, the author utilized two sine waves and one triangle wave, applying this ADSR envelope to modulate the volume of a pluck sound, creating a rhythmic pattern reminiscent of a heartbeat—an auditory representation often associated with living organisms. Furthermore, the unidirectional growth of the tree is used to modulate the heartbeat's tempo. As the tree continues to grow, the heartbeat's speed gradually increases, reflecting the dynamic nature of growth.

2.4 Volume

The author utilizes the unidirectional growth of the tree to modulate the volume. As the tree extends upwards, the volume correspondingly increases. Additionally, this increase in volume begins gradually but accelerates over time. This is due to the fact that, as the tree grows, the number of fixed molecules increases, which in turn facilitates the capture of active molecules by the tree structure, leading to a more rapid volume expansion.

2.5 Panning

The author implements a panning class with stereo output, utilizing a sine wave low-frequency oscillator (LFO) to modulate the panning, resulting in continuous movement from side to side. Furthermore, the growth of the tree in a single direction is employed to modulate the panning width. Initially, the sound is centered, but as the tree expands, the panning width increases, causing the sound to gradually shift between the stereo channels from one side to the other. At last, the author send the whole sound buffer to a reverb function, so that the sound becomes milder and more beautiful.

3. INTERFACE

3.1 Speed

Two buttons are set: watering and pruning, which means speed up and speed down the growth of the tree.

3.2 Direction

Five buttons are set: up, down, left, right, and random, which can control the orientation of the tree's growth and make different sound. For instance, if the "left" button is clicked, the molecules will generate from the top of the screen, which will let the tree more likely to grow toward left direction, then lead the range of cut off frequency of the filter larger.

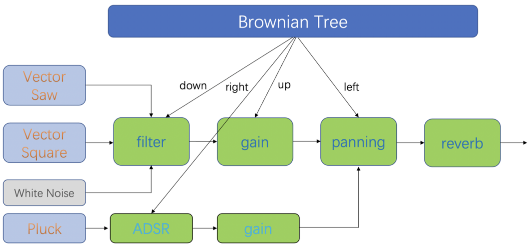

Figure 1. Structure

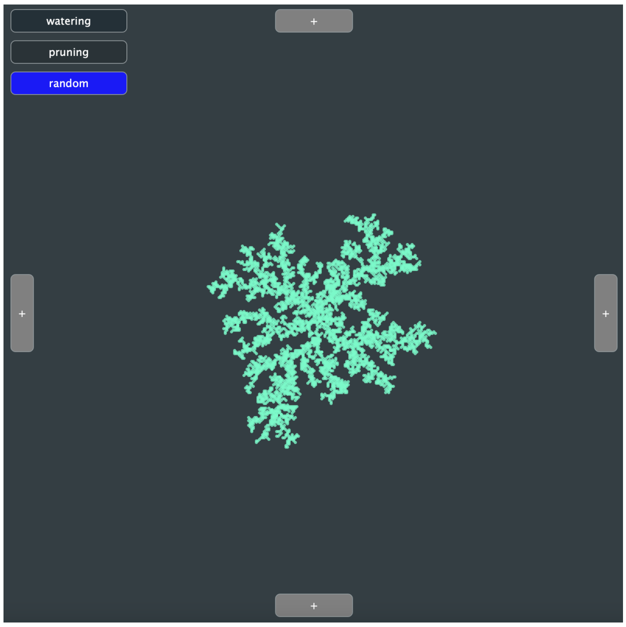

Figure 2. Interface