

PROTOTYPING MUSICAL EXPERIMENTS FOR TANGISENSE, A TANGIBLE AND TRACEABLE TABLE

Daniel Arfib

Laboratoire d'Informatique de
Grenoble (LIG)

Daniel.Arfib@imag.fr

Jean-Julien Filatriau

Université Catholique de
Louvain la Neuve (UCL)

Jehan-Julien.Filatriau@uclouvain.be

Loïc Kessous

Université Paris6
(ISIR-UPMC)

loic.kessous@gmail.com

ABSTRACT

We describe two musical experiments that are designed for the interaction with a new tangible interface named by us Tangisense, based on a set of antennas and RFIDs. These experiments (classification, game of) use different kind of time schedule, and are now simulated using Max-Msp and Java programs and common computer-human interfaces. They are developed in such a way that they can be ported on a specific tangible interface using RFID tags in its heart. Details about this portage are given. These experiments will in the future serve as user-centered applications of this interactive table, be it for musical practice or sonic interaction design.

1. INTRODUCTION

We will in this article do a prospective plunge in the use of a tangible interface in the artistic or pedagogic domain. We will try as far as possible to bring a framework rather than just experiences. Our study is sound oriented rather than device oriented, which means that the goal of this interaction is the sound. Levels of interaction depend upon the making of the sound, and we will see that the timing itself of the sound production (out of real time, events and curves in real time) drives the interaction style.

Touchable and tangible tables are now largely used in music production. Touchable devices (including touch screens) are popularized by the Ipod and Iphone series, but belong to a long tradition, which includes multitouch tables. Tangible interfaces by definition use objects, and are also named graspable. Links can be found on this topic [1]. Musical applications have been popularized by the Reactable (see [2] for an overview on this subject), which uses special tags named "fiducials", and NIME conferences (New Interfaces for Musical Expression) are full of articles and demos on such subjects¹.

¹ <http://www.nime.org>

2. TANGISENSE, A TANGIBLE AND TRACEABLE TABLE



Figure 1. the first prototype of the Tangisense table

Our Tangisense table is part of a user-centered interface, named Tangisense in the TTT project (Interactive table with tangible and traceable object). The hardware itself can be described as a retina of antennas, which can track RFID tags (Figure 1). The table is composed of 25 tiles, each of them containing 64 antennas. Each tile contains a DSP processor that reads the antennas, an antenna multiplexer, and a communication processor. The table is connected via a control interface to the host computer by an Ethernet bus. From the computer point of view, every time a tag is detected one gets its specific identification number and coordinates. This Tangisense table is part of a French national project named TTT, which involves two laboratories ((LAMIH, LIG) and two companies (CEA, RFIdées). It is now in a prototype stage, and the definitive version should be available mid-2009.

More than the hardware itself, the software structure is an important feature of this table. An architecture in 3 layers has been defined (Figure 2). These layers are written in Java.

1-the capture and interface layer handles tangible objects with tags (one or may per object) and creates Java objects associated to forms.

2-.the traceability layer handles events associated to these objects. It communicates the information to the next layer, but also traces the information and can be asked information about these objects-moves

3- the applicative layer is the one where the specific use of the table is done, in our case the musical experiments.

We usually design this musical application layer in two parts: one, written in Java, communicates with the capture and traceability levels, gathering information and transforming it into events or curves; the second one activates the sound. Communication between these two parts use a bidirectional OSC protocol (using the Java-OSC library).This second part is most of the time a Max-Msp patch, specific for each experiment.

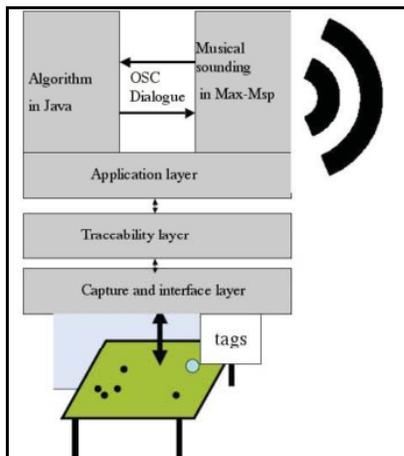


Figure 2. Software layers

Some musical experiments will now be described, with the final goal of having them working on the Tangisense Table. These experiments have been devised in two steps: a simulation one, where tags are simulated as objects on a computer window, and moved by mouse or tablet interaction. They serve as prototypes (hence the title of the article) for an implementation on Tangisense. The feasibility of the implementation of musical experiments with Tangisense is done, however as the definitive version of this table is not yet available, experiments have been conducted with individual tiles but large scale experimentation of the musical content and moreover evaluation of the sonic interaction design is definitely out of the scope of this article.

Two experiments clearly illustrate different ways where interaction with sounds may happen and are described in the core of this article, A third one is only evoked in the future directions section:

1 the first application is a classification of sounds using “baskets”. Depending upon the judgment of different users, a map can be made which corresponds to evaluated distances between sounds. The goal here is to provide navigation or selection spaces where a musician can get oriented palettes of sounds. It is especially intended for the use of textures, a musical domain hard to map.

2 the second experiment is a “MIDI-oriented” application where a cellular automata, activated by a metronome is made audible by triggering events linked to its cells.

3. ORIENTING A SONIC SPACE: THE BASKET TECHNIQUE AND ITS IMPLICATIONS.

The goal here is to provide a user interface that can help the musician in the navigation of sounds.

Two main approaches can be followed when dealing with the classification of musical sounds. The first one, referred as Music Information Retrieval (MIR), relies on an objective description of the sound based on a series of features computed on the audio signal [3][4]. The MIR community has been rapidly growing for a tens of years and a number of MIR tools are now available for experimentation².

The second strategy, which we adopt here, is that sound classification can be a perception-based approach. In this case, the classification does not rely anymore on mathematical descriptors but rather on results of psychoacoustic experiments. Typically in such experiments human listeners are asked to evaluate similarity between pair of sounds, group sounds in categories or assess distance between several groups of sounds [5][6]. These two complementary approaches for sound classification aims at addressing specific questions and give slightly different results.

3.1. baskets

Among the many possibilities of classifying sounds, there exist a technique that really fits a tangible paradigm: the basket (or packets) style which can be described as this: given n samples to be classified, one ask to m experimenters to separate them in different packets. The metaphor clearly is here to separate a set of objects (cards for example) in different packets. The main goal is to be able to create an estimated distance between pairs of objects, so that a multidimensional or cluster analysis can be applied.

²Marsyas <http://marsyas.sness.net>

CLAM <http://clam-project.org>

MirToolbox <http://www.jyu.fi/hum/laitokset/musiikki/en/research/coe/materials/mirtoolbox>

For one experimenter, one can say that the estimated distance is zero if 2 objects are put in the same basket, and one if put in different packets. If we use many experimenters we can sum up these individual experiments this way: we build a matrix where each cell represents the number of times objects have been put in different baskets (divided by the number of experimenters). This is the estimated mean distance between two objects.

MDS analysis is sometimes defined as a way to retrieve a geographical map from estimated distances. It is a dimension reduction very often used in sociological issues. The input is a matrix of dissimilarity; the output is a N-dimensional map that gives information on the proximity of these samples. We have used this technique to provide a classification of 10 sonic textures (textures can be defined as such: their long term appearance is uniform, while their short term revelation can be quite different according to time), but the technique is the same for images, such as visual textures or even psychological cards. The goal is to find a classification where no a priori statement on the nature of the textures has been done.

3.2. The simulation

First we have devised a simulation written in Java, where a set of circles represent a sonic texture, and three spaces where the user has the task to put similar textures (Figure 3). There is a surrounding space, which can be considered as a place of uncertainty. The application is built in such a way that it is mouse-driven: when the mouse goes over a circle, this one turns from green to blue. When clicked this circle gets red and can be moved anywhere on the graphic plane. A last circle when moved indicates the end of the user session and a file is created which indicates for each circle its belonging to a box (1-3) or a free one (0).

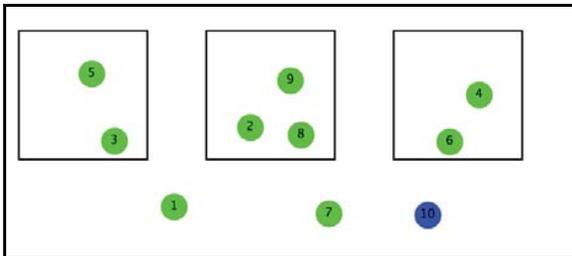


Figure 3. The computer screen as it appears to the user. Green circles become blue when browsed and red when clicked and dragged. Three baskets are symbolized by squares.

A Matlab program has been written that takes all the files corresponding to different users, and builds the dissemblance matrix by summing individual matrix, and then performs a multidimensional analysis (MDS). A MDS analysis requires the choice of the dimension of the reduction. Two is an obvious choice for a graphical representation but there are different techniques in exploration of data, which allow to estimate the best order

[7]. The output of such a program (Figure 4) is a valuable representation of a set of sounds, especially when it comes to navigation in a sonic database. Moreover it can be used in performance, using Max patches similar to the SYTER interpolator), see references on the subject of 2D mapping in Bencina [8].

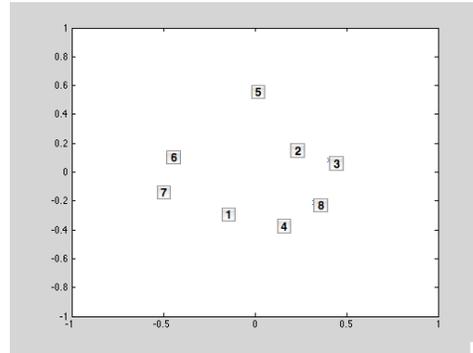


Figure 4. A map resulting to the reduction of data in a 2D space of a sonic texture database.

Another way to analyze dissemblance matrixes is cluster analysis: this way sounds are separated according to branches, giving place to clusters.

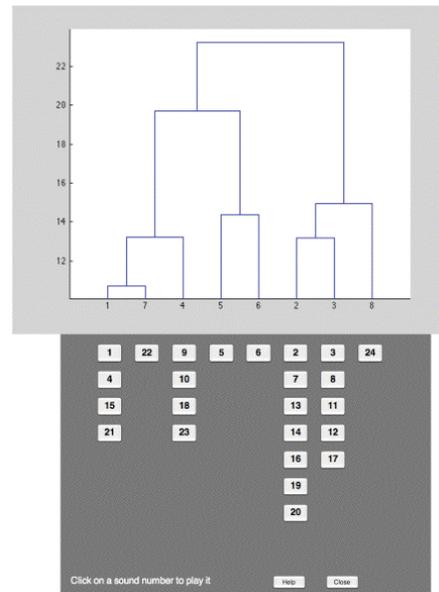


Figure 5. A tree resulting from a cluster analysis and the associated garland of sounds

To do this, we use a classical algorithm issued from the Mathworks Statistics toolbox, but we complement it by a special presentation of the results written by ourselves: for each branch of the clustering, we draw grapes of sounds

corresponding to this branch (Figure 5). This way we have a clickable presentation of a sonic database where one can explore different branches, for example to select in an auditory way the best representatives of each category.

3.3. The tangible experiment

An obvious interest of tangible interfaces is to make the computer (and its mouse/screen components) disappear. We have put on the table pads that symbolise sounds (throwing them on the table in random order) plus one which gives the end signal and ask users to put them in three baskets, with the possibility for them not to use ones too hard to classify. As every object has a personal RFID, including the ultimate pad that when moved gives the signal for the end of one classification, the program is straightforward: instead of being mouse-driven, virtual objects are driven by the tags position and the program stays the same for what matters the writing of the file with positions, the MDS, cluster analysis and the garland of sounds.

One difference between the simulation and the tangible experience is the fact that we need to find a situation for actuating the sound that is represented by the pad. We have chosen the strategy of the sonic wall, or alternatively the sonic pillar: whenever we approach the pad near a wall, or inside a circle (the pillar) the object reveals its sound. Another way we are thinking of is to add another RFID on the pad, which can be activated by a switch. The “click” metaphor is back, but integrated in a “graspable” object.

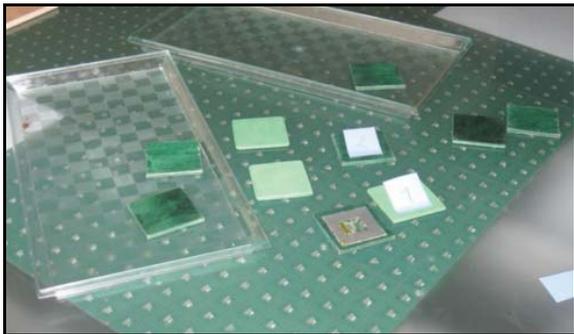


Figure 6. The Tangisense table with objects and baskets

4. INTERACTING WITH THE GAME OF LIFE.

We have previously seen a musical situation that can be considered as “out of real time”. But most musical interactions, especially the art of performance are concerned with real-time experiments. One subset of it is the event driven musical flow, popularised by MIDI synthesisers and note oriented music.

We have decided to find an experiment that can be a good example of “user centred” application, which in our terms means that the computer is disappearing: here we will

have a table with blinking lamps, and will bring the metaphor of a “sonic stethoscope” to drive a percussion generator. This is in the vein of cellular automata music [9][10], with a specific sonic interaction design flavour.

4.1. the parts

the game of life algorithm: this is a classical in “artificial life intelligence”: typing “game of life” on a browser will give thousands of links, one of them being the original article from Gardner. [11] Many implementations are also available, but we have programmed an easy Java program for our own purpose.

Starting from an arbitrary (or not) matrix of ones and zeros (Figure 7), we consider an evolution process where the rules are taken from Conway. Conway’s genetic laws are simple. First note that each cell of the checkerboard (assumed to be an infinite plane) has eight neighbouring cells, four adjacent orthogonally, four adjacent diagonally. The rules are:

1. Survivals. Every counter with two or three neighbouring counters survives for the next generation.
2. Deaths. Each counter with four or more neighbours dies (is removed) from overpopulation. Every counter with one neighbour or none dies from isolation.
3. Births. Each empty cell adjacent to exactly three neighbours is a birth cell.

This way we have an evolution process, where populations live, grows and eventually die (which is normally the end of the game). The interesting part is that depending upon the initial configuration, we may find gliders, oscillators with different rates possible, quasi-fractal patterns, and so on. Though not particularly new, this game is still exciting generations of students, mathematicians and curious people.



Figure 7. An instant in the game of life

The stethoscope: in this experiment every point of the game can be checked by a stethoscope-akin pad (Figure 8) and whenever a cell is activated, we will trigger a sound. As this process develops sounds related to an evolving data set, it is related to data sonification (the sonic equivalent of data visualisation). Obviously we may have two strategies: only use one trigger only when going from zero to one, or retriggering events when cells continue to light.

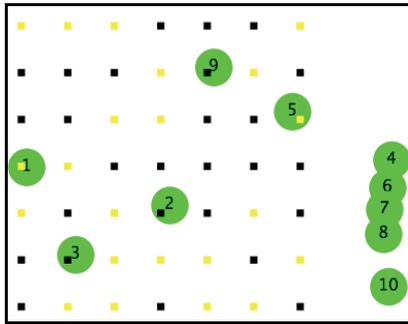


Figure 8. the “game of life”screen with the virtual pads

The sonic process: rhythm boxes are widely used, with samples or synthetic sounds, and clearly show us a path for a polyphonic stethoscope, where the individual sounds would refer to a specific pad number. Many Max patches can be used for this purpose. We particularly like the CNMAT implementations of modal synthesis³.

4.2. The simulation.

On one part, we have a musical generator including a metronome and a sonic polyphonic generator. This is written in Max-Msp. The metronome part is indeed a basic one, while the polyphonic generator must take care that retriggering can occur. The communication between the musical process and the interaction one is bidirectional: as soon as one metronome tick is coming, an OSC message is sent, and the interaction scheme immediately sends OSC messages corresponding to note triggering.

The game of life itself is written in Java, and is an engine that runs for every click of the metronome. It must be initially given a size for the matrix, as well as the definition of the initial cells.

We have devised some tags, be them virtual or real, which must first inherit from some sonic properties. Hence we have to assign to each of the tags a sonic identity. This can be done in two ways: either we name the tags, and put an icon on them, or let them free of any assignment, in which case we must at some points get to a place where they are “recharged” with a sound.

Then we can freely move these tags in places where cell will “pulse” the sonic material. This is of course a game, where many participants can play. It is also a big way to study the process of creativity, because each of these tags are traceable, so it is not only the result that is important, but also the process itself.

³Musical Applications of New Filter Extensions to Max/MSP http://web.media.mit.edu/~tristan/Papers/ICMC99_MaxFilters.pdf

4.3. The tangible experiment

The main point about using a tangible and traceable table is to establish a link between what the user’s action and what he gets as sounds. Basically the metaphor that is used is really important, especially if a visual feedback is provided. As leds are part of the TT Tangisense table, the game of life really takes its manifestation with light and the coordination with sound events is easy to draw (Figure 9).

Tags are put on table and the resulting sound corresponds to the lighting of a particular cell in a way similar to the simulation. Two domains are concerned by this experiment.

- Human-computer interaction. As an example the addition of LEDs on the table immediately connects the user on the experience itself: rather than having a displaced display, here we have a direct interconnection between one what sees and what one does and hear.
- Human-human interaction through technology. When computers disappear, the human being becomes free to share with others: this is a collaborative experience and the musical result, and its evolution greatly depends upon the “presence” of the performers, their reactivity, the sense of surprise they can bring: in a word they are musical performers.

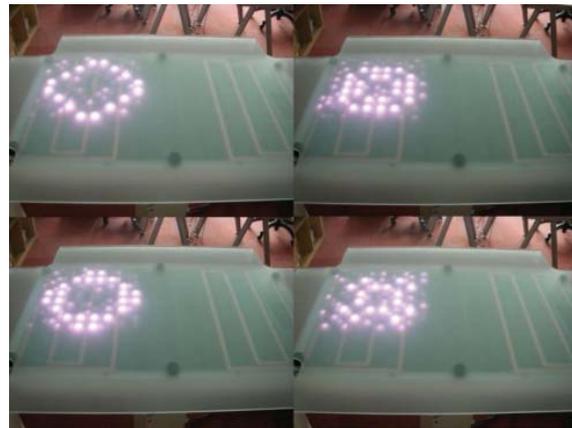


Figure 9. four ticks of the metronome drive 4 successive instants in the game of life on the Tangisense table.

5. FUTURE DIRECTIONS.

As we did see, it is possible to prepare musical experiments that can take benefit from the tangible and traceable aspect of our table. Nevertheless, musical performance largely uses gestures that are rapid, and it is interesting to see how far we can go with fast gestures.

We did modify a set of Max-Msp patches devised by Arfib et al [12] for the interactive use with graphical tablets, in order to make them controllable by a tag on the Tangisense interactive table.

We have chosen as a start to use a synthesis reminiscent to the photosonic one, where the X axis is mapped on a digital mixing of specific waves. In a way, it is navigation in a database, except that sounds are synthetic and governed by a single low frequency pitch. The Y axis is mapped on the coefficients of three filters, thereby providing a subtractive filtering to the preceding sound source. As an example filters vary from “i” to “oo” depending upon the Y axis.

With one tag we are able to drive this synthesis in real time, and delays are quite short and not noticeable. Of course the resolution of the table is less than the one of a Wacom tablet, but this works fine if one smoothes a little bit the flow of coordinates. The problem that remains is the way to trigger sounds without removing the tags, an easy game with graphic pen, an ergonomic question with RFIDs. We will in the future try many different experiments on that style of interaction.

The main future direction is the one of usability and we know this can lead to a vast discussion [13]. As stated in the article, we have demonstrated the feasibility of sonic interaction with a tangible and traceable table, but also situated the early stage of the experiments in a musical situation. These “user-centered” experiments and evaluation will follow, with a main concern on two things: the ergonomic aspect of the objects put on the table (until now this table has been used by the authors in an intuitive way, every experiment will have its own design, instructions and procedure); the evaluation aspect will be taken in account to measure the usability and improve the design and use of such a combination of software and hardware.

6. CONCLUSION

Many tangible tables rely on a video system and tags that are drawn on the surface of objects. Here we have a totally different technology, and a table initially not devoted to sonic applications. We have seen that it is possible to prototype musical experiments that can be linked to this table and make them run. More research has to follow to make comparisons with existing systems, but we also feel that our way of thinking sound, for example creating maps that can help the navigation or even the performance are innovative and can be a good framework for a community of musicians wanting to try the tangible and traceable aspect of interaction.

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