Synthesis of Environmental Sounds in Multimedia Applications

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1 Introduction

This paper presents work in progress on automatic generation of "environmental sounds" based on physical modelling. The increase in complexity of the Graphical User Interfaces and the expansion of Virtual Reality and multimedia applications has led to the necessity of using sound to ease the human computer interaction. This category of sounds can be used as non-speech audio presentation of objects and as interaction mechanisms to non-visual interfaces. They occur in everyone´s experience and exclude the necessity of previous special training. They are also very suggestive, permitting the meaningful mapping of events from the real world to computer-related activities and are not annoying for the user.

2 The Approach

Every sound could be described as result of interaction between objects in specific environments. Each interaction has attributes that influence the generated sound. One can distinguish between object-specific and context-specific attributes. The first category includes material parameters, shape, size and allows us to find for each object a physical model (i.e. the equation of motion with boundary conditions and their solutions), assuming that the natural modes of vibration are at the origin of the sound. The second one includes parameters such as: position of the interaction point related to the body of objects, the speed and force at the moment of interaction, etc. These attributes control the manner in which the individual natural modes of vibration are excited (initial spectrum of the sound), the behaviour of their amplitudes in time (modal damping), and the overall decay of the sound wave (system damping or reverberation time). The last one needs a thorough description of the whole system, including the acoustical room where the interaction takes place and is very difficult to be modelled through mathematical descriptions. In this case a qualitative analysis is preferred that provides values for different usual interaction patterns.

3 Potential Applications

• **Human Computer Interfaces.** Sound can provide information and can ease the communication between computer and user. Many transitions, events, operations, file/resource management tasks are suited to be signalised with adequate, not annoying sounds. Our every day experience provides meaningful analogies so that we can easily find "audio" correspondents for the above-mentioned activities.

• **Virtual Reality.** Most of the sounds that are used in the current virtual reality applications are stored on disk and need large memory space. These applications are always interactive and allow the user to self-configure his virtual spatial room. The sound library is often limited and can not contain correspondents for all the possible sound producing events in the virtual room. Model generated sounds offer the possibility to configure the virtual space also from the acoustical point of view, in a sense that all the objects, through their parameters and physical model, can produce sounds according to their possible interactions. This is a much more powerful technique than a simple sound rendering of the virtual space with arbitrarily chosen sound sources and increase the degree of "reality" of these applications. The drawback of the method, its expensive computational cost in case of complex interacting objects, becomes less and less significant, as the computing power of the new machines increases.

• **Visually Impaired Computer Users.** Blind or visually impaired people make use of everyday sounds for orientation in their life. The integration of everyday sounds in user interfaces brings forward new ways for this group of computer users. The use of software systems and applications (for instance learning tools for training) supplemented with everyday sounds become easier and more intuitive because these sounds are close to their mental model.