Graphical Control of Granular Synthesis using Cellular Automata and the Freehand Program

Richard Orton, Andy Hunt, Ross Kirk
Music Technology Group
University of York
Heslington, YORK YO1 5DD
United Kingdom
Email: r01, adh2, prk1 @ uk.ac.york.vaxa

ABSTRACT: Freehand is a graphical drawing program designed for multiple outputs: to Csound, a DSP environment (MIDAS), a set of Composers' Desktop Project signal processing routines (Groucho), and MIDI. Recent work has focused on its use with granular synthesis techniques, permitting streams to be specified in terms of density, frequency movement, bandwidth and relative amplitude. A novel feature is the use of cellular automata to filter or otherwise modify the output by mapping the cellular automata to the tendency masks produced by the Freehand output. Comparative musical examples will be given.

Freehand

The essential features of the Freehand program were briefly discussed in a paper at ICMC, Glasgow 1990. Traces which represent musical events can be drawn with a mouse, grouped into objects, and mapped to a choice of one or more outputs. The output to Csound has been extensively used while awaiting the MIDAS hardware. Freehand creates a number of files: input files, which are data-reduced representations of the screen traces, and output files, for example a Csound score and a number of data tables which are written in floating-point format (as floatsamps) to the Composers' Desktop Project (CDP) soundfile system. That they are written as soundfiles is largely a matter of convenience: there can be very many files, and the soundfile area is normally a large block of disk memory capable of storing multiple files. Conversion facilities to normal operating system files and back again exist if these were to be required.

![Diagram of Freehand menu items]

Fig 1: Collage of Freehand menu items
Each of these tiles contains 1K of floats, lying between ambitus 1 and plus 1, calculated from the screen coordinates of the traces drawn. In all cases, if using the standard CDP 640 by 400 pixel screen, interpolation between screen points has taken place in order to expand the data to 1K. The most typical use of such trace-data is to regard them as controls to an oscillator, permitting, for example, glissandi of arbitrary complexity to be made. Within CSound, these tables can be read by GEN 01, and mapped to whatever frequency input is required. Within Freerand it is possible to set frequency limits as offsets which are then written into the CSound score, enabling reinterpretations of the same data to be made with different results. However, as will be readily understood, the data can be mapped onto other parameters, and it is this possibility which has been used to explore the granular synthesis technique.

Parameters for Granular Synthesis

Let us briefly consider the parameters which we might wish to control in creating granular streams. These might be: stream density (i.e., the average number of streams occurring at a particular time); the frequency trajectory of streams; the bandwidth of frequency displacement around the trajectories; the spatial location of a stream, and the positional spread of the grains within the spatial soundfield; the relative intensity of streams, and the degree of amplitude variation permitted within a stream. This is by no means an exhaustive list, but will suffice to indicate that a great many controls are possible, particularly when we wish to vary these parameters during the course of the evolution of streams.

There is actually a further important feature, which at least in the CSound implementation of granular synthesis adopted here is tackled by a different route: the harmonic/inharmonic content of the source grains used. There exists within the CDP system a means of graphically controlling the evolution of paritals within additive synthesis, where up to sixty-four paritals can be individually controlled. By adopting this method, the individual grains can be shaped quite precisely, and the amplitude and frequency values set as scalars to the frequency and amplitude content of the individual grain data, using the addumon generator.

So Freerand traces may be suitably scaled within the score and sent as controls to whatever unit generator output is required for a particular function. The user can assign each trace output to one or more granular control parameters. The same trace may be used for several different controls, with different scales of output, or separate traces may be created to control as many different functions as required. In practice, Freerand has been found to be most useful in controlling those aspects which lend themselves to visualisation, such as the control of frequency sweeps and spatial positioning, while other more statistical data is usually left to control from the score.
Since scores contain many thousands of individual events, it is important to find an automatic way to produce them. One method is to use CScore to generate the score according to stochastic principles from special format data files. Here the broad tendencies of the streams to move in a particular direction can be described in the data file, which is then given particular detailed shape by the application of CScore. We envisage two methods by which this may be done: the first, which we term ‘parallel’ streaming, is achieved by creating a single Freemandata trace which provides the tendency mask. Successive perturbations based on stochastic processes are applied to the mask in order to produce multiple stream outputs to the stream density required. The second method, which we term ‘serial’ streaming, is again produced starting from a single trace. In this case, however, the trace is replaced at each stream generation by perturbations applied to its predecessor. This produces stream textures which tend to deviate further from the original trace. In each case, CScore creates an often massive score which is normally retained only long enough for the synthesis to take place.

Instead of using CScore to provide these perturbations, the output of a Cellular Automaton (CA) can be used. The CA Workstation described elsewhere in these Proceedings can produce several tables of numbers calculated from user-partitioned areas of the CA pattern. These values are scaled such that when applied to the tendency mask, the results remain within the frequency limit specified by the Freehand user.

An extension of this concept is to specify anD tendency masks as upper and lower constraints for the perturbations allowed. These two tendency masks are permitted to cross—possibly more than once—since the crossing point merely implies a non-perturbed singular value. With this method pulsating bandwidths can be created.

Future Work

We are currently working on implementations of the granular synthesis perturbation technique operating under the MILAN protocols used by the MIDAS system. This is being undertaken initially by simulation on the NeXT computer before being ported onto the MIDAS hardware. In this way a preliminary evaluation of the MILAN protocols can be carried out.

References

[4] CScore provides a 'C' library for the creation of scores, and is released with the CSound software.
[5] We are grateful to Peter Bowcott, who originally suggested the use of CScore to expand reduced storage data.

ICMC 418