

CONSTRUCTION IN KNEADING: AUDIOVISUALISING THE MANDELBOX

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ABSTRACT

Construction in Kneading is an immersive live audiovisual work incorporating elements of both auditory display and music. It involves simultaneous data sonification and visualisation of a generative system based on the Mandelbox. This text introduces techniques found in the work and their precedents including “audiovisualisation” (simultaneous data sonification and visualisation), “self-similar sonification” (sonification at different time-scales), sonification as auditory display / music, and sonification at audio rate as audification and non-standard synthesis.

1. INTRODUCTION

Construction in Kneading (CiK) is a live generative audiovisual work. It can be performed live using multiple channels of video and audio, surrounding the audience in sound and moving image. It performs simultaneous sonification and visualisation – or “audiovisualisation” [1] – of a generative system based on the Mandelbox [2], an n -dimensional fractal inspired by the Mandelbrot set. Its recursion formula resembles the actions of kneading dough in bread making, similar to the baker’s map. A performance consists of an improvised duet/duel between a human and a machine, where the performer manipulates parameters and audiovisualisation processes of the semi-autonomous generative system in real-time. The work is implemented in Max/MSP/Jitter.

2. MANDELBOX

The Mandelbox is a recent escape-time fractal inspired by and based on the famous Mandelbrot set. The recursive algorithm involves the following four steps [2]:

1. Fold in area past length L from the origin along each axis.
2. Fold out circle past radius R from origin in each dimension.
3. Multiply by scale S .
4. Add constant C .

Standard variable values are $S=2$, $R=0.5$ and $L=1$.

CiK is the first and only example of the sonification of the Mandelbox.

3. AUDIOVISUALISATION

Simultaneous sonification and visualisation of the same data source has been studied in the field of auditory displays [3] [4] [5]. Although the findings may be considered preliminary [6] [7], factors highlighted are nevertheless useful in understanding the potential of audiovisualisation, developed in an artistic context in *CiK*. The use of visualisation provides an additional means by which the underlying data

may be presented to the audience, thereby reinforcing through the duplication of data or supplementing the sonified data, the effect being more than mere “mickey-mousing” [1]. Aesthetic concerns in the sound and moving image are also considered alongside clarity, with the two being balanced in varying ways in the three sections of *CiK*.

Relevant existing artistic examples to *CiK* include pioneering work in optical sound in which waveforms were represented visually, carried out around 1930 in Russia and Germany. Additional analogue precedents include John and James Whitneys’ *Five Abstract Film Exercises* (1941-44), Norman McLaren’s *Synchromy* (1971), Lis Rhodes’s *Dresden Dynamo* (1971) and Steve Farrer’s *Ten Drawings* (1976) which feature film animation derived from or identical to the drawn optical soundtrack. Analogous processes are performed in *CiK* through audification and visualisation in the digital domain which additionally enables real-time generativity and live manipulation. Relevant examples in the digital domain include chdh’s *vivarium* (2009) and Mick Grierson’s *Delusions of Alien Control* (2006-9) which sonify and visualise physical models and escape-time fractals respectively. They are, however, limited to the use of sonification at one time-scale e.g. at audio rate (audification) or control rate (parameter mapping sonification).

4. SELF-SIMILARITY

In *CiK*, data is used simultaneously at audio rate, control rate and sometimes at “phrasal” level (relating to phrases at time-scales of approximately 1 to 30 seconds) through an approach which could be described as “self-similar sonification” [8]. This refers to the use of data as sound at multiple time-scales, which also provides formal coherence in the audiovisualisation of a fractal.

Self-similarity as a concept has been used in the description, analyses and composition of classical and contemporary music [9][10][11] where the smallest possible unit remains the note. In contrast, digital audio allows for its audio rate use, significantly extending the scale at which self-similarity can be applied. Fractal processes have been used at the scale of audio samples [12][13]. Theoretical explorations may also be found [14]. Otherwise, its practical application remains limited.

A precedent to self-similar sonification may be found in the work of Iannis Xenakis who suggests the use of generative processes at both audio and control rate [15]. However, it is only evident to a limited extent in his *GENDY3* (1991) where the microlevel is determined by his dynamic stochastic synthesis program GENDY3, and the larger scale structure is controlled by an additional program PARAG.



5. AUDITORY DISPLAY / MUSIC

CiK is an example of a work with elements of both auditory display and music [16]. Apt descriptions for the interdisciplinary approach include Grond and Hermann's, who state that "sound becomes sonification when it can claim to possess explanatory powers: when it is neither solely music nor serves as mere illustration" [17], whilst Vickers and Barrass refer to the middle ground between information visualisation and data art [18].

The Mandelbox is audiovisualised using an increasing number of dimensions in each part of the work. Part 1 visualises one dimension (i.e. line) of the Mandelbox, sonified using inverse FFT resynthesis. Part 2 visualises two dimensions (i.e. slice), sonified using audification. Part 3 visualises three dimensions (i.e. volume), sonified using both inverse FFT resynthesis and audification.

Both audification and FFT resynthesis operate at audio rate, the analogous method found in music being non-standard synthesis [17] where "sound is specified in terms of basic digital processes rather than by the rules of acoustics or by traditional concepts of frequency, pitch, over-tone structure, and the like" [19]. Existing examples include the aforementioned *GENDY3*.

6. DISCUSSIONS ON APPROACH

CiK has been performed on over 20 occasions ranging from computer and visual music conferences to experimental music and art festivals where its context as auditory display may be appreciated to widely varying degrees [20].

Data from the Mandelbox are emergent: they are dynamic and unpredictable, producing ostensive macro-level coherence. In *CiK*, the combined use of sonification and visualisation facilitates the perception of such properties as well as the use of sonification at multiple time-scales e.g. ordered repetitions may manifest visually as straight lines, flat surfaces or regular grids, and sonically as timbres with prominent pitches and repetitive rhythms or phrases, whilst chaotic patterns may manifest visually as jagged lines, uneven surfaces or irregular volumes and sonically as noisy timbres and less repetitive rhythms or phrases. The main sources of interest are, however, what may be observed in between these two poles which could be described as classic characteristics of emergent behaviour. Individual responses to the work have been varied but in general, the initial pure sensory appeal is followed by a gradual understanding of its relation to the data through the audiovisual relation.

7. ONLINE DOCUMENTATION

Documentation of single-channel video live performances of *CiK* are available online [21][22], as are excerpts from the fixed-media single-channel video version [23]. Documentation for the 4-channel video and quadrasonic version, *Construction in Kneading* [surround], may be found on the author's website [24].

8. REFERENCES

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