Afasia: the Ultimate Homeric One-man-multimedia-band

Sergi Jordà

Music Technology Group, Audiovisual Institute
Pompeu Fabra University
Passeig de la Circumval·lació 8, 08003 Barcelona, Spain
sergi.jorda@iua.upf.es

Abstract

In this paper we present *Afasia*, an interactive multimedia performance based in Homer's *Odyssey* [2]. *Afasia* is a one-man digital theater play in which a lone performer fitted with a sensor-suit conducts, like Homer, the whole show by himself, controlling 2D animations, DVD video and conducting the music mechanically performed by a robot quartet. After contextualizing the piece, all of its technical elements, starting with the hardware input and output components, are described. A special emphasis is given to the interactivity strategies and the subsequent software design. Since its first version premiered in Barcelona in 1998, *Afasia* has been performed in many European and American countries and has received several international awards.

Keywords

Multimedia interaction, musical robots, real-time musical systems.

INTRODUCTION: CONTEXT AND ANTECEDENTS

*Aphasia***:** the loss of the ability to speak and to understand speech due to cerebral disturbance.

Afasia is an interactive multimedia revision of Homer's epic poem, *The Odyssey*. Homer, probably a poet performer, had only his voice for reciting or chanting a story. *Afasia* takes out speech proposing a wordless version, which by no means converts this free version of the *Odyssey* into a minimalist piece. Quite the reverse, as we will see.

Afasia is the third interactive project produced by the visual artist and performer Marcel.lí Antúnez with the collaboration of the mechanical sculptor Roland Olbeter and myself, in charge of the interactivity, music and software design. And it can be seen as a logical development of the two previous pieces developed by the same team, both from a technical and from a conceptual point of view.

In *JoAn l'home de carn* (1992), we build a gesticulating human "being" (or robot) completely covered with natural pig skin. A real flesh nude body, which moved the head and the arms, in accordance with the words or the sound of the spectators' voices. Like many XIXth and early XXth century automatons, JoAn was sitting on a chair inside a glass cabinet, and was exhibited in public places (specially food markets), where he would greet and establish a "restricted dialog" with those who would talk to him [1]. Although being myself a musician, this installation was soundless; sound was not one of the system outputs but it was its only input, the cause of JoAn's limited interactivity.

In *Epizoo* (1994) Antúnez takes JoAn's place, and his body, submitted to a complex computer-controlled pneumatic system, is exposed to the wills of the audience through a videogame-like interface [1,3 and 5]. This controversial performance piece, exhibited in art galleries, media art festivals, theaters and raves, in Europe and America for about three years, incorporates interactive music and animations. Its game-like GUI allows members of the audience to manipulate parts of the body of the performer (nose, buttocks, chests, mouth and ears), but makes them also responsible for constructing in real time the whole show music. It is however worth mentionable that transforming the audience into a kind of instrument of martyrdom, too often vanishes any musical aspiration from this active audience!

AFASIA: THE ELEMENTS OF THE SHOW

In *Afasia*, Antúnez, tired of being manipulated, becomes the big puppeteer, the one who pulls the strings. Fitted with a sensor-suit (the *exoskeleton*), he conducts, like Homer, the whole show by himself. *Afasia* can be considered a theatre play but no other actors are on stage; only a bunch of mechanical and digital elements controlled by a computer that executes Antúnez's instructions.

The show that lasts for about an hour is usually performed in theatre rooms and has been devised to be seen from the front. The front stage is occupied by a robot quartet constituted by an electric guitar, a one-string violin, a drum and a three-bagpipe "horn section". These robots play mechanical music, while interactive 2-D animations or movies are projected onto a big screen that fills all the backstage. The performer determines in real time all these sonic and visual elements.

Other elements that can be heard (but not seen on stage) include a sampler, an audio CD player, three effect racks and a mixing console. Like the robots, all of them are MIDI controlled from the central computer. The same computer is also responsible for generating the interactive animations, controlling a DVD player and remotely switching the video projector's SVGA or video inputs. Figure 1 shows a diagram of the whole system.
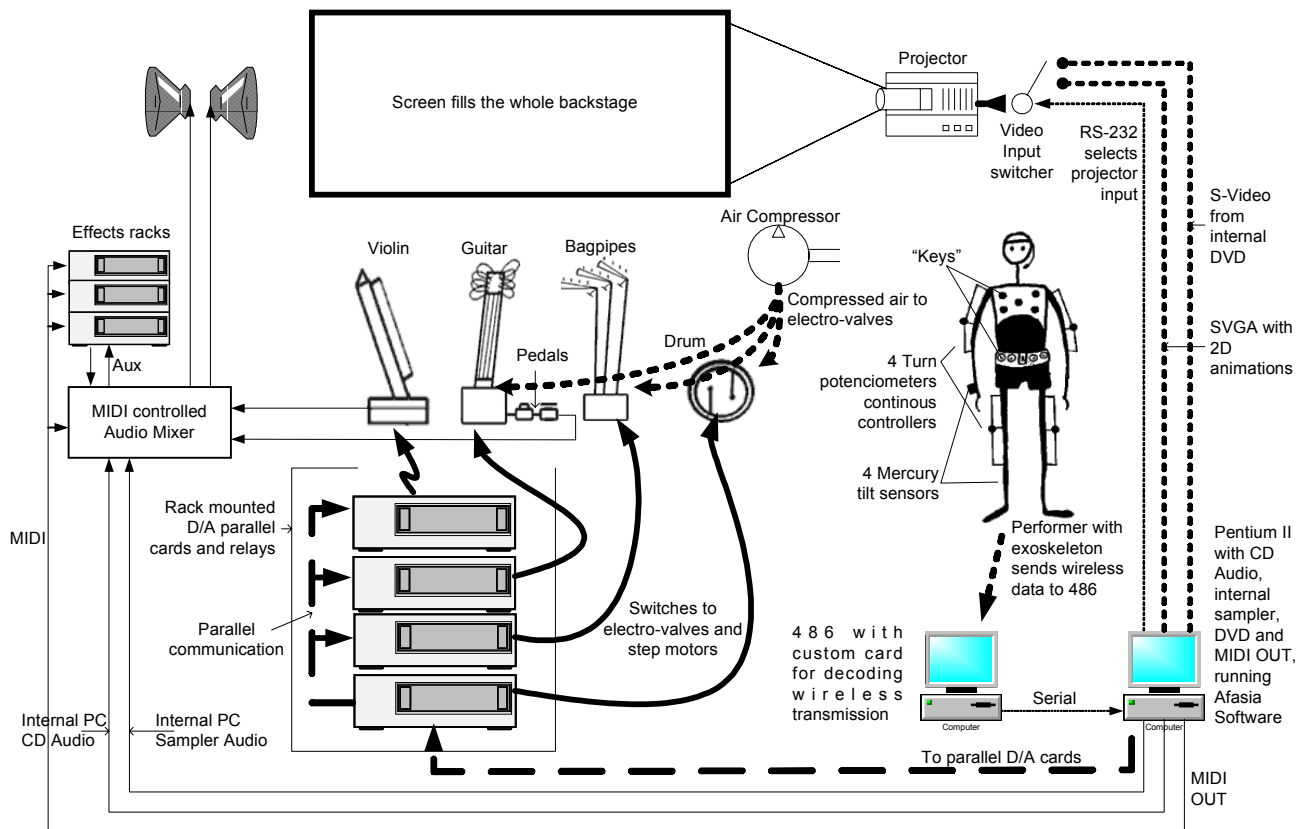
Figure 1. Afasia hardware and communications diagram

The Input: Exoskeleton and Sensors

I have insisted in other articles [4] that when conceiving and building new music instruments or interactive systems, a parallel design between the controller and the generator components is very convenient. However, *Afasia* takes essentially the opposite approach. Because of the diversity of tasks it has to solve, the input system was conceived as a robust, basic and polyvalent controller. The design process took therefore more into account the performer who would be using (i.e. Antúnez) and the general conditions of the show, than the specific functionalities of the related output system.

One of the show premises was that all the interaction protocols should be easily seen and understood by the audience. The input system has been designed to be visibly obvious (the show can be quite dark at moments), and according to the personality of the performer, who likes to move in brusque and coarse movements. It includes four continuous controllers, a set of keyboard-like switches and four mercury tilt sensors for detecting orientation and fast movements.

Afasia's sensor system is built into an *exoskeleton* worn by the performer, designed and constructed by Roland Olbeter, and somehow aesthetically reminiscent of the gladiators' "fashion" found in *peplum* movies. Many sophisticated bodysuits and control exoskeletons, like the *BodySynth* by Van Raalte and Severinghaus [6] have been designed for musical purposes or in the Virtual Reality field. Compared to most of them, *Afasia*'s system employs quite simple technologies. It consists of a

breast cuirass made of fiber glass and metal, a backpack that centralizes all the electric connections, a metal belt, sensor gloves and arms and legs metal prosthesis, all made to measure to the performer's body.

The four continuous controllers are situated at each of the performers extremities' articulations (elbows and knees). Instead of bend sensors, robust and traditional turn potentiometer are used, firmly tied to the performer by means of mechanical legs and arms, as it can be seen in figure 2.
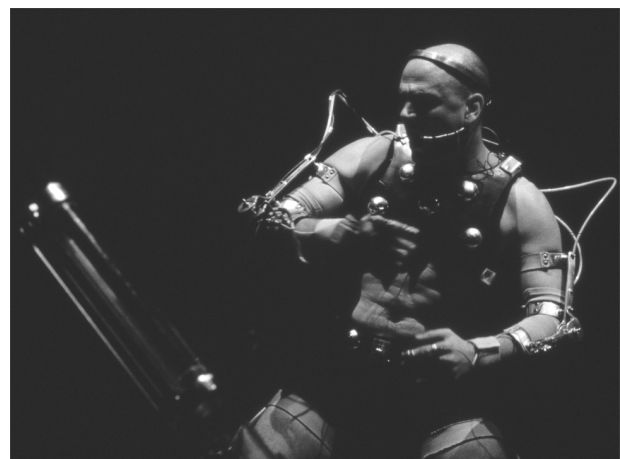

Figure 2. Antúnez with the exoskeleton, interacting with the violin robot (photography by Darius Koehli)

For a one-hour long show with many different parts and settings, a sort of a keyboard (i.e any device that can offer unambiguous multiple discrete choices) is a trusty element. In *Afasia* this "keyboard" is build into the breast cuirass, by means of five metal hemispheres of

about seven centimeters of diameter each. These electrically isolated metal parts function as keys or buttons, closing electric circuits when touched with the special finger showed on figure 3.
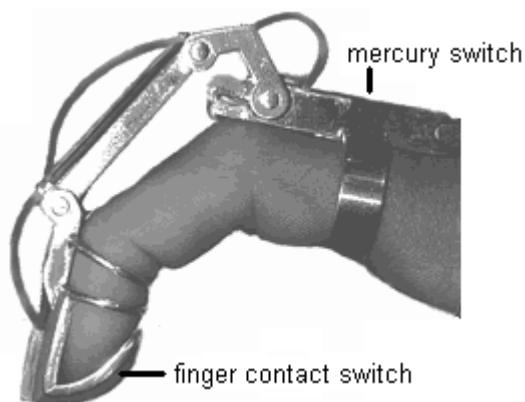
Figure 3. Detail of one "contact finger" with its mercury sensor

By applying different resistors to each of these hemispheric metal parts, this very simple technology allows to use only one analog input channel for all the breast buttons. Furthermore, it could also allow distinguishing between all of the performer's fingers, if using a different analog channel for each of the fingers. This former solution was however finally discarded as it proved to be quite confusing for the performer. Consequently, only the forefinger of each hand is active. In addition, five contact zones following the same principle are also built into the performer's belt, giving the performer a total of ten easily available "keys".

The four remaining sensors are cheap mercury tilt sensors. They are situated on each forefinger (as shown in figure 3), and also on the bottom of each leg prosthesis. Mercury switches are often employed as a cheap alternative to accelerometers for tilt or orientation purposes. Here, they are simply used as fast gesture detectors or as average activity indicators.

The Backpack: Wired and Wireless Transmission

All the electrical connections for the aforementioned potentiometers and switches are plugged into a small backpack tight to the cuirass, and sent from there to the computer analog inputs. For that purpose, two different analog input systems where developed. The first version used a wired connection between the backpack and the computer, with a small analog to digital box plugged into one of the computer's serial port. The performer was therefore linked to the main computer by a 10-meter umbilical cord.

A wireless version has been developed later, using wireless microphone technology and an old 486 computer fitted with a custom card that works as a digital decoder. This less powerful computer is serially connected to the main computer. After several corrections, this wireless version has proved to be quite reliable, although the attainable input sampling frequency is only 15 Hz, which is slower than the one available with the wired version.

The Output: The Robot Quartet

A big part of *Afasia*'s music is mechanically played on stage by a robot quartet, integrated by an electric guitar, a one-string violin, a drum and a three-bagpipe "horn section", all designed and build by Roland Olbeter.

Robots' Physical and Logical Communications and Control

The communication between the computer and the robots is assured by means of several digital to analog cards daisy-chained to the computer parallel port. These cards control altogether almost a hundred relays and several step motors. All these mechanisms (cards, relays, etc.) are mounted into four racks, one for each of the robots. These racks are chained-connected to the main computer parallel port, while each robot is plugged to its respective rack using 19-pin S*ocapex* industrial connectors[1], conforming a reliable and easy to mount system.

The whole robots setup is MIDI controlled. Robots are able to play from strictly sequenced sections to free parts where the performer uses the exoskeleton-robots combination as a real musical instrument. Sequenced parts can be directly triggered by the performer or indirectly activated by the system, as in the case of musical fragments linked to given film sequences.

To simplify the bridge between the musical MIDI messages addressed to the robots by the interactive software, and the D/A cards switches, each of the robots has its own virtual MIDI driver installed in the main computer.

Robots' Construction Guidelines

Afasia's robots are not anthropomorphic; they look like instruments, not like players.

The drum, the guitar and the bagpipe robots use exclusively pneumatic mechanisms. A common air compressor feeds them all. The air that reaches the robots is governed by electro-valves, each of them connected to a separated relay. The number of *air-channels* or relays employed by each robot varies from the two channel used in the drum to the 72 channels of the guitar. The violin, on the other side, uses only step motors.

The drum and the bagpipe robot are acoustic instruments, while the guitar and the violin robots are electric; their monophonic audio line outputs are connected to the mixing deck.

The following sections describe in more details some of the specificities of each of these robots.

The Drum Robot

This is the simplest of them all. It consists of a tom drum with two independent sticks; only two electro-valves and two relay switches are therefore used. However, unlike

---

[1] <http://www.amphenol-socapex.com>

the other robots, this drum can also slowly move on stage; the drum is always lied down and its cylindrical body can spin under the computer control.

The Electric Guitar Robot

This is the biggest and heaviest robot. As seen in figure 4, this robot does not have a "right hand". Instead, it plays tapping the frets with its "72-fingers left hand" in the manner of guitarists Stanley Jordan or Adrian Belew.
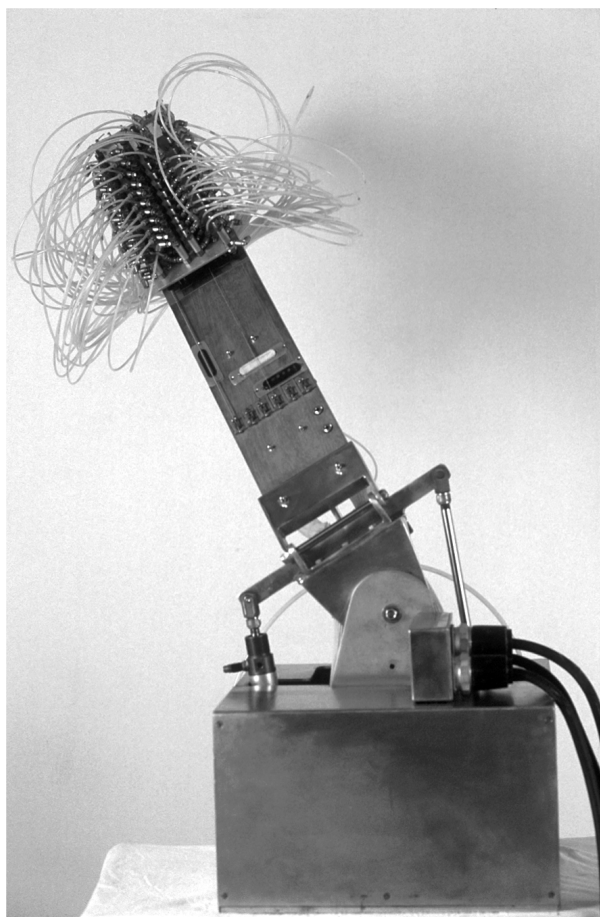

Figure 4. The electric guitar robot. The upper plastic tubes are connected to the electro-valves that tap each of the guitar frets. The lower "legs" are used for twisting the guitar neck (photography by Darius Koehli).

The instrument has six strings. Five are regular electric guitar strings, while the lower one is a bass guitar low string. Each string has 12 frets and each fret is accessible by an independent and small *hammer-finger* controlled by an electro-valve. The virtual MIDI driver of this robot addresses six MIDI channels, one for each of the strings.

The guitar big neck is also able to twist with two degrees of freedom under the computer control, allowing for simple but effective rock'n roll choreographies! The output of the instrument goes into two pedals (a fuzz and a wah-wah) that are not MIDI-controlled but can be played by the performer.

The Three-bagpipe Robot

This robot, shown in figure 5, is made of three bagpipe tubes. The principle is similar to the one employed in the guitar. Each hole can be closed by a dedicated finger, controlled by an electro-valve. Three additional electro-valves and three pressure stabilizers are used for turning the blow on and off. Its virtual MIDI driver addresses three monophonic MIDI channels (one for each bagpipe). The mapping between MIDI notes and relays is obviously not so straightforward as in the guitar, as fingering techniques have to be considered.
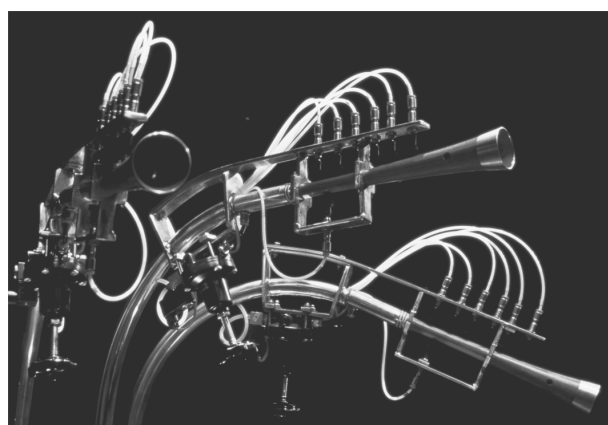
Figure 5. The three-bagpipe robot (photography by Darius Koehli).

Each bagpipe looks like a 2-meter tall standard lamp. Like "real big-band saxophonist", bagpipes are able to pivot front and back about 45°. Unlike real big-band saxophonists, Afasia's bagpipes are never in tune!

The Violin Robot

The violin robot has only one (electric guitar) string and one glissando finger. This string is fretted by an *Ebow*[2] while the finger, controlled by a step motor, can slide up and down. As shown in figure 6, the violin neck is a transparent plastic cylinder with a lamp inside. This cylinder is sustained in its gravity center and can delicately oscillate around it with two degrees of freedom.

The purity of its sound and the grace of its movements make the violin the perfect counterpoint of the clumsy and brutish electric guitar robot fellow.

Complementary Music and Sound Control

The music mechanically played by the electric robots (i.e. guitar and violin), is mixed together with the music coming from an internal sampler card and with occasional prerecorded audio fragments triggered from an internal CD audio player, into a MIDI-controlled Yamaha audio mixer. This output is eventually processed through three effects processors racks, which are also MIDI controlled by the main computer.
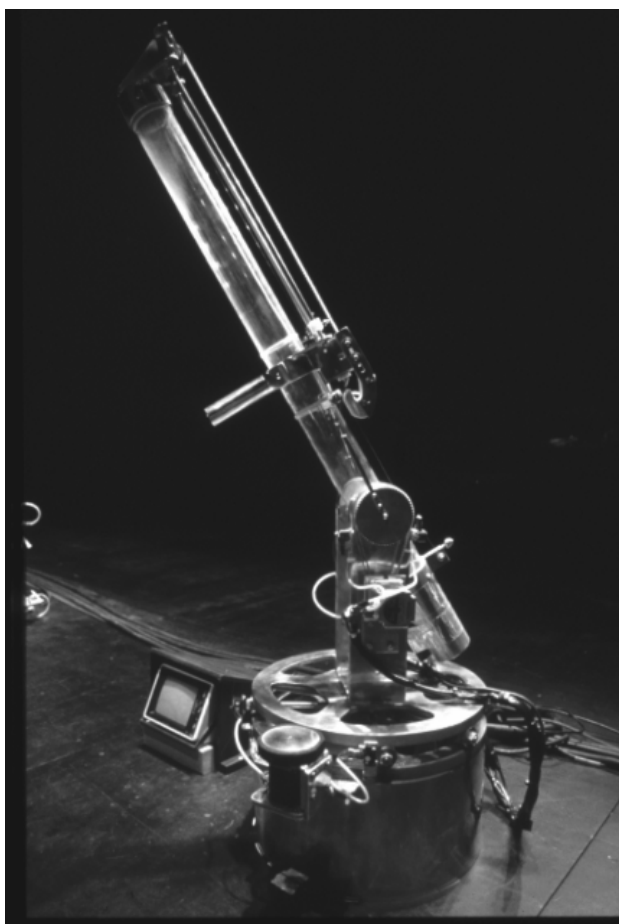
---

[2] < http://www.ebow.com>

Figure 6. The violin robot (photography by Darius Koehli).

INTERACTIVITY STRATEGIES AND SOFTWARE DESIGN

Interactive language is often closer to being a metaphor for a geographical or spatial area than for a time sequence. Using Ulysses' voyage as a metaphor, *Afasia* is structured on different expressive and space-like levels, proposing a series of interrelations between sound, vision and performance. The division of the show in various *islands* or independent interactive environments is also a technical consequence of the complexity of the elements to be controlled as opposed to the limited semantics of the sensors employed.

Afasia's Odyssey is consequently a sea with islands, sections or states, each with its own interactive elements and behavior, each using the interfaces, the robots and the visuals in different ways, with varied input-output mappings and varied restricted degrees of freedom.

Although the navigation main menu that permits to jump from one *island-state* to another, and the control of the interactive visuals, both bring many innovative solutions, the rest of the paper will only cover the interactive music aspects.

Afasia Interactive MIDI Files

In Afasia, all musical interactivity is treated by means of format 1 Standard MIDI Files, expanded with the inclu-

sion of proprietary text meta-events and reproduced through a custom interactive sequencer.

Text events are often used by sequencers to name parts of the tracks or to display synchronized lyrics. In the *Afasia* software they are used as commands that tell the custom sequencer player how to deal with, and process, the recorded MIDI events, according to the performer's gestures. This approach enables to write, record and program interactive *Afasia* music using any standard sequencer software, although the interactivity is only available when the file is played in the custom *Afasia* sequencer player (when *Afasia* Standard MIDI files are reproduced on a conventional sequencer no interactivity is attained, as sequencers simply skip text meta-events).

Here is a brief description of the *Afasia* MIDI files structure:

- Each part (or *island*) of the show is associated with one Standard MIDI file.

- Each MIDI file is made of any number of **blocks** (an *Afasia* concept not present in standard MIDI files).

- A **block** is a group of sequencer's tracks that behaves like a permutable section of a score, only one block being active at any time.

- Each block is made of a special **control track** and any number of conventional MIDI tracks.

- **Control tracks** only contain text meta-events that indicate how to interact with the other block's tracks, alter the block structure or jump to other blocks.

- Conventional tracks can also contain text meta-events that indicate how to interact or modify the MIDI data inside the track.

- As conventional sequencer tracks, each track (except for control tracks) is directed to a specific port or device, and to a specific channel within that device.

- Six MIDI ports are used in *Afasia* (a custom port for each of the four robots, the standard internal MIDI port for controlling the soundcard sampler, and the standard external MIDI port for controlling the audio mixer and the three effects processors).

- Each device can have several MIDI channels (e.g. the electric guitar robot has one channel for each of its strings, while the bagpipe section MIDI port uses three channels, one for each bagpipe).

The text meta-events embedded in the sequencer tracks, specify interactive commands and do always have the following structure:

```
COMMAND_NAME=param1,param2,...,paramN$
```

The number of parameters (*N*) and their meanings varies with each command type. The first parameter usually corresponds to an input sensor number while the second

indicates which track of the block the command applies to. Following parameters define how these incoming sensor values have to be mapped.

For example, the command TRANSPOSE=4,3,12$ indicates that the third track of the block will be transposed according to the incoming values of sensor #4, in a maximum range of +-12 semitones. Many commands (TRANSPOSE is one of them) have an *end* version command (e.g. ENDTRANSPOSE) that disables the effect.

More than forty commands are implemented in *Afasia*. They allow to dynamically switch between blocks, mute/unmute tracks, transpose the tracks, loop any sequence and modify their lengths, modify the current play position, generate or modify any MIDI controller (either setting directly the new value, its increment or the range of random variation), quantize tracks, delay tracks, control tempo, compress/expand temporal events, trigger audio CD tracks or define chords or scales to which new generated notes will be matched.

Several additional macro-commands called *solo modes* can also be activated, each one defining a peculiar way of playing (i.e. entering new MIDI note messages into the system). While the previous commands use simple one-to-one mappings, *solo modes* apply more sophisticated gesture detection mechanisms, that allow for example to *play* the robot-guitar in an almost "conventional" manner, controlling pitch with the performer's left elbow angle, while triggering notes with different right-arm fast movements that enable the performer to play chords, arpeggios or monophonic lines. Twelve solo modes (three for each robot) have been defined.

Animations and DVD Quick Overview

Afasia is not only an interactive music system. As it has already been told, the software also allows the performer to control 2D animations or access a DVD video. All this is attained by means of complementary text files that constitute the interactive script of the play. The principle of these multimedia script files is similar (although simpler) to the one developed for the interactive MIDI.

Each island or part of the show is a section of the text. It defines the input channels, the output elements employed (sprites or image files, DVD tracks, etc.) and the mappings applied between the inputs and the outputs.

In a given part, a continuous controller could, for instance, determine the position of a sprite in the screen or the frame number of an animated sequence, while a discrete controller could select a chapter or a section of the DVD. Several image-processing techniques (e.g. zoom, color modifications, etc.) are also available. Besides, as only one projector is used, the system automatically controls the active input of the beamer, switching as needed between the video (DVD) and the SVGA inputs by means of RS-232 messages.

CONCLUSIONS

The first version of Afasia was premiered in 1998 in the Teatre Nacional de Catalunya of Barcelona. Since then it has been performed in several European and American countries and has received several international awards. The system has proved to be so reliable and easy to set-up that when touring, only one technician accompanies the performer.

The system has also proved to be a flexible framework for interactive music composition and performance. Its varied interactive possibilities turn it into a powerful and flexible interactive system, which permits anything from free audiovisual improvisation to completely pre-recorded sequence playing. The Afasia software can be considered in that sense, as a multimedia instrument, for which the Afasia interactive play is its first (and for the moment only) composition. Besides all of its multimedia capabilities, the approach taken by Afasia's interactive MIDI kernel seems also especially suitable for interactive soundtracks in videogames or other multimedia environments and should be further explored.

REFERENCES

[1] Gianetti, C., *Marcel.lí Antúnez Roca: Performances, Objects and Drawings*, MECAD, Barcelona (1998).

[2] Homer (Fitzerald, R. translator), *The Oddissey*, Anchor Books, Garden City, NJ (1989).

[3] Jordà, S., "EPIZOO: Cruelty and Gratuitousness in Real Virtuality." Proceedings of 5CYBERCONF, fifth International Conference on Cyberspace (1996), at
<http://www.telefonica.es/fat/ejorda.html>.

[4] Jordà, S. "Improvising with Computers: A personal Survey (1989-2001)." *Proceedings of the 2001 International Computer Music Conference*. San Francisco: International Computer Music Association.

[5] Macri, T., *Il corpo postorganico, Sconfinamento della performance*, Costa & Nolan, Genova (1996).

[6] Severinghaus, E. and C.V. Raalte. "The BodySynth" <http://www.synthzone.com/bsynth.html>.