USER, SOUND CONTEXT AND USE CONTEXT: WHAT ARE THEIR ROLES IN 3D SOUND METAPHORS DESIGN?

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ABSTRACT

The sound metaphor is considered as an assistant tool for the user activity. In order to create such new use, the classical design process must be adapted to the design object and viewed with a creative and prospective approach.

As shown, the cognitive capacities of the user, the use context and the sound context play a specific and important role in the design process of the sound metaphor. We propose a structure for the sound metaphor, which is about to be validated.

In our point of view, designing sound metaphors can be based on psychological studies of analogy. The search of analogy is led by goals, manipulated objects and mainly by activation of the knowledge of the subject regarding the situation and the use of context [1][2]. It depends on the degree of abstraction between the representation of the situation (target) and the activated knowledge (source). So, we use the context of perception of 3D natural environment. Our studies have shown importance of the use of 3D sounds and context for identifying sounds and for activating the knowledge related to this sound.

1. INTRODUCTION

The expansion of new technologies (communication, computer science, telecommunications) generates some needs especially about the taking into consideration of the user. After an only technological approach, the contribution of human science is primordial. In fact, the comprehension of the cognitive working and the expectations of the user is a very important step so as to adapt the sound metaphor to the user. In the case of designing new computer environments, we have to conduct the design process in a creative and prospective way with a conceptual approach. In order to adapt and to optimise the sound metaphor, the design process must take situation features (use, technology etc.) and the user cognitive working into account.

This work is realised in Menson [1]project. The goal is to propose a structure of sound metaphor adapted to the user activity. We have adopted a conceptual step before the implemantation of the sound metaphor. The sound metaphor is defined as a case of analogy based on sound [3] [4]. So, we focus on research concerning the use of sound in computer environment and the psychological theories of analogy. In spite of some gaps, these theoretic fields allow to circle three important parts in the design process as cognitive processes of the user, the sound context and the use context.

As we explain later, the framework of analogy offers tracks for the design and particularly for the design of sound metaphors in Human Computer Interaction (HCI). The explanatory mechanisms of access and the use of a reference domain are central in our approach because they give some useful elements for elaborating the sound metaphor.

More, sound in computer environment is yet considered as a poor media or just like a direct feedback of action. It uses without regarding the cognitive working of the user and theirs expectations as intention of action, for example. Few works are interested in cognitive aspects of sound. Therefore, one of ours goals is to verify the user knowledge linked to sounds of his everyday environment.

So, these different reports show certain lacks concerning the sound metaphor design in HCI. But, analogy theories [5] [6] and technical potentialities of sound manipulation in computer or virtual environment [7] [8] [9] permit to envisage an optimal use of sound according to users needs and use context.

2. ACTUAL USES OF SOUND IN HUMAN COMPUTER INTERACTION

We usually classify the use of sound in Human Computer Interaction as music use, voice use, feed back, notification [10]. Concerning our study, we are focused on research about auditory displays. Main works concern sonification or data auralization, earcons, auditory icons and more recently sonic browsers. Auditory displays applications permit to manage information. We summarily present them in next part.

2.1. Sonification or data auralization

The sonification is a sound use distinguished during ICAD'92. The utilisation of sound consists in taking place of visual data or completing visual data. It gives possible to represent an action or an object by sound. As Kramer [11, p.187] specified, « In sonification, there are substantial mediating factors, as the sound generation technique need not have any direct relationship to the data being generated. The simplest sonifications include a direct mapping of the data to a simple auditory parameter, such as pitch or loudness ».

This principle offers many possibilities and solutions in order to resolve problems linked to the visual display in computer environment. For example, Bly [12] uses data auralization in case of management of more of three kinds of

[1] Menson is a French project supported by the National Center of Telecoms Studies (France Telecom/ CNET/CCETT of Rennes). Menson could be translate as metaphors for sound environment.

data concerning flowers. The mapping between data and auditory parameters is direct and arbitrarily established as Tavera [13] do it. We see an emergence of a new type of application, sonic browsers or browsing with sound support [14].

2.2. Earcons

Musical messages are another auditory tools in human computer interaction. Blattner [15][16] called them EARcons. She has developed a method to create EARcons based on a hierarchical language. An EARcon is a ground or a combination of grounds. For example, given A and B, two grounds. A corresponds to the file entity and B corresponds to the delete action. So, AB means to delete a file. Blattner and collaborators have used the method to design auditory maps. The mapping between the EARcon and associated information is also arbitrary and only symbolic.

Brewster and colleagues [17][18][19] showed the usability of Earcons in many cases, for graphics package, navigation in a menu hierarchy or in mobile phone menus.

Earcons are another example of the sound utilisation for facilitating the navigation supported or not by visual information and for facilitating the data visual management.

2.3. Auditory icons

Gaver [20] was the first to introduce sound in a graphical interface with the *SonicFinder*. He used environmental sounds for giving users information that they could not see. It concerns the selection of interface elements like file type, for example, and feedbacks. In fact, auditory icons use sound as “an integral part of the interface [involving] creating auditory, everyday sound producing events” [7]. So, auditory icons are based on real events and provide a metaphoric or iconic structure for the mapping between sounds and information that the first ones convey. Thus, the auditory mapping is not arbitrary, but based on an analogy with the everyday environment.

Many applications are based on this principle as ARKola [21], Sharemon [22], mercator [23], among others.

But, the information given by auditory icons only concerns computer activities like monitoring background activities [24], 1998) that users generally could not see or action feedbacks.

2.4. Conclusion and questions

Regarding most of auditory displays applications, the sound uses are notification, feedbacks and sonification. The notification gives information about events in the computer. The sound feedback provides a confirmation of the user action. The sonification uses the sound for completing or replacing the visual data displays.

Such systems can supported the computer-human interaction without regarding the user. Several questions pose problems. What is the real sound impact on the user activity? If the cognitive capacities of the user are known, is it possible to design more abstract sound icons like sound metaphor? Is it possible to design sound metaphor adapted to the user, to the use context? Can we define a pragmatic semantic of the sound use in human computer interaction?

3. ANALOGY FRAMEWORK: SOUND ANALOGY OR SOUND METAPHOR

Sound metaphor is a term from the computer science theory. The sound metaphor forms an external representation from the user and supports information.

On the contrary, sound analogy is the result of a complex mental process: analogy process. The most important theories of analogy are the structure-mapping theory of Gentner [25] [1] [26] [27] [5] [28] and the schema theory of Holyoak [29] [30] [31] [32] [33] [34]. Both of these theories have different approach. Globally, we can define an analogy as following. An analogy is the result of a comparison process between the mental representation of a target situation and the mental representation of a source or referent situation. The source or referent situation is a well-known, old and internal domain from the user. The target is an unknown, new and external domain from the user. The target situation is presented to the user and will active his knowledge (source). After the source access, the user utilizes his knowledge to resolve a task.

« Access is the process of retrieving a familiar source analog (or schema, rules) from memory given a novel target problem as a cue. Mapping is the process of discovering which elements in the target correspond to which in the source» [35].

The access to the source situation depends on recovery parameters called surface similarities. Surface similarities are linked to the semantic aspect of the situation and can facilitate the access to the source [36]. After the access to the source, the source is used and this use corresponds to the mapping process between the source and the target. The analogical transfer is promoted by parameters called structure similarities [37]. As shown, the access step is important for the analogy process because the following step depends on the success for having access to the user knowledge (source).

In this framework, the sound metaphor design consists of the design of a sound target that is to say, of a sound external representation from the user. This one conveys sound information and active the user knowledge (source) according to similarities and the user comprehension. This knowledge is used to realise a task.

Then, the explanatory mechanisms of the access and the use of the source situation are central because they are useful for elaborating the target domain. We consider sound metaphor as a target situation and the challenge is to design sound metaphor allowing user to act efficiently with the computer environment. We don’t design isomorphic sound analogies with the familiar world of the user but we have to determine invariable parameters of the user sound comprehension and the associated actions in order to transpose them in the sound metaphor structure [38].

4. ABSTRACTION LEVELS AND SOUND METAPHORS

As we said before, the sound metaphor design consists of the design of the target situation. In the analogy framework, the analogy search depends on the abstract degree between the representation of the situation and the activated knowledge. So, the sound design is based on the manipulation of different abstraction levels. We have established two abstraction levels: an abstract metaphor and a local metaphor.

Abstract metaphor is defined as a sound atmosphere or sound environment. It is composed of sound objects set. This set of

sound objects is determinated by use context. The local metaphor is a part of the abstract metaphor. It is a sub-set of the sound objects of the abstract metaphor. The passage from the abstract metaphor to the local metaphor is generated by user request. This action will give more specific information.

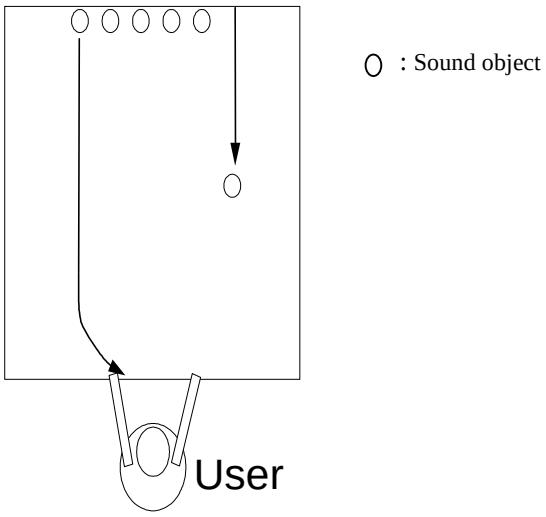

Figure 1. *Illustration of abstract metaphor, local metaphor and sound zoom.*

Pratically, some sound objects of the abstract metaphors become salient. This change forms the local metaphor. We use spatialisation and dynamic aspect of sound in order to produce this passage. We call this effect "sound zoom" or "sound focus" (figure 1, for illustration). The principle is the following. The user hears a sound ambiance. One sound of this ambiance is dynamically spatialized and moves to the front of the user. This action is made after the user request [38].

So, a such sound metaphor structure is supported by different abstraction levels. This structure can be adapted regarding the use context. To adapt means to change semantic characteristics of the situation. In other words, characteristics of the sound context, characteristics of the use context and cognitive capacities of the user are going to instantiate the abstract metaphor and the local metaphor.

5. STRUCTURE FOR DESIGNING SOUND METAPHOR

The sound metaphor is considered as an assistant tool to the user activity. In that way, the design is based on three fundamental elements: user (cognitive working of the user), the sound context and the use context (figure 2).

5.1. The user (1)

The human interprets the world around him. On account of confrontations with his environment, he builds his knowledge (Know-how, skills etc.). The user cognitive characteristics must be considered. In fact, the sound metaphor is used to give information so as to help user in his activity. That is why we take the user knowledge into consideration for supporting the structure of the sound metaphor. In that way, we use everyday sounds. These ones are played with the respect of the 3D natural perception because the play mode facilitates the access of the user knowledge [3] [39].

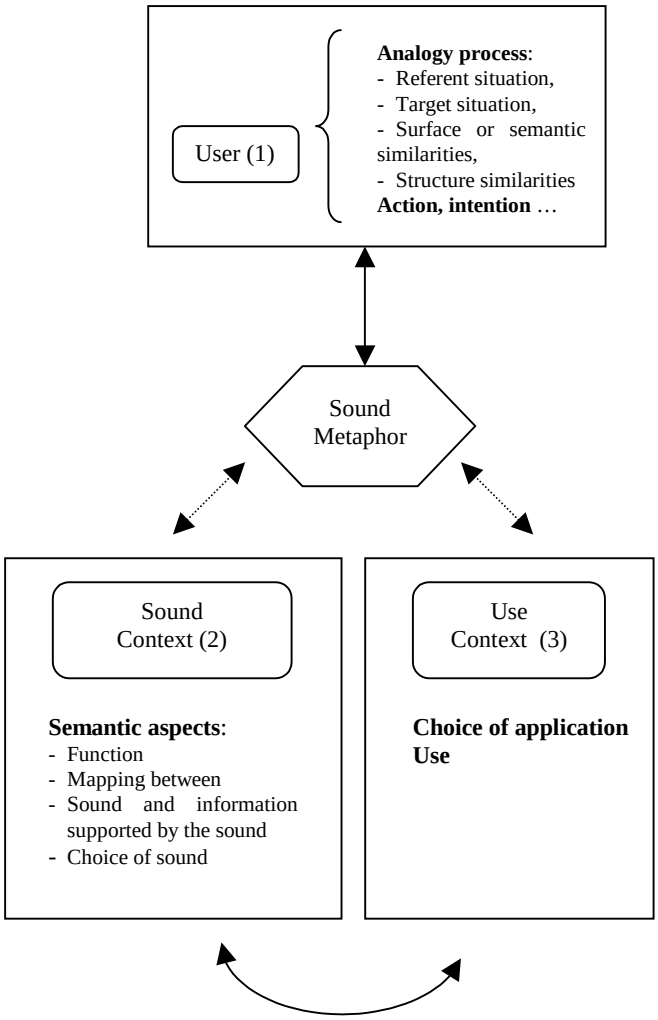

Figure 2. *Structure for designing the sound metaphor in the human computer interaction*.

5.2. The sound context (2)

The sound context depends on the cognitive capacities, that is to say, user knowledge about the sound environment and the use context. So, sound information of the metaphor must be adapted to the user and to use context. The semantic structure of sound metaphor is according to these characteristics and is based on analogy theories of the access and the use of activated

knowledge by the situation [1]. Only sound invariable parameters can be transpose in the sound metaphor structure.

The sound also gives the semantic aspect of the sound metaphor. For that, the sound characteristics are defined by the following points : function of sounds, type of mapping between the sound and the associated information, choice of sounds.

5.3. The use context (3)

There is an impact on the choice of the sound context type (cf. 5.2) concerning the semantic structure and the architecture of the sound metaphor. To resolve a task, the user produces several actions in order to attain the final goal. So, the invariable actions associated to sound are transposed in the metaphor structure.

6. CONCLUSION

The present work uses an original approach based on psychological and ergonomic theories. A conceptual thinking is realized before the implementation at the first step of the design process. The analogy theory is central and gives some elements for the elaboration. We have given here just a summary of our research work.

Moreover, several experimentations are conducted for validating the sound metaphor structure. The results show the importance of the use of 3D sounds and context for identifying sounds and for activating the knowledge related to this sound. These ones are in favour of the sound metaphor structure.

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