A Look at the Design and Creation of a Graphically Controlled Digital Musical Instrument

Daniel Gómez
Cultural Studies
Universidad EAFIT
Medellín Colombia
dgomezm1@eafit.edu.co

Tjebbe Donner
Cultural Studies
Universidad EAFIT
Medellín Colombia
t_donner@yahoo.com

Andrés Posada
Cultural Studies
Universidad EAFIT
Medellín Colombia
anposada@eafit.edu.co

Abstract
In this article we want to show how graphical languages can be used successfully for monitoring and controlling a digital musical instrument. An overview of the design and development stages of this instrument shows how we can create models which will simplify the control and use of different kinds of musical algorithms for synthesis and sequencing.

1. INTRODUCTION
Programs which allow users to write their own algorithms for generating and controlling sound (Pure Data, Max/MSP, Supercollider among others) are an advance in musical creation for musical composers and enthusiasts with programming knowledge [1]. Nonetheless prior knowledge needed for using these programs, including mathematics, physics and logic, have created a perception that their access is limited to persons with this knowledge and that musician's cannot have access to them [2], [3]. For this reason, people with good musical ideas and skills decide not to use these programs due to the high learning curve associated with them. We can see therefore how the creation of new instruments with the power and flexibility of algorithmic programs but that are easier to manipulate and program becomes an important task for digital luthiers [4][5].

We will present some of the characteristics we believe these instruments should possess in this paper, where we will talk about the design and creation of the SIMTE instrument, created to try and solve some of these accessibility and comprehension issues.

2. DEVELOPMENT
During 2006 we carried out a number of activities aiming at designing and developing this musical instrument.

2.1 Preliminary Research:
We began by studying graphic notations from 20th and 21st Century composers [6],[17] surveying their compositions and symbols with the following questions in mind: Why did they need this symbol? What can we infer from it in designing graphical objects of use in our instrument? What ideas of control, mapping, sonority and temporality do these symbols imply?

Alongside this, we developed algorithms of Subtractive, FM and Granular synthesis that would offer mappable control variables.

We sought alternatives for sharing data between our graphical interface, to be designed in Java, and our synthesis engine, developed in Pure Data [22], and decided to use the OSC protocol. [18]

A number of ideas arose from this initial stage which we applied during the development process. These ideas affected the interface, synthesis operation and internal variable mapping:

- Permanent graphical feedback for receiving information regarding the instrument's state and controlling it with the least possible latency between gestures made on the interface and the sonic response.[4]
- Use of basic geometrical figures (Morton Feldman, Cage) in designing the interface.
- Possibility of randomness and non-linearity (Cage "Concert for piano and orchestra")
- Possibility of Indetermination at the moment of interpretation, using a continuous line that draws a dynamic or melodic profile. [6],[20]
- Use of color to demonstrate the connection between different graphical elements.
- Creation of a framework which will allow the user to control all the Synthesizers and use them to create sequences.

Using these guidelines we began a process of experimentation where we approached each kind of synthesis independently analyzing both their general processes of sonic transformation and the particular elements each one presents.

Some of these elements are common to the different types of synthesis (envelopes, oscillators), but the relationships between them vary depending on the kind of synthesis. Thus, the particular elements that make up a "general interpretation" of synthesis were mapped differently to the algorithms, seeking to exploit to the highest degree the variables in each graphic (color, shape, position, size and relation to other elements), using them for sonic control.

2.2 The Instrument
2.2.1 The Interface
Our general idea with the interface was using it as a surface for both monitoring and controlling the application.

This need arises from experience with hardware synthesizers (or their digital emulations), where the number of elements assigned to different variables makes it difficult to understand how a sound is programmed with a glance at the control surface. This happens because: All the knobs look the same, they hold information pertaining to a single variable, and the manner in which modulators (LFOs, envelopes, modulation wheel) are assigned to variables (frequencies, times, volumes, etc.) isn't permanently visible.

So we decided that:

- The controls for all the variables of our algorithms must be visible.
- These controls must offer the possibility of manipulation in a number of dimensions.
- We will use color for indicating a connection between a modulator and its affected variable.

2.2.2 Sequencing

SIMTE has a central interface where the user can organize sequences of sound in time and other interfaces which allow the user to modify the timbre of the generated sounds.

Seeking simplicity in the sequencing interface we used color squares to symbolize a sonic event and to store its variables. These colored squares have an air of Mondriaan paintings or of Molton Feldman's scores, especially the composition called "projection I" [8].

The squares with musical information can be connected to each other in order to organize cells of small musical phrases which can be looped. An unlimited number of cells can operate in parallel. See Figure 1 for an example of a musical cell in SIMTE's Sequencer.

Playback for each cell can be activated using any of its elements as a starting point, offering new orders of playback within the same cell. An element was also created that allow random playback within the cell.

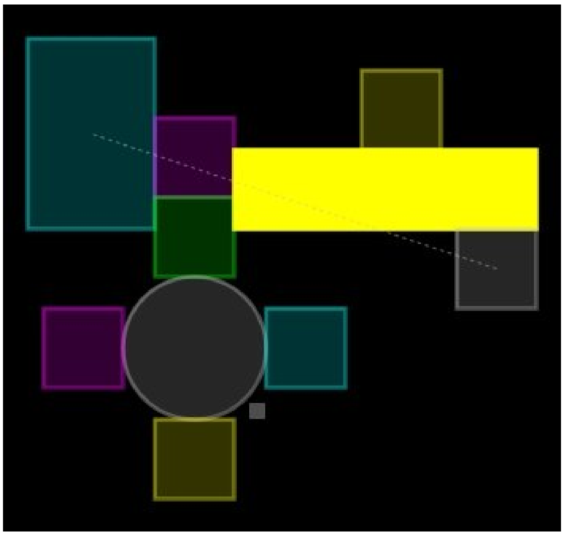

Figure 1: Fragment of a cell in SIMTE's Sequencer interface

2.2.3 Elements of Synthesis

We have designed the graphical elements for controlling the synthesis algorithms to allow simpler and more intuitive manipulation than on finds in classical synthesizers. [19]

Filters, for example, are colored objects than can become a resonant low pass, high pass or band pass filter by modifying their width and position in x-y space.

LFOs can be freely drawn by the user, and with a single stroke can control oscillation speed, amplitude, amount of modulation and a personalized waveform. [19]

2.2.4 Synthesizers

SIMTE contains subtractive, FM [23] and granular synthesis modules. The following is an example of how we implemented graphical FM synthesis: Ever since the commercial introduction of FM synthesizers [9], programming (but not using) this synthesis has been the realm of experts, since the behavior of the harmonics it generates is more complicated than subtraction with filters or addition using oscillators. [10]

Nonetheless, the rich tones achievable with FM synthesis and the small number of elements necessary for achieving them make them a fundamental part of our instrument.

Using 3 rings as metaphors for the modulating oscillators whose position controls amplitude and tuning regarding a carrier wave, we have a simple method for manipulating FM synthesis without using sound banks but rather working at the heart itself of sound generation. Each modulator has a sub-modulator, an envelope and can have controlled random "vibration".

3. FUTURE WORK

This first version of SIMTE hasn't left the lab yet. One of the next steps will be placing this musical instrument into the hands of professional and amateur musicians who will carry out different exercises in composition which will reveal different uses which haven't been thought of by the work group, design failures, and directions in which the instrument should grow, according to different musical contexts.

We will also be working on connecting different SIMTE instruments over the Internet in order to create networks of remote musicians who can make music in real time.

SIMTE's reduced size (only a few hundred KB) and its interface programmed in Java, allow us to consider incorporating SIMTE into mobile devices that could control remote audio engines.

Finally, the work done on the graphical representation of complex data and musical algorithms, allows us to foresee simpler and more efficient interfaces for representing and controlling musical instruments.

4. CONCLUSIONS

The creation of digital instruments is a science that is only just bearing its first fruits, especially as regards overcoming the paradigm of imitating the analog world and starting to make proper use of the advantages offered by computers, such as powerful graphics generation and processing power.

Nonetheless there are still a number of paradigms to overcome such as the division between Synthesis and Sequencing inherited from the separation between Composition and Interpretation. One could imagine the development of complex instruments where sequencer variables are interleaved with synthesis variables in order to create instruments for future music.

Finally, the graphical representation of the synthesis process allows us to understand sonic generation in terms of spatial and chromatic relationships between a limited set of elements. This permits a faster interpretation and operation of synthesis algorithms and can therefore become a powerful teaching tool.

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6. BIBLIOGRAPHY

[1] Puckette, Miller. Using Pd as a score language

[2] Schnell, Norbert & Battier, Marc. "Introducing Composed Instruments, Technical and Musicological Implications" in Proceedings NIME 2002.

[3] Berio, Luciano, “Prospettive nella musica,” Elettronica, 5(3), 1956.
[4] Magnusson, Thor. ixi software: The Interface as Instrument
[5] Jordá, Sergi. “Digital Instruments and Players: Part I – Efficiency and Apprenticeship” in Proceedings of NIME 2004.
[6] READ, Gardner. “Pictographic Score Notation: A Compendium”. Greenwood Press (May 30, 1998) preface.
[7] Pritchett, James, “The music of John Cage”. Cambridge University Press (1996)
[8] DeLio, Thomas, “Music of Morton Feldman”. Routledge (2001)
[9] Dodge, C.,Jerse,T., “Computer music: Syntheis, Composition and performance.”
[10] Roads, Curtis, "Computer music tutorial". MIT press (1996)
[11] Jordá, S., “Interactive music systems for everyone: exploring visual feedback as a way for creating more intuitive, efficient and learnable instruments” Proceedings of the Stockholm Music Acoustics Conference, August 6-9, 2003 (SMAC 03)
[12] Wanderley, Marcelo. “Gestural Control of Music.” IRCAM, Centre Pompidou, Paris
[13] Cook. P., "Principles for Designing Computer Music Controllers", NIME Workshop – CHI, 2001.
[14] Jordà, S. “Improvising with Computers: A personal Survey (1989-2001).” Proceedings of the 2001 International Computer Music Conference. San Francisco: International Computer Music Association.
[15] Jordá S. “Sonigraphical Instruments: From FMOL to the *reacTable**”
[16] Miranda, Eduardo. “Composing Music with Computers” (Music Technology Series) Focal Press (2001)
[17] http://sourceforge.net/projects/iannix
[18] Wright, Matthew & Freed, Adrian "Open SoundControl: A New Protocol for Communicating with Sound Synthesizers". Center for New Music and Audio Technologies, U.C. Berkeley. ICM97
[19] Zadel, Marc. “Different Strokes: a Prototype Software System forLaptop Performance and Improvisation” in Proceedings NIME 2006
[20] Read, Gardner. “Compendium of Modern Instrumental Techniques” Greenwood Press (1993)
[21] Jorda, Sergi. “Digital Lutherie Crafting musical computers for new musics’ performance and improvisation“ PHD Thesis (Technollogy and digital communication) Universitat Pompeu Fabra, Technology Department 2005.
[22] http://crca.ucsd.edu/~msp/software.html
[23] Chowning, J.,"The Synthesis of Complex Audio Spectra by Means of Frequency Modulation", Journal Of the Audio Engineering Society,vol 21,1973.