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ORIGINAL ARTICLE

High-level control of sound synthesis for sonification processes

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Abstract Methods of sonification based on the design and control of sound synthesis is presented in this paper. The semiotics of isolated sounds was evidenced by performing fundamental studies using a combined acoustical and brain imaging (event-related potentials) approach. The perceptual cues (which are known as invariants) responsible for the evocations elicited by the sounds generated by impacts, moving sound sources, dynamic events and vehicles (car-door closing and car engine noise) were then identified based on physical and perceptual considerations. Lastly, some examples of the high-level control of a synthesis process simulating immersive 3-D auditory scenes, interacting objects and evoked dynamics are presented.

Keywords High-level control · Invariants · Synthesis · Semiotics

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1 Introduction

Sonification consists in associating the data obtained by performing measurements of various kinds with sounds. The main idea is to use human beings' natural perceptual ability to identify sound structures to detect hidden coherences in a set of data. Sonification is often based on "music-like" strategies, whereby data are attributed to elementary sound sequences in which the tempo, rhythm and the duration of the sounds are controlled. Few studies have dealt so far with the use of sounds as a "language" based on timbre.

In this paper, we focused on the design and control of synthesis processes for sonification purposes. In the first step, a fundamental approach based on brain imaging techniques was used to investigate the semiotics of sounds, i.e., how we attribute a meaning to specific sounds. Experiments based on the use of categorization and priming tasks were then conducted in order to determine how isolated and contextualized sounds are processed by normal subjects. The results obtained suggest the existence of structural invariants which endow sounds with specific meanings. To determine these invariants, we further analyzed both the physical behavior of the sound-generating sources and the perceptual impact of the sounds on the listeners. Examples of the invariants associated with the physical properties of impact sounds and moving sound sources are presented. In the case of other less clearly defined situations such as the evoked dynamics or quality of industrial sounds, the invariants associated with the signal morphologies were identified by performing listening tests. Based on the invariant signal structures found to be specific to given sound categories, high-level control of real-time synthesis processes on the basis of the parameters mainly responsible for perceptual evocations was developed. These