Motion and emotion using home-made digital musical instruments

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Abstract

A combination of hardware and software using a gestural control and an audio system cannot be called a musical instrument till its musical use is not proven. In this article, after a general description of gestural system, we will focus on certain realisations of home-made digital instruments. For each of them we will focus on the repertoire of gestures, and then the musical use it provides. As a matter of conclusion the special link between motion and emotion will be evoked in these particular implementations.

1 Making a musical instrument

Before building from scratch what will be a digital musical instrument, it is good to have a though about what is gestural control of musical synthesis systems. At one end, we have a algorithm that can calculate a sonic signal. This algorithm is governed by data, and when these data evolve with time, we can hear (or not) what is called in musicology a musical gesture. This is a cognitive process where the combination of the physiology of the ear, the cognitive process of perception, and the cultural inheritance (be it of a new trend) mix to make us hear an energy, a dynamism, an harmony or whatever is a movement in the sound. These things are the object of a special discipline, the machine listening. On the other hand (if one can say so) we have different sensors, and when physical gestures are done, we get some specific data. In fact our intention is translated into data, which can preserve or not the entirety of this intention. The intermediary part, named mapping is the way to connect the physical data and the sonic data. We have proposed (Arfib et al., 2002b)to use an intermediate layer where the intention process is retrieved form the gestural data, and connects thewith psychoacoustic data related to what we hear from a sound. This is not always so trivial, but we should keep in mind one thing: the best we define this layer, the easiest way the feedback or the graphical interface will be.

1.1 The design of instruments

All the instruments we have designed use Max-Msp patches on a Macintosh, where gesture data comes from peripherals linked to the machine. A special care is taken about the mapping, but also the repertoire of gestures and the musical possibilities of these instruments that will be seen in next sections. As these instruments have already been described elsewhere, only a short presentation will be made in this article.

The peripherals can be of different kind, and some taxonomy of these sensors have been tempted by different authors. Two main division are to us very important:

- free / not free: either the user wear or touches something or his free movements are captured (usually via a camera). The devices we use are equipments.

- Using a surface or not: tablets are surface oriented, while gloves are not. The pointing fingers are a special case while they can be of both kind.

The dynamic/non dynamic status of the mapping provided in the instrument is especially important. When we introduce a dynamical system in between the gestural data and the synthesis one, we can say that we no more control the sound but we control the dynamical system included in the sound. It makes a big difference in terms of gestures, every gesture is followed by the response of this system.

1.2 the repertoire of gestures

One extremely important point using a digital musical instrument is the panorama of gestures that it permits. These gestures are first akin to the peripherals we use: surfaces induce scratching movements, gloves induce movements such as to take, aso. But musically, it is important to see these three kind of movements:

- selection: we take an object, or select a patch number.

- activation: we trigger this object and this gives an event which can last over time but is governed only by its initial values

- modulation: the data evolve with time, and follow the gesture.

These big gestures are the basis of the architecture of many sound systems. But the expressivity one can add when interpreting a score mostly comes from added values such as nuances, small glides of frequency (appoggiatura, trill, portamento) or vibrato. Nuances by themselves can be seen from two points of view: either it is a climate change, or it is an accentuation given at a time where something else happens.

2 Home-made instruments and associated gestures

We will now see how each of our home-made instruments has its own territory of gestures, a notion which is at the basis of the concept of a true instrument.

2.1 The scangloves

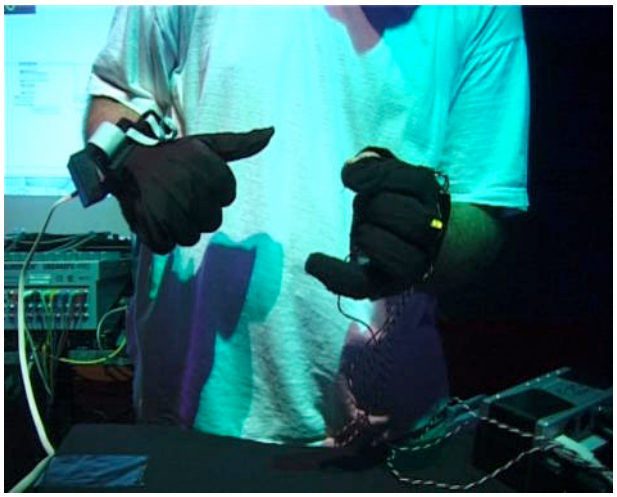

Figure 1: the two scanned gloves

The scan gloves (described in another article in this gims symposium) are a combination of two gloves linked to a scanned synthesis algorithm(Verplank et al., 2000). Once again it is a bimanual control (Kessous and Arfib, 2003)where one hand uses a sign recognition algorithm to provide pitch, whereas the second one both triggers (as a plectrum) and modulates the sonic signal (as the aftertouch of a keyboard).

Here we have a gesture of selection from one hand and a decision/modulation gesture from the other. The non-referred hand gives the pitch and it is only when it is triggered that it is activated again, and then modulated. This can be compared with the guitar, from which it takes its metaphor: one hand touches the strings while the other one uses a plectrum. However the second hand also acts as a distort effecter so that it is again a combined gesture, very akin to the after touch of keyboard. This is possible by the way of tweaking a pressure sensor between a thumb and index finger, a way very sensitive for the human being. We see here that ergonomics has its importance, notwithstanding the fact that there is a musical choice behind every decision we make.

2.2 The voicer

The voicer links a vocal synthesis program with a gesture caption using both hands. The separation between the source signal and the filter algorithm allows a good discrimination and combination of musical gestures with an easy link to the devices. The mapping itself uses a special function to translate circular data on a tablet to pitch and an interpolation scheme for the calculation of filters simulating vowels (Kessous and Arfib, 2003).

Figure 2: the voicer in action

The gestures that are strictly necessary are of two kinds: the circular coordinates of position of the stylet on the tablet gives the pitch, while the position of the joystick gives the vowel in the interpolation plane. But gestures are not static, and it is worth noting that it is the movement including the gestures that renders a movement in the sound. We will take three examples of these special gestures:

- continuous melodies are given by moving the stylet around a circle. When vibrato is needed, the special configuration of the mapping between the angle and the pitch allows to use the separation between two notes as a glide, a trill or vibrato.

- As the amplitude depends upon the stylet pressure, a melody can be built in a detached manner by using an inking gesture together with the pointing of different notes. A very good combination is to use the mechanical feedback of the joystick to provide movements with the other hand always coming back to the centre. This allows a real virtuosity with one hand while the other one only modulates slightly the vocality.

- Reversely it is possible to ply strict vowels while phrasing melodies each phrase being colored by a different vowel, such as the exposition of a theme by different colorations.

2.3 The filtering string

The filtering string uses a scanned synthesis algorithm (Arfib et al., 2002a)for the drive of an equaliser. The gestural data controls the scanned cord, in such a way that

Figure 3: a demonstration of one tactex gesture

Figure 4: the photosonic emulator

a dynamical sytem is in between the two: by the way of forces, a movement is induced in this cord, which shape finally serves as a template for the equalisation system. A particularity, that we will see effective in the gesture range is that it uses a multipoint tablet for the introduction of these forces.

The dynamic characteristics influence much the gestures that are possible with such an algorithm. While one hand has a static mapping (similar to the voicer) for the scaning frequency, the other one uses a multipoint device to induce forces in the algorithm. This means that the dynamic of the gesture will be enhanced by the dynamic of the algorithm. Putting fingers in a static configuration on the Tactex tablets establishes a fixed sound (after a while) and specific movements will change dramatically the play. Here are some possible movements

- construct a form by moving the hand, sliding each finger in a gentle way

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- play more rapidly, in a kind of random fashion, in order to introduce new forces

- at a point it can even be conceived as a percussion instrument, where the action of impulses forces is followed by the response of the instrument.

Of course it is difficult to talk about gestures (videos are evidently better for this purpose) but this gives the hint that a repertoire of gesture can be build according to the dynamic aspect of the instrument itself.

2.4 The photosonic emulator

The photosonic emulator (Arfib and Dudon, 2002) takes benefit of a A3 Wacom tablet to capture the data from two surface sensors. This bi-dimensional data drives an algorithm combining the navigation in a sonic data base of rings (with some blend between them) anda very effective filtering which enhances and colours the sound according to the gestures. The mapping is quite straightforward: one hand governs the navigation and the other one the filtering action.

The repertoire of gestures has been demonstrated with the initial photosonic synthesiser and the same gestures are kept in the emulator. From a general point of view, the division between the work of both hands is governed by two principles

- navigation in a data base of rings can be perceived either as a melody or a climate, depending the speed, and the precision of hold we will have concerning these rings

- filtering cannot be seen as an independent feature. As an exemple extracting one harmonic from a ring depends upon the sonic content of this ring, so that the filtering gesture has to adapt to the work of the other hand.

New gestures may also happen from the interaction of gesture and sound listening. If vibrato gesture is quite intuitive (a vertical movement on the filtering device gives a vibrato) articulation such as arches spirals and circles, shut down with octaviation can be described using the navigation scheme because of two features: one coordinate corresponds to amplitude, and a specific button on the stylet of the tablet allows for octaviation, hence a possible rhythm.

2.5 Interfacing with pointing fingers.

Though it is not in itself an instrument, the concept of pointing fingers (Couturier and Arfib, 2003)is interesting, as it is a device that can replace other peripherals to select, trigger or modulate signals., bring some of its idiosyncrasies.

The pointing fingers allow to select (assigning an object by pointing at it), activate (via a trigger button placed either at the end of the finger or on the side of it) and modulate / navigate. It has been used both with the scanned

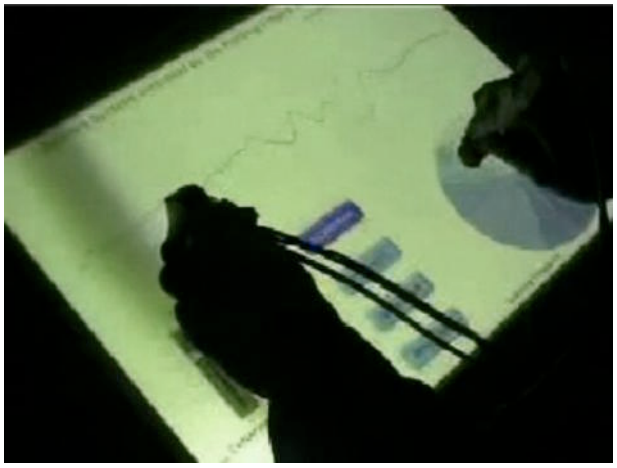

Figure 5: the pointing fingers in action

synthesis algorithm and the photosonic emulator. The fact that the visual inerface is just under the movement makes it clearly a very responsive device for the feedback, making a step towards the design of new musical instruments in virtual reality systems.

3 So what is a digital music instrument?

So far we have assumed that a good mapping and the good choice of devices allows a repertoire of gestures that caracterise the gestural control of systhesis algorithm. Now the main question comes. When can it be called a digital music instrument?

3.1 Acoustic and digital instruments

Let us see first what happens with acoustical instruments: they are called instruments because a performer can go on stage, play different scores in different styles, and also adapt his play to the other players. Some instruments like piano, which have a very rough in term of control (just hit a key with a specific velocity) are in the meantime fabulous instruments for the experimentation of harmony, so that one can say that a pianist is an orchestra of fingers. Another instrument, guitar, has proved to be a way bring orchestration features in the very play of the instrument.

Though it may be risky, let us try to see how gestural control can become musical instrument: we must first name it and use it as such; so go on stage, play with it and with others. We must be able to play a range of scores, for exemple a melodic trajectory, or an harmonic path, or a timbral evolution. Though we may play by heart (or intuition) at least we must be able to provide a way to use the unstrument, and have a pedagogy for it. Maybe be we still are a little bit far of this, but at least the most important features are there.

Every of our instruments has been played on stage, with scores that we have written for ourselves. And from this experience we know more how to provide a real identification for this instrument: it can be an identification by the dynamic of the sound, or the recognition of known repertoire of sounds. This is of course helped if there is some kind of melody or harmony in the structure so that it is even possible to provide a regular score. But also timbre for example is able to provide a real dynamism, a musical gesture, so that the purpose is to open new possibilities without closing too many others. As an example the use of scales in these new instruments is fine, and even more when one knows how to restrict oneself to what may bring the groove of a band.

So one general rule for the introduction of new instruments is to find the adequation of these instrument towards the musical objectives: the combination of a melodic structure together with a possible modulation/articulation of timbre may bring new ways to play (for example deplacing the perception focus on timbre allows to play fast and approximate melodies). The dynamic aspect must always been taken in account: gestures are not postures and even a clarinettist playing one note is always modulating it.

3.2 Evaluation in term of Computer Human Interfaces? motion and emotion

This leads to an open question: is it possible to evaluate a musical instrument, in ways similar to human-computer interfaces? First we must define the context of this evaluation, tasks are not always similar to expression for example. The criteria of musicality should be defined in a more precise way, the same for the ergonomy or the practical manipulability. One answer would be: how easy is it to explore the sonic universe that is suggested by the instrument.

One should say again and again that designing a digital musical instrument is not only a matter of mapping or devices, it is the adequation of the sound with the movement one can make, so the emotion that one wants to express corresponds with the sonic result and its emotional content. Inadequations though they may be fruitful as challenges must not break the fragile link between what one plays and what one hears. In a word it should be possible to incorporate new instruments so that they make part of us. Looking at videos (on rehearsal or during concerts) gives very good hints on the way these instruments allow the imagination to be connected in real time, which is a good sign for the future developments.

4 Conclusion

The title motion and emotion is hard to tackle directly. An alternative strategy has been taken: starting from the simple, algorithms and gestures, we have scrutinised the

missing link, the mapping, as the key point to provide a good repertoire of gestures. From there it has been possible to reintroduce the emotion as a way to play real music. And this music gives plenty of information on the movement used, influencing back again the design, the ergonomics of the instrument making.

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