TANGIBLE INTERACTION WITH A RYTHMIC SONIFICATION OF THE "GAME OF LIFE" PROCESS

Daniel ARFIB, Valentin VAALS, Karine XUE

LIG Multicom
Grenoble, France
Daniel.Arfib@imag.fr

ABSTRACT

This article is about interaction with a sonification algorithm of a cellular automaton through the use of tangible objects. A link is done between sounds and the "game of life" process by triggering sounds according to changes in the state of specified cells. The focus is about the choice of tools for the affectation and activation of sounds by the way of tangible objects. These objects are figurines that are identified by RFID tags and are interactively placed on a novel interface (named Tangisense) consisting in a matrix of antennas and associated LEDs. A discussion is done on the strategies required for the appearances of these figurines and the affordance they suggest. On the algorithmic and visualisation side of the game of life, we find figurines that develop the initialisation of the matrix, the sequence of events and their pause or termination. On the sonic side, we find tangible objects that allow the affectation of specific instruments of a drum kit, and other for the download of sound banks and the free mapping to selected sounds.

The interest is first a cross-fertilisation between sound and interaction: it can be seen either as a sonification process or a musical play through a tangible interface. Another one is that such an experiment is a formidable testing-ground of the usability of tangible objects: we can examine (and in the near future evaluate) how people use such devices in information research or in an entertainment play.

1. THE FRAMEWORK

The goal of our experiment is to show the role of a proper interaction technique in a sonification process. We will first describe the implementation of this interactive sonification.

1.1. The TTT table (Tangisense)

Figure 1. *The Tangisense (TTT) table.*

TangiSense (issued form the TTT project, Fig 1) is a table that uses the RFID technology (Radio-frequency identification). TTT means Traceable Table for collaborative manipulation of Tangible objects. This is an interactive person-machine system, in the same vein as the tDesk [11].

1600 antennas that form a 40X40 matrix, where each antenna is a RFID reader, compose the table. This table is a perception matrix for a computer, as the insect eye retina. As a RFID tag has its unique SID (identification), we can identify one object (Fig 2) by its RFID tag(s). The dimension of TangiSense is 1 meter x 1 meter. Each antenna is a square of 25mm; the measure accuracy is 12.5 mm. The reaction time is fast, at 20Hz. With this table, we can localize the object, analyse its form and its movement. Hence, we can analyse the behaviour, the interaction between the objects. Apart from RFID tag detection, each antenna has 4 LED, so we can show images in a 80*80 dimension.

A computer drives the Tangisense table. The software installation in the computer has 3 layouts: capture and interface, trace (history), applicative (agent and CHI). The software is written in Java and works under Eclipse, so the application can be used in different operating systems. The software architecture allows the table to be used in a large domain: games, team meeting for conception, aso.

The use of TangiSense has less restriction comparing to other digital, intelligent tables. We can handle hundreds of objects in same time, and TangiSense don't ask for a specific environment light.

Figure 2. *RFID tags under cubic objects.*

1.2. The game of life

We have used as an example of application the sonification of a "biological" process, the game of life automata introduced by Conway. A cellular automaton is represented on Tangisense via its network of LEDs (Fig 3). Whenever a living cell encounters a tangible object representing a sonic function, a sound is emitted through loudspeakers.

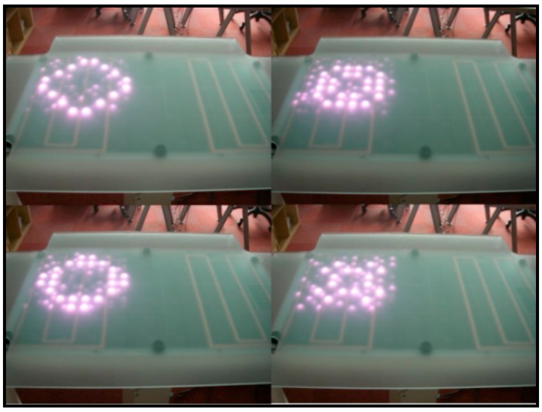

Figure 3. *Four successive steps in the visualisation of a game of life process.*

The algorithm in itself follows Conway's genetic laws. 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, grow 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. Some implementations already exist, that take the game of life as a generative process ([4],[5]). By ourselves, we have chosen to activate some sounds according to the state of a specific cell according time. This has the big advantage tat it is easy to push the intervention of interaction in the tangible domain: the process itself is trivial, the sonification too, and the interaction brings everything in.

1.3. Interaction

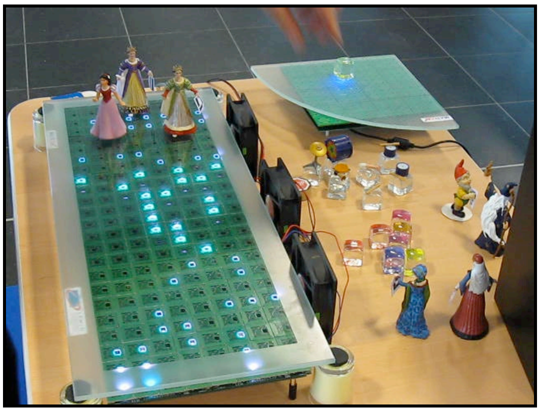

Figure 4. *A set-up of 3 tiles with tagged objects*

The user can interact with the process and it sonification by posing and moving tangible objects on which RFID tags are glued (Fig 4). There are four kind of objects characterized by their behaviour and their aspects;
1-objects that inject patterns in the game of life. Among the chosen patterns are the "block", the "glider", "kok's galaxy" and "gourmet" which give a periodic evolution. The figurines show the appearance of processes
2- sonic objects they cubes made of glass, eventually with add-ons. This class is divided in two: immutable cubes that are directly related to a specific sound and abstract cubes that can be linked to different sounds.
3- relation-creators, which are objects that can make a link between objects and functions related to them. The major example in our case is the association of a cube with a sound taken from a specific sonic bank.
4- control objects that can start, stop, clear the game; mute sounds; regulate the speed of the process.

From a point of view of the programming, each object is an agent. This agent has a behavior, it receives messages according to the landing or removal of an object on the table and its coordinates. It can act on the simulation of the game of life, on the LED lightning and the production of sounds. The whole application is around this protocol, and the Java code is implemented in a very modular manner. Parameters related to the objects and their relation to a behavior is done through the XML language. Some behavioral parameters such as the initial states for the game of life or the description of sound banks are also written in XML.

The application itself has passed through many improvements. As an example the first version was sending MIDI codes to an external synthesizer; the next one used sound fonts; the last one has sound samples in .wav files that are activated through OpenAL.

1. TANGIBILITY AND VISUALISATION

The concept behind our research is the fact that tangibility is a major key in computer human interfaces. It is a step in the technical domain, where new interfaces can be built which incorporate RFIDs in objects, but moreover it is a step in the social implication: the removal of computer screen and mouse in the design of creative systems is a quantum leap in our human behaviour: we leave the "screen society" and come back to the "touchable and mouldable society".

Figure 5. *Each of these figurines can initiate the starting point of a game of life process*

One basic stone of this concept is the notion of affordance. This term has had many meanings since its invention by Gibson and Norman and has to be précised in the tangible domain: it is the fact that we can associate some actions to an object and gestures around it. In our specific case, these actions will be visual and sonic production. There is a set of figurines that are assigned to the initialization of a game of life (Fig 5). The one on the right initiates a random value on the grid, while the two others initiate specific states. These states have been chosen so that there is a repetitive cycle in the game of life process. In order to reinforce the association with a specific pattern, a sign has been posted in the hand of each figurine, so that one can recall the type of patterns. Even with only one figurine, one can play tricky: one can move the figurine, which superimposes the imprint related with this figurine every time it is detected, hence the periodic feature is lost and a semi-chaotic behaviour may happen, which includes the death of the process. One can also put many of these figurines on the board, and in such case the matrix takes the cumulative effect of their presence.

Figure 6. *These objects allow to stop the process, or to erase every cell. The last one is a mute tag.*

The LEDs on the table are blinking according to each step of the game of life algorithm, initially with a default value for the clocking of events. It is possible to freeze the process by putting on the table a “stop” sign (Fig 6, left), which is a strong affordance understandable at once. The rubber (Fig 6, middle) can be used on the fly, while figurines are on, in which case it can be considered as a reset. It can also be put at anytime, for example after the removal of figurines, to clear the matrix.

Figure 7. *This object acts as a postmark. On one side it puts a cell to zero, and on the other to 1 (better used in the stop state)*

The wooden object marked with a zero on one side and one on the other (Fig 8) serves as a postmark

2. TANGIBILITY AND SONIFICATION

Now that the game of life is operating, let us see how we can introduce tangibility inside the sonification. First we have designed a strong affordance between objects and sounds by linking dedicated objects to sounds belonging to a standard drum kit (Fig 8). Hence each time this object is used, the corresponding sound will play. These sounds are taken from a drum kit from a soundfont (but extracted as a sound wave)

Figure 8. *These tagged object reflect the choice of sounds from a sound font*

An important feature of the game of life is the time period between two states. Here we have chosen a specific tagged object (Fig 9, right), mimicking a metronome. Many choices are available for the action that changes the period value. We have chosen to link an absolute value to the vertical coordinate on a tile. It would have also been possible to use the tag position as relative (e.g. to scratch up or down).

Figure 9. The metronome object (right).

As far as we use sound fonts, it is possible to switch from one sound font to another, keeping the game of life and associated tags the same. This is the role of a tagged object, which suggests the use of different drum kit soundfonts

When it comes to change dramatically the sounds, we break the affordance between an object and it sonic meaning by using nude cubes, but we bring in a new metaphor: we freely associate a sound with a cube (Fig. 10).This is done in two steps: first we choose a sound bank, and then we associate a sound of this sound bank to a cube.

Figure 10. *This set of cubes can be linked to sounds.*

The call for a sound bank is done through the use a set of tagged CDs (Fig.11), and when one is put on the table, the complete set of sounds is provided for a specific choice (Fig. 12).We create a link between a nude cube and a sound by exploring the sound bank on the table.

Figure 11. *The objects representing sound banks.*

This way every cube can now have its affordance, we could say that each cube can develop a sound. This metaphor is interesting, as it can apply to anything specific to an object: an image, an algorithm, a function or whatever a human being can think about. Examples can be found using the following link: http://daniel.arfib.free.fr/ison2010 .

Figure 12. *A good way to put an affordance between an object and a sound issued from a sound bank.*

3. CONCLUSION

This experiment illustrates two ways to see the relationship between sound and interaction. It can be seen as a sonification process, in which case the interaction serves as a way to trigger and modify the link between the process and its sonification. It can also be the other way around: we can directly look at the link between a gesture and sound, via a process, in which case we are more in the creative domain of gesture controlled audio-systems, or simply digital music instruments [8].

The concepts that are behind this experiment are not only technical: the basic principle is human: what we touch, we remember. What we play with, we grow our knowledge. It may sound terribly simple, but tangibility brings us back from the screen society to a sensitive one.

The matter of evaluation of this human ability is not part of our present paper, but is part of our thinking and principles. for sure, these are user-centered experiences, that can further be evaluated in living labs contexts [9,10]

4. REFERENCES

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