Towards Interactive Operas: the Virtualis project

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ABSTRACT

We are presenting the *Virtualis* project, which is a virtual interactive opera : it is a CD-ROM opera specially designed and composed to be " performed " on any personal computer and proposing possibilities of interaction. Opera can then be accessed at home and no longer in theatres. It is both an artistic project (as an opera creation) and a scientific one (in the field of human-machine interaction).
We have first been modelling the interaction situation in traditional opera using an interagent collaboration formalism called MADEINCOOP. We then applied this model to the interactive opera performance, where a user faces a computer.

For the interaction model, we have chosen to use an analogy of a system of physical forces (e.g. electrical or gravitation forces). Forces and fields rule the evolution of the positions of the characters on the screen, whereas the user/listener triggers perturbations by his/her actions.

We are currently implementing the *Virtualis* project, using Director and also a specific environment named ALMA we have developped. It enables the creation of fine correspondances between musical fragments (described using GUIDO language) and graphical 3D elements. The user may wander inside music and interact with it, either with sounds or texts.

KEYWORDS: interactive opera, interaction modeling.

VIRTUALIS FEATURES

Virtualis is a computer-based interactive opera (CD-ROM) we have been developping both as an artistic creation project, launched by Alain Bonardi, and as a research project in the field of human-computer interaction, led by Francis Rousseaux. It provides the spectator the possibility of " playing " with an opera at home, interacting with operatic contents. In the case of such a digital opera as *Virtualis*, the latter include texts (read or sung), musical fragments and sounds, as well as graphic elements. It is not a virtual reality restoration of a past work nor of an existing opera hall.

Artistic features

Interactive opera belongs to the lineage of open works proposed by the composers in the fifties and sixties. In 1957, Pierre Boulez (born in 1925) in his *Third Sonata* for piano and Karlheinz Stockhausen (born in 1928) in his *Klavierstück XI* proposed to the pianist possibilities of variable linkings between carefully written sections : the instrumentist may take different paths at

each performance, following the combinatory rules set by the composer. André Boucourechliev (1925-1998) would then go beyond the articulation of pre-defined contents : in *Archipel IV* (1971) for piano, the musician can dynamically build the music itself, associating melodic schemes with rythmic ones in real time.

These works put in a way the listener offside. Whereas the relationship of musicians to the score is renewed, wheras composers experiment new ways of writing, the listener does not feel concerned by instrumental open forms, which are difficult to be perceived. It would require several listenings of the same piece.

These musical open forms have become obsolete. We think that multimedia computing can revive this genre, by shifting it to the listener's benefit and to the detriment of musicians. Listeners will be able to handle musical contents that musicians just record, without possibilities of intervention. Moreover, from our point of view, it is important to state that the CD-ROM media can be used for whole musical works, not only to comment or analyze music as many ones propose.

Interactive features

This kind of works arouses new relationships to opera, either for composers of for listeners. Reading and writing activities are no longer separated as they used to be in traditional opera. However it would be illusory to let spectators imagine they could become composers thanks to this digital application. Our purpose does not consist in protecting the composer's figure, but it is clear that multimedia activities supposed to be creative do not abolish it at all. On the contrary, they handle it indirectly, since they promise users they could become artists in the traditional occidental meaning : everyone should be able to reach this " status ".

We believe that the possibilities of intervention provided to users in our opera are no longer based on these conceptions. We do hope that the interactive relationship arouses new modalities of expression that in a way get rid of traditional divisions between artists and members of the audience.

INTERACTION MODELS IN VIRTUALIS

We are interested in modelling the interactions to take place during opera performances, either traditional ones in opera halls or concerning interactive operas. To achieve that purpose, we have chosen [2] a modelling method inspired by MADEINCOOP [8], which has been developped since 1992 by a group of researchers working on human-computer cooperation.

Modelling interaction situations in opera using MadeInCoop

Let us sum up our approach by presenting basic principles the method is based on :

- Cooperation is taken into account at the knowledge level : purposes and knwoledge are attributed to human and artificial agents, without any reference to their technical features.
- The first step in the method is the definition of the agents involved and the tasks achieved.
- During the activity modelling, three points of view are considered : the problem resolution point of view, the coordination

point of view, and the communication point of view.

Dealing with our two kinds of opera – traditional or interactive –, we can establish a list of agents (dispatched between human and artificial ones) and a list of tasks (dispatched between background, prescription, interpretation and updating ones) for each of them :

	Traditional Opera
List of agents	• *human agents* : actors, stage managers, spectators • *artificial agents* : scenic systems
List of tasks	• *background tasks* : executing an indication, following the performance • *prescription tasks* : prescribing the behaviour of artificial agents, prescribing the actors' play • *interpretation tasks* : interpretating the score, interpretating what is seen and listened to • *updating tasks* : updating one's initial conceptions

	Interactive Opera (*Virtualis*)
List of agents	• *human agent* : a spectator/user playing with the opera • *artificial agent* : a computer supporting creative interactivity
List of tasks	• *background taks* : executing an instruction, following the performance and its evolution • *prescription tasks* : prescribing the evolution of the performance, prescribing sounds and images • *interpretation tasks* : interpretating the user's action, interpretating what is seen and listened to • *updating tasks* : updating one's initial conceptions

Figure 1: The boards of agents and tasks during opera performance, comparing traditional and interactive operas.

General principles of interaction

We are now presenting the interactivity principles we have chosen to implement the models that have just been introduced. This will enable users to play the various roles we have listed in traditional opera : spectator of course, but also actor and stage manager. What are the main features of our *Virtualis* project ?

- We are looking for a discrete interactivity that would not present itself as such. Links and icons are generally used to point out interactivity, they are interactivity figures that exhibit its possibilities. We would like to adjust fluid processes where it is implicitely proposed to the user to intervene, as he/she wishes. If he/she does not intervene, the opera keeps following its former path, according to some data and according to what the computer has stored from previous playings. The purpose is to avoid any interruption of the opera flow, by orientating it continuously.

- As in any interactive application the action/reaction question is raised. How is the user's intention taken into account and how can the computer prepare an answer ? In *Virtualis*, we have tried to implement a non-psychological model : the user's motivations and behaviour are not modelled. The user is considered as an external element who can act on the interactive work which is an autonomous system, without being explicitely taken into account in his psychological complexity. To achieve that purpose, we have elaborated a model based on physical forces.

The interactive opera *Virtualis* proposes three types of scenes :

- Scenes proposing interactive games based on opera dialectics. In one of them, named " Words and sea ", rocks represent words whereas the sea represents music. According to the level of water that the user may vary, spoken words are more or less modified, their sound contents being transformed to musical contents. We will not present these scenes further in this article.

- Transition scenes named " Music Wandering " that provide users the opportunity of wandering inside a three dimensional world where music is represented thanks to graphical metaphors. We will go deeply into the description of theses scenes in the 2.3. paragraph.

- Transition scenes named " The Recitative ", which are short interactive dramatic moments involving some of the six characters (two men, two men, two children). We have developped the physical model we have already evoked for these scenes, and we will come back to it in the 2.4. section.

" Music Wandering "

" Music Wandering " consists in transitions between scenes. They can happen or not, according to random choices. However they are each time based on an identical principle, though music taking place vary. Three main functionalities are proposed to users :

- Wandering through music in a geometrical space that represents some structural properties.

- Modifying music, represented as graphical objects that can be handled.

- Orientating oneself towards another musical sequence.

Let us first examine the principles of the wandering activity through musical contents. The user is flying in a cubic cage, which contains musical objects represented by 3D volumes with various shapes, colors and textures. These objects are monodic musical fragments.

Associated musics are played according to loops, each of them having a different length, and that leads to a permanent interval between them. Sound files are mixed, but relative intensities depend on the user's position and distance related to the graphical objects that represent them. The figure 2 shows an example of wandering through a kind of tunnel associated to a piano melody.

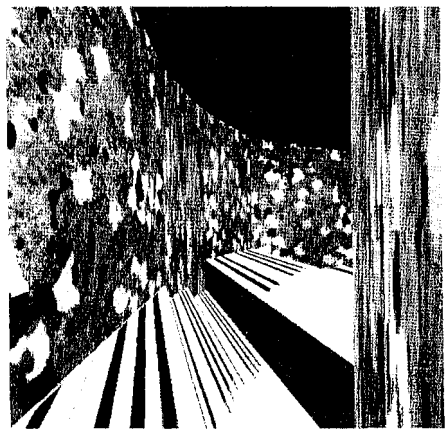

Figure 2: Moving forward at the pace of music in a representation of a melodic fragment

To prepare these scenes, we have first created an application named ALMA, which enables the creation of graphical objects from musical contents (described using GUIDO [3]), to generate melodic variations and to implement interactions. In its MIDI version, the user can not only modify such macroscopic parameters as tempo, sound volume, panoramic position of sound, but also generate structural variations that modify the contents played.

The " Recitative "

The " Recitative " stages two characters, a man and a woman, telling a story split in very short dramatic " moments ". The main question is to know how to make it interactive, an therefore choose an adequate interaction model. We have decided to experiment a physical model using forces equivalent to classical electrical attraction or gravitation.

In our mind, this duet should be more inspired by choreography than by theatre, the positions of the two "virtual" actors determining what they sing and its variations. Physical forces, which determine the actors' movements and positions have two sources : on one hand they are produced by each character, on the other hand by attractors located out of the screen, producing force fields supposed to be constant and influencing the actors.

From the user's point of view, the possibilities of interaction include:

- He/She may in a way " conduct " the singers, by triggering their music parts when clicking on their icons. According to the length of the musical phrase, the figure of the character is progressively faded until it is finished. At this time, the user can launch another musical phrase by clicking once more.

- He/She may move one of the singers, and that triggers a modification of what is sung. As another consequence, the other singer will also move, being driven by the computer.

- He/She may choose an element of the set and click onto him to access another short " moment " of the Recitative. If not, the computer will play the next moment planned according a principle of physical forces to be explained in the next section.

The dynamics of each scene is computed in real time according the system of forces, the updating of the characters' positions and singing. We assume that four different forces exist. Each character is therefore modelled by four "affective" charges or masses corresponding to four feelings : tenderness aspiration, boldness/resignation, egotism and jealousy. The mass or the charge of each character according these four dimensions varies from one "dramatic" moment to another.

Possible interactions concern:

- The attraction/repulsion between the two characters ;

- The attraction/repulsion between each of the characters and the external forces.

The figure 3 below shows the different forces to happen in an example of scene. The stage is represented as a rectangle. Forces F_{21} and F_{12} are respectively the one exerted by the male character on the female one and its opposite. G_1 and G_2 represent the force fields exerting themselves on the two characters according to the four " masses " or " charges " we have mentioned.

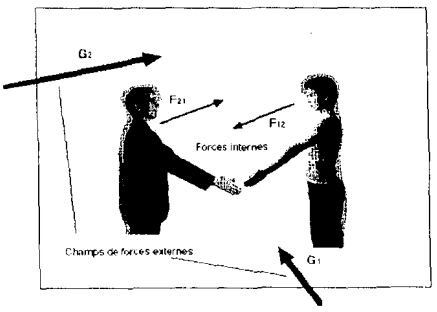

Figure 3: Internal and external forces exerting on the stage

To set the characters' positions and mouvements, the computer solves the basic Newton equation of dynamics, thanks to the Euler algorithm (double integration). The physical force model is also used to rule the text and music variations. In a way, it is similar to dance, where movements create the expression. Each sung sequence has several variations concerning text and music. Text variations are achieved by progressive semantic distortion on a theme, either going from inside feelings to the external situation or conversely. We have built semantic axes AS_i. Each external force exerted on one character has more or less influence on these axes, according to an α_i coefficient between 0 and 1.

Let us give an example of a dramatic " moment " to take place at the countryside. Here is the synopsis of this moment :

(in french)

L'homme et la femme passent l'après-midi à la campagne.

L'homme aime ce lieu ; la femme

s'ennuie. L'homme veut rester. La femme ne sait pas ce qu'elle veut. Elle soupçonne de ne pas être la première à venir avec l'homme en ce lieu.

(translation to english)

A man and a woman spend an afternoon at the countryside.

The man likes the place ; the woman is getting bored. The man wants to stay. The woman does not know what she wants. She suspects she is not the first one to come with this man to this place.

The figure 4 presents two examples of semantic axes for the two characters.

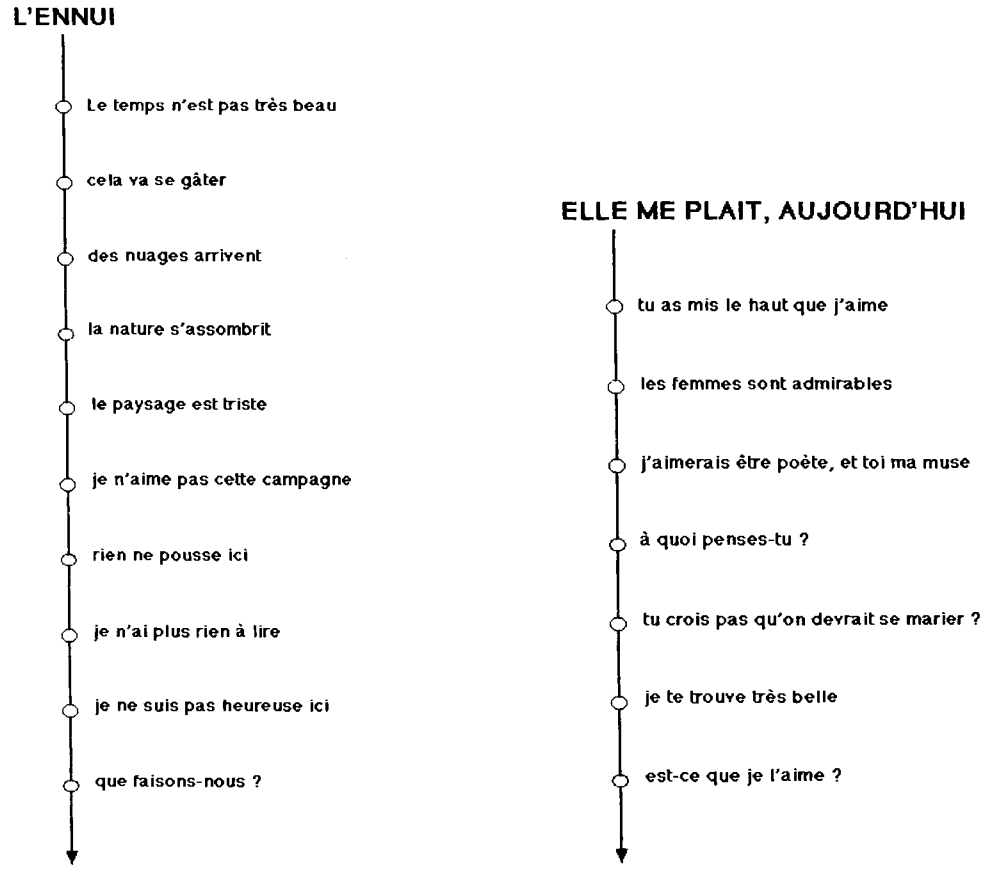

Figure 4 :Two semantic axes (for the woman, on the left ; for the man, on the right)

We have designed musical axes AM_j by the same kind of process, from the original melody to its variations. These axes are influenced by the force fields according to a μ_j coefficient. These axes are orthogonal to the previous ones, and therefore independent from semantic levels. Once set together, we have a music-text net as shown on the figure 5 grasping pre-recorded audio files.

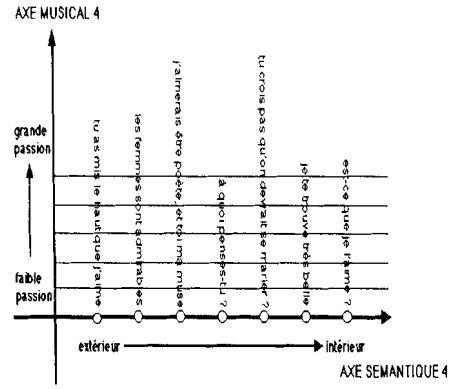

Figure 5: Example of a music-text net

The orientation of the net, especially the progression according to music or text is given by a global variable γ. The user can modify its value as shown on the figure 6.

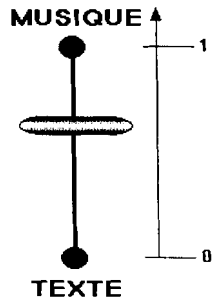

Figure 6: Cursor to dispatch the influence of external force fields between text and music

These physical models directly connect gestual input from the user (moving his/her mouse, etc.) and the actualization of contents. Contrarily to psychological models, they give up the ambition of a superior level of interpretation of the physical phenomena detected. They do not try to establish facts induced from these actions and then to compute a reaction to them.

CONCLUSION

We have presented the interactive opera project *Virtualis* and its interaction physical models we have been developing in that framework. It provides users an original playing, reading and writing activity. Contents are kind of operatic documents. The absence of any user psychological modeling leads to a singular relationship to the computer. The purpose is no longer to guess the computer's answer before interacting.

For multimedia designers, physical models lead to a programming conception that is no longer procedural. As in constraint programming, it is based on the definition of interactive frameworks, and inside them the computer proposes renewed solutions

from one time to another.

REFERENCES

1. Barrière, J.-B., " L'informatique musicale comme approche cognitive : simulation, timbre et processus formels ", in *La musique et les sciences cognitives*, Liège, Mardaga, 1988, pp. 181-202.

2. Bonardi, A., Contribution à l'établissement d'un genre : l'Opéra Virtuel Interactif, Ph.D. dissertation, Université Paris IV, 2000.

3. Hoos, H., Hamel, K., The GUIDO Music Notation Format Version 1.0 – Specification Part 1 : Basic GUIDO, Technical Report 20/97 of the Computer Science of Darmstadt Technical University, may be browsed at the following URL: http://www.informatik.tu-darmstadt..de/AFS/CM/GUIDO/docu/spec1.htm.

4. Goldberg, R., Performance Art, from Futurism to the Present, London, Thames and Hudson, 1979, 216 p.

5. Jorion, P., Principes des systèmes intelligents, Paris, Masson, 1990, 188 p.

6. Pellegrino, R., The Electronic Arts of Sound and Light, New-York, Van Nostrand Reinhold, 1981.

7. Poizat, M., L'opéra ou le cri de l'ange, Paris, Editions A.M. Métailié, 1986.

8. Rousseaux, F., Une contribution de l'intelligence artificielle et de l'apprentissage symbolique automatique à l'élaboration d'un modèle d'enseignement de l'écoute musicale, Thèse de doctorat de l'Université Paris 6, 1990.

9. Rousseaux, F., Contribution à une méthodologie d'acquisition des connaissances pour l'ingénierie des Systèmes d'Information et de Communication : l'exemple de CHEOPS pour l'aide à la gestion de crises collectives à caractère géopolitique, thèse d'habilitation à diriger des recherches, Université Paris 6, Paris, 1995.

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