Adaptive Hyperinstruments: Applying Evolutionary Techniques to Sound Synthesis and Performance

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DESCRIPTION

This paper describes the Genophone [2], a hyperinstrument developed for Sound-Performance-Design using the evolutionary paradigm of selective breeding as the driving process. Sound design, and control assignments (performance mappings), on most current systems rely heavily on an intimate knowledge of the Sound Synthesis Techniques (SSTs) employed by the sound generator (hardware or software based). This intimate knowledge can only be achieved by investing long periods of time playing around with sounds and experimenting with how parameters change the nature of the sounds produced. This experience is also needed when control mappings are defined for performance purposes, so external stimuli can effect changes in SST parameters. Often such experience can be gained after years of interaction with one particular SST. The system presented here attempts to aid the user in designing performance sounds and mappings without the necessity for deep knowledge of the SSTs involved. This is achieved by a selective breeding process on populations of individual sounds and their mapping. The initial populations are made up of individuals of existing hand-coded sounds and their mapping. Initial populations never have randomly derived individuals (this is not an issue as man's best friend was also not selectively bred from protozoa). The user previews the population then expresses how much individuals are liked by their relative repositioning on the screen (fitness). Some individuals are selected as parents to create a new population of offspring, through variable mutation and genetic recombination. These operators use the fitness as a bias for their function, and they were also successfully used in MutaSynth [1]. The offspring are then evaluated (as their parents were) and selected for breeding. This cycle continues until satisfactory sounds and their mapping are reached. Individuals can also be saved to disk for future "strain" development. The aim of the system is to encourage the creation of novel performance mappings and sounds with emphasis on exploration, rather than designs that satisfy specific a priori criteria.

By using "locked" parameter sets (a definable set of parameters who's values are not allowed to change), variable control can be exercised on the non-deterministic effect of the evolutionary process. This feature, on the one hand, exercises some control on the shape evolution takes and on the other, allows a gradual familiarisation with the SST involved (if desired). Manual editing of individual parameters for the particular SST is also provided, therefore allowing for precise control, if desired.

Genophone [2] is a "Hyperinstrument" [Machover & Chung, 89] or "Virtual Musical Instrument" [3], comprising a dataglove, synthesiser and a PC that runs the evolutionary software. Real-time information from the glove is used to manipulate parameters that affect the sounds produced by a KORG Prophecy synthesiser. A single finger flex (one of five) can control up to four parameters. This problem of mapping lower dimensionality performance controllers to higher dimensionality parameters [4] [5] is also tackled within the same evolutionary framework. The resulting mappings are used during performance. by changing sound characteristics in real-time.

Originally it was thought that some kind of structured language would have to be used for describing those evolved mappings [3] [4] [Machover & Chung, 89]. The use of such formalisation hasn't been necessary yet, partly because Prophecy implements its own one-to-many (1 to 4) mapping formalisation through SysEx parameters, and partly because the relatively low dimensionality of the input device (dataglove) which has only five degrees of freedom. It was a simple and cheap approach for viability testing.

The selective breeding process generates System Exclusive MIDI messages (SysEx) for sound definitions and gesture mappings, which are then sent to the synthesiser to get rendered. This level of abstraction facilitates the use of different external synthesisers with minimal effort by using SysEx definition files. It also taps into the ability of commercial synthesisers to produce musical sounds by design and the existing wealth of sounds available for them. Dahlstedt [1] also had encouraging results by using SysEx as communication protocol. Use of proprietary protocols in other systems limits their usage to one particular piece of hardware (or software emulation) that often employs only a single SST, additionally; "musical" sounds are much harder to evolve.

This project has also shown that selective breeding can be used successfully on several SSTs, demonstrating the feasibility of a "generic" approach in sound and mapping design for all different SSTs and input devices. This approach is fast; often just a few generations are needed for evolving sounds and mappings that are interesting, complex and of good quality. It is also very easy and fun to use, as well as being easy to learn.

GENOPHONE and VMIs

As a Virtual Musical Instrument Genophone can be considered as a new step in the development of musical instruments in the classification system proposed by Mulder [3]. Genophone belongs to a class of Adaptive VMIs and exhibits the following characteristics: Expanded in real-time, continuous timbral control; gesture-set is user designed via breeding. Any gestures or movements can be mapped to any class of sounds where both the mappings and the sounds are subject to the same evolutionary forces explored by the user.

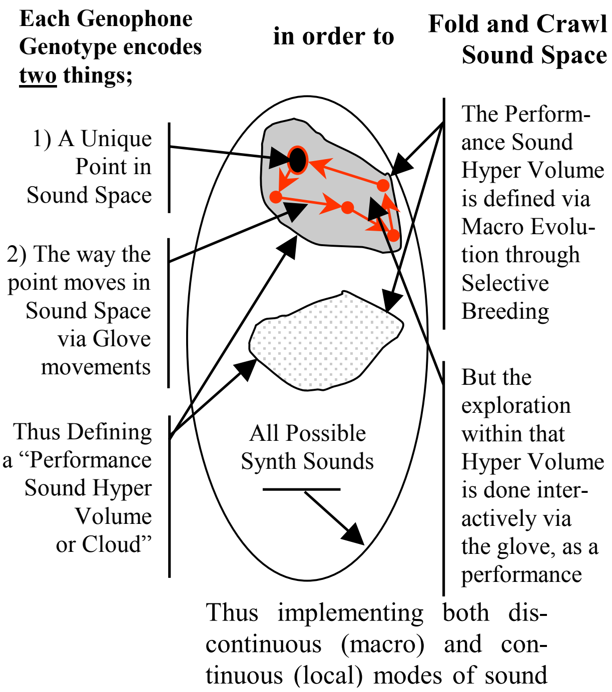

Figure 2. Genophone operation

EXPERIENCES WITH GENOPHONE

The preliminary results from this project are encouraging. Most of the initial aims for this pilot phase have been satisfied and can be summarized as;

- The UI used is very intuitive and effective (the project is also a study of the most appropriate UI): fun.
- The selective breeding paradigm is an accessible one and users were able to breed complex sounds and mappings after only a brief introduction: easy.
- The sounds and mappings produced were of such quality that would take someone with quite a bit of experience in the SST involved if they were to be programmed manually, which would be much slower: effective.
- Evolving novel gesture mappings is easy but lengthier than just sound evolution i.e. familiarisation takes time.
- Different SSTs can be used without the use of Specific Domain Knowledge: a "generic" approach.
- The observation that genetic recombination produces higher quality results than if mutation is used alone.
- The use of the glove is very responsive and expressive, even with only five degrees of freedom: fun.
- Mappings are readily internalised after a brief period of interaction. A rhythmic framework can facilitate this.
- As a by-product meta-parameters are evolved, abstractions that capture an aesthetic value: evolved meta-SST.

FUTURE DIRECTIONS

The current setup is effectively a proof of concept, enhancements planned for the next phase would allow for more complex experiments. It would be interesting to see if the ease of internalising mappings is retained when input devices of more degrees of freedom are used. When more complex synthesisers and input devices are used, the issue of a mapping formalisation will also have to be readdressed. Additionally the two processes for *sound* evolution and *motion-to-sound-mapping* evolution might have to be separated from the same genotype. More operators are currently being developed and tested.

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