SoundStrand

A toy for music composition

Eyal Shahar
Opera of the Future Group
MIT Media Lab
Cambridge, MA
persones@media.mit.edu

***Abstract*— While the use of tangible interfaces in music is mostly restricted to exploration and manipulation of pre-composed music due to their limited amount of degrees of freedom, no system has yet been developed that allows explicit music composition through tangible interaction. SoundStrand is a tangible interface that supports an alternative paradigm to the process of music composition. This approach not only enables the use of tangible interfaces for music composition but also leads to new directions in collaborative music composition, traditional music training and sonic installations.**

Keywords-tangible; interface; composition; algorithmic

I. Introduction

With the spreading of research in the field of tangible interfaces, specific interfaces for use in the realm of music are a natural focus of interest. The existing interfaces, however, focus on either allowing the user to explore or modify an existing piece of music, or create a static soundscape[1][2][4]. The reason for this limited use of tangible musical interfaces is their ability to present only a limited amount of degrees or freedom, and these tend to have a relatively coarse resolution. A musical composition, however, and even the simplest one, is a product of a large number of fine choices. SoundStrand is a music composition interface that attempts to bridge the gap. It demonstrates a new paradigm that enables the description of a musical piece with a limited number of degrees of freedom.

II. Composing by Phrase Manipulation

SoundStrand is a set of cylindrical objects called *cells* that can be sequentially connected to each other, with each cell representing a musical phrase. Cells come in various *cell-types* to represent different phrases. When cells are connected to each other their phrases are played sequentially, hence by connecting a large number of cells into a *strand* the user can create a long musical theme (Fig. 1).

Figure 1. A strand with 5 cells

Each cell can be physically manipulated to produce variations of the original phrase. Bending a cell changes the directionality of the melody. By doing so, the original notes are transposed upwards or downwards, depending on the direction of the bending motion. Notes that are further towards the end of the phrase are transposed more than the notes that are in the beginning of the phrase. This assures that the phrase maintains its musical meaning and that the sense of the mapping from physical cell bending to melodic directionality diversion is clear and intuitive.

When a cell's elongation property is changed, i.e. stretched or compressed along its length, the rhythmic distribution of the notes is changed. Although any rhythmical pattern can be associated with any elongation value, the default mapping asserts that a phrase has an adjustable center of rhythmic mass. For example, if a phrase is one musical bar long and it is comprised of four consecutive one-quarter notes, it is said that its center of rhythmic mass is 0.5, i.e. in the middle of the measure. If a cell is stretched, the center of rhythmic mass is increased and notes are shifted towards the end of the measure and vice versa.

Finally, when a cell is twisted, its harmonic tension degree is changed. Five different twisting degrees are available and these correspond to five harmonic tension degrees inspired by David Cope's SPEAC system [1]. The choice of chord to be played with the cell's phrase is a function of the cell's harmonic tension as expressed by its twist and the chord of the previous cell. A pre-programmed harmonic transition table (HTT) expresses this function.

III. Cell Design

SoundStrand's cells are designed to be held comfortably in a human hand. They are cylinders, about 100mm in length and 50mm inches in diameter [3]. The plastic skeletal structure is fabricated in a process of 3D printing and is shown I.A.1)Figure 2 2. The cell's skin is a tube made of elastic fabric to which rubber rings are sewed on both its ends. These rings fit into grooves in the plastic skeleton.

Cells are connected to each other by inserting a set of three cross-shaped extrusions on the surface of the male side of one cell to matching holes in the surface of the female side of the other cell. As for electronic connections, the male side also features a standard 2x2, 2.54mm pitch header that connects to a corresponding connector embedded in the surface of the female side of the adjacent cell. Cells transfer information and share voltage supply through this connector. The last cell in the strand connects to a computer through this same connector using a modified FTDI-USB cable.

The electronic circuitry of the cell is based on an Atmel ATmega168 microcontroller that measures the position of three potentiometers embedded in the skeleton. The cell's physical configuration is determined periodically and transferred as a serial communication packet to the next cell through the electronic connections. The circuit also comprises an RGB-LED that lights in correspondence to the cell's physical configuration.

IV. Software Tools

A. *SoundStrand Player*

The SoundStrand Player is the main software operating in conjunction with the physical SoundStrand interface. It receives from the strand a digital representation of the strand's physical configuration and translates it into a musical theme. A piano-roll style view of the resulting theme is displayed in a designated window, and it features a play-head that marks the current playback time. The Player allows the user to change several parameters that influence the manner in which the translation is done.

- *Phrases content file selection*: Phrases content files contain a collection of phrases, each corresponding to a certain cell-type. The data that describes a phrase is the list of notes' pitches and a list of the possible rhythmic variations.
- *HTT file selection*: HTT Files contain tables that determine the chord to be associated with each cell based on its selected harmonic tension and the chord of the preceding cell.
- *Melodic interpolation algorithm selection*: These algorithms determine how bending, which results in a diversion of the melodic direction, actually modifies the individual notes. Different algorithms make different decisions regarding pitch of the first note in the phrase, the quantization of notes' pitches to the current chord or the entire song's key and so forth.

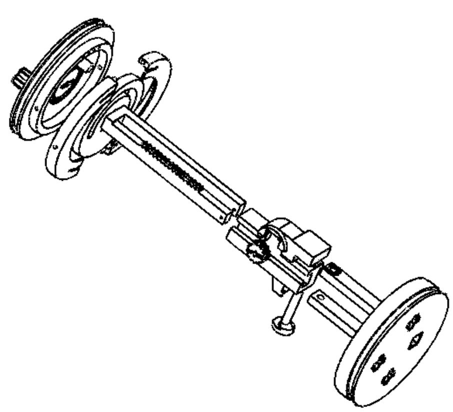

Figure 2. A dissassembled cell skeleton

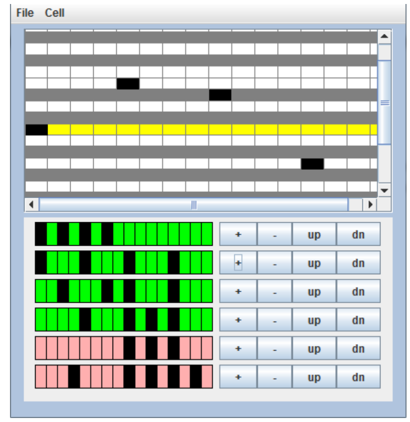

Figure 3. A screenshot of the Cell Editor, showing the pitch area on the top and the rhythm area on the bottom. The red patterns are illegal as having an incorrect number of events

In addition, the Player offers some more traditional features, such as a tempo handle and timbre selection for the melody, harmony and bass parts. The Player also features a transport bar that allows the user to play a single phrase or the entire theme, stop the playback, and enable disable a "loop" option.

Finally, the Player allows the user to enter a "simulation" mode, in which cells are added, removed and re-ordered by pressing buttons in the Player's GUI. When selecting this option the user does not need the actual SoundStrand interface in order to compose.

B. *Cell Editor*

The Cell Editor allows the user to program cell-specific properties. The user can create new cell types, edit them and save a collection of cells-types as a set. Saved sets can be loaded for further editing (Fig. 3).

Once a cell type is selected or created, the user modifies its properties in two areas of the window: the Pitch Area defines the number of notes present in the cell type and their pitches at stable state. This area is a piano-roll like editor, and although the timing of the events is also expressed in this editor it is only for reference and for the initial setting of every new rhythmic pattern. The actual timing is specified in the Rhythm Area.

The Rhythm Area allows the user to create the various rhythmic patterns accessible through modifying the elongation property. The pattern editing interface is a row of boxes representing the 1/16th note intervals in the measure. The user edits a pattern by marking the desired onset times. When a pattern has the same number of onsets as the number of events in the Pitch Area, the pattern is legal and it is painted green. Otherwise, it is painted red and the saving the collection is disabled until the conflict is resolved. The user can add, delete and change the order of the patterns. This will be very significant when later using these cell types with SoundStrand – when changing the cells elongation property from fully compressed to fully stretched the patterns will be selected in this order.

C. HTT Editor

The HTT editor allows the user to create and edit HTTs that will be used by the Player to determine the chord to be played with every cell. The rows of the table correspond to the chord played by a previous cell. The columns correspond to the five twist positions that the current cell can be in. These are named after the five different SPEAC tension degrees, and the user is advised to consider them while editing the table. In summary, when a chord c is specified in line x and row y, the Player will interpret that as “if the previous chord is x and the cell is twisted to SPEAC degree y, then the harmonic transition of this cell will be c”.

Transitions appear in the HTT as diatonic functions, and these are represented by Roman numerals. The user may add lines to the table to define possible diatonic functions. Once a diatonic function has a line in the table, it is added to the vocabulary and may be used by the user as a transition in any other line.

V. CONCLUSION

SoundStrand and the philosophy of music composition it demonstrates provide an experience that is very different from conventional music composition methods. It encapsulates the composer’s focus on different layers of the musical theme into discrete processes. When using SoundStrand and the accompanying Player software, the composer is dedicated to the arrangement of motifs and the theme’s melodic and harmonic tension trajectory; when working with the Cell Editor software the composer focuses on melodic phrases and rhythmic patterns – the motivic vocabulary of the theme; and when working with the HTT editor the composer defines the piece’s emotional grammar. Hopefully, this encapsulation and separation of the lingual aspects of the musical piece can influence on music learning, collaborative composition and the development of additional interfaces.

ACKNOWLEDGMENT

I would like to thank Yan Shen and Kelsey Brigance for their key contribution in the mechanical design and Tod Machover for supporting this project.

REFERENCES

[1] D. Cope, “Experiments in musical intelligence,” A-R Editions, Madison,Wisconsin, 1996

[2] S. Jorda, M. Kaltenbrunner, G. Geiger, and R. Bencina, “The reacTable*,” In Proceedings of the International Computer Music Conference, Barcelona, Spain, 2005

[3] Y. Shen, “SoundStrand design: designing mechanical joints to facilitate user interaction within a physical representation of digital music,” B.S. Thesis. Massachusetts Institute of Technology, Cambridge, MA, 2011

[4] G. Weinberg, “Playpens, fireflies, and squeezables – new musical instruments for bridging the thoughtful and the joyful” Leonardo Music Journal, MIT Press, 2003. Vol. 12, pp. 43-51