Self–Similar Grain Distribution : A Fractal Approach to Granular Synthesis

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Abstract

This paper outlines the techniques behind, and results from, an investigation into the adequacy of a range of fractal–driven methods for granular synthesis. The paper contains an outline of the project aims, the methods investigated, and results obtained from these investigations.

1 Introduction

Granular synthesis allows for the specification of a complex sound as the assemblage of a number of simple sonic quanta (grains) [Roads, 1988]. The task of describing a sound is therefore one of providing a set of grains distributed over the space of their own parameters. The large quantity of grains required implies the necessity for an algorithmic approach to grain generation. The large number of approaches taken with this regard have included stochastics [Xenakis, 1971], genetic algorithms [Fujinaga and Vantomme, 1994], and non–linear systems [Hamman, 1991].

Fractals and chaotic systems have been used in computer music to drive a large range of processes [Truax, 1990] from compositional algorithms [Bidlack, 1992] to the direct generation of waveforms [Dobson and Fitch, 1995]. This paper outlines an investigation into the potential usefulness of such systems to drive the generation of granular distributions. The research is therefore concerned with analysing the effectiveness of a number of fractal–based techniques with particular regard to compositional considerations [Harley, 1994]. The following text, therefore, describes the methods by which some of these techniques have, and are continuing to be, examined.

2 Equations

The generation of fractals in the complex plane by the measurement of the divergence of a recurrence equation can cite the Mandelbrot set as its most famous example. The translation of such sets of data into sound is akin to the process of audification [Kramer and Ellison, 1991], an example of which in the fractal domain may be found in [Gogins, 1995]. The generation of a granular distribution, therefore, adheres to the following three steps.

(i) Selection of recurrence equation and the test for divergence.
(ii) Selection of mapping from points to grains.
(iii) Selection of the path through the fractal, and summation of the results of this navigation.

To facilitate the investigation of each of these steps a computer language (**Amy**) has been implemented in which equations, mappings to grains, and navigation can be specified and processed to produce the resulting sound. The **Amy** language has been given to a number of researchers, and composers, to gain feedback regarding the usefulness of the program, and the approach it implements.

3 Recursion

Given that all our classes of grains have at most *n* distinct parameters,we may represent any grain as a point in an n–dimensional space given by the Cartesian product of each grain parameter's dimension. We can then proceed to choose a subset of this space, and *decorate* this with grains by choosing a number of points to add to a set of grains to render. If we then *divide* our original set into a number of non–equal subsets, we can repeat the process of decorating and dividing upon these, and continue recursively onwards to a specified depth, or ad infinitum. In cases where the methods of decoration and division repeat themselves, we can produce a self–similar distribution of grains. The production of a distribution of grains via this method requires the selection of the following.

(i) Selection of the granular space.
(ii) Selection of the dividing function.
(iii) Selection of the decorating function.
(iv) Selection of which sections to hear at a given time.

A program has therefore been implemented, and distributed, to test the above approach in a similar fashion to the equation–based technique.

4 Conclusions

The equation–based technique provides a great amount of complexity from a small quantity of specification. However, unlike the recursive method, is is restricted in terms of the amount of data described by a single point, making mapping to more complex grains overly trivial.

Future research will entail the development of better tools for specifying the parameters for each technique. An example of this will be a graphical tool for navigating through a fractal whilst generating and editing grains, to produce **Amy** code to drive the synthesis of the resulting sound. This will further aid the task of analysing the properties of granular sounds produced with the above techniques.

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