

10.3 Interaction with Sound in auditory Computer Games

Niklas Röber (University of Magdeburg, Germany)

Maic Masuch (University of Magdeburg, Germany)

Computer games enjoy a constant increase in popularity, and are still one of the fastest growing industries in computer science. In recent years, a small niche for accessible games has emerged, so called Audiogames. This article presents an introduction into these audio-only computer games and discusses current state of the art, as well as research related sonification and interaction techniques.

10.3.1 Sound in Computer Games

The first games to be played on a computer were designed in the early 1960s and 1970s. These games were very simple, had only primitive graphics and almost no sound. Since then, games have evolved tremendously and attract people even more today. Currently, games are one of the major industries in computer science and a huge driving force in research and computer development. Computer games were used at all times for fun, enjoyment and competition and nowadays also in applied sciences in the area of serious and health related computer games [7]. See also Section 10.4 on sonification-based sport games.

The first largely available computer games were played on the Commodore and Atari computers and later moved to the PC platform. Compared to its contemporaries (the Amiga and Atari systems), the PC of this time was very limited in its sound synthesis capabilities. This changed in the late 1980s when the first add-on soundcards were introduced. Today's PC sound hardware is well advanced, and able to produce 3D sound and surround effects, simulate room acoustics and is in some cases even programmable through customized DSP¹ algorithms.

Sound is important for every game genre, and a bad acoustic environment can ruin an otherwise perfect game. 3D sound has proven to be advantageous, especially for very realistic games such as 3D FPS². Here it assists the player to detect the opponent also acoustically. The simulation of room acoustics plays an important role, as it intensifies the atmosphere and the degree of immersion into the virtual game world.

Although, sound hardware has not evolved as fast as graphics hardware, game audio has received a lot of attention in recent years, and the awareness of the capabilities of a good sound system is present in both the developer's and the

¹ DSP – Digital Signal Processor

² FPS – First Person Shooting games

player's mind. Future trends see a further improvement in quality and quantity and a similar programmability as in today's graphics hardware.

10.3.2 Audiogames

Audiogames, also known as *audio-only* computer games, classify a group of games which are played and perceived by auditory means alone. These games are often developed by and for the visually impaired. One of the first audiogames developed was "Real Sound – Kaze no Regret" (1999), an audio adventure that was inspired by blind fans and available for Sega's Saturn and Dreamcast consoles. Over the last years, several genres from the visual game domain have been adopted as audiogames, including adventures, action and racing games as well as simulations and role-playing games. The differences in game-play between a visual and an auditory implementation can be quite substantial. Audio is very well suited for presenting narrative content, but even several action games that rely on precise listening and fast user reactions are available. The blind community is quite active in this area and many of the old text-adventures are still played by the blind as they can be easily read out. An overview of the different genres and games can be found at the audiogames.net website [8].

A real advantage of audiogames is that the player's fantasy is stronger stimulated. This results in a higher immersion, similar to radio listeners who often state that the "pictures *look* better on the radio". Other advantages include an accessible game-play and a simplified development cycle. Difficulties occur within the game in the estimation of distances and the mapping of sounds to specific events.

Although there is a potentially big market, most audiogames are still rather simple and far less complex than their visual counterparts. But a current trend moves towards more complex and challenging games as well as to the concept of augmented and real world game play. The most important rule in designing audiogames is to immerse the player in a high quality virtual auditory world and to use techniques that support and enhance this sensation. Crucial is here the design of the user interface and its integration within the game. In some games, also visual ones, problems can occur due to poorly designed interfaces and menus that break the illusion of being immersed in a virtual world.

Following is a discussion of two well designed audiogames:

1. *Terraformer*³ is a so-called hybrid game. These are conventional audio-visual computer games that have been extended by certain sonification techniques to make them accessible for the blind. Hybrid games are quite common among audiogames, as this makes the game more attractive to a larger community and sighted and blind people can play together. *Terraformer* is an action-adventure game and set in a futuristic 3D world. The player's task is to fight against rebelling robots, find

³ <http://www.terraformers.nu/>

missing pieces of technology an re-establish the terraforming process. The game has received a lot of attention, due to some novel sonification techniques. The acoustic orientation and navigation is supported by 3D sound and the user has also a sonar-like technique for exploration.

2. *Seuss Crane: Detective for Hire*⁴ is an audio adventure game in which one plays a detective that has to unveil a murderer. It is based on a radio-play, in which the player chooses the locations to investigate, and after a while has to accuse someone of the murder. The game has an interesting story and is played by professional voices. Even though the game does not rely on any visual information, the user interface is still in the form of a simple hypertext-like menu. Another drawback is that one has to follow a predefined sequence in order to get points and to solve the game.

Next we discuss our research on interactive auditory environments that extend and generalises the current audiogames approach.

10.3.3 Interactive auditory environments

Interactive auditory environments take audiogames one step further. They generalize the ideas behind and combine the existing approach with common sonification and interaction techniques to form a 3D auditory environment. These can be thought of as being the acoustic analogue to a visual 3D game world. Applications exist not only in the areas of entertainment and edutainment, but also in from of general auditory user interfaces and the development of tools to aid the visually impaired. It is imperative to have an intuitive and integrated design and the right balance between aesthetics and functionality.

The main components that characterise interactive auditory environments are:

- A 3D virtual scene/world described by a non-realistic acoustic design.
- Intuitive sonification and interaction techniques to enable the user to explore, navigate, and interact.
- A narrative concept that focuses on an acoustic presentation.

In the following, we describe a research prototype that focuses on the implementation of such interactive auditory environments. The acoustic presentation that describes the scenery must have a non-realistic design, in which a realistic representation is exaggerated and enhanced at certain points and also enriched with additional information. This information can be conveyed through auditory textures, earcons, beacons and other sonification means. The quality of the sound rendering should be as high as possible, especially the 3D sound spatialization and the simulation of environmental (room acoustic) effects, as they directly assist the player in orientation and navigation.

⁴ <http://radio-play.com/>

For experimenting with the various sonification and interaction techniques, we have designed a framework for interactive auditory environments, which also served us as platform to prototype user interfaces and simple audiogames. Figure 10.3 shows an overview of the system. It is based on OpenScenegraph⁵ to manage the various 3D scenes and uses OpenAL/EAX⁶ for the sound rendering. The majority of sounds are spatialized using HRTFs⁷ and the simulation of room acoustics is achieved by the EAX/EFX system. Although the orientation and navigation within 3D virtual auditory environments is challenging, it can be greatly improved by incorporating the user's (head-) orientation and movements. For tracking these motions, we use a Polhemus Fastrak[®] that is controlled by the VRPN library⁸ and tracks the position and orientation of the receiver and the stylus component. The modelling of the 3D environment takes place in 3DStudioMAX[®], from which the data is exported and integrated into our framework as an extended XML file.

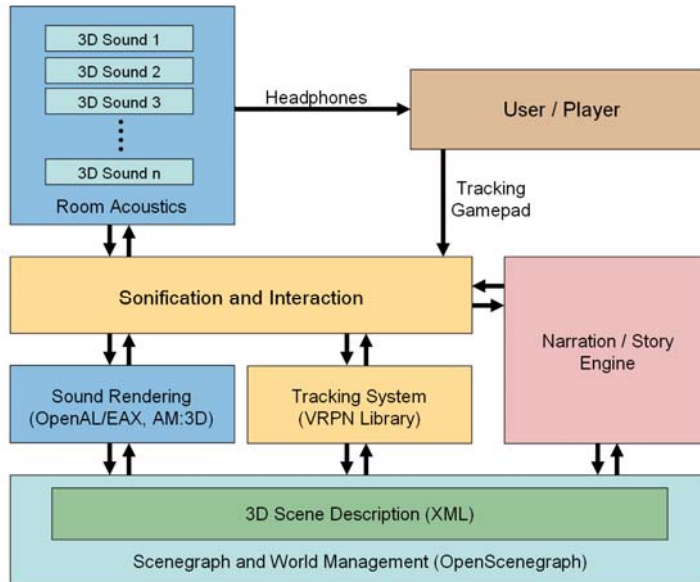


Figure 10.3: Overview of a System for interactive auditory environments

The sonification and interaction techniques are closely related and depend on each other: Sonification is used to transfer information from the scene to the user, while interaction is required to input the user's changes into the virtual

⁵ OpenScenegraph – <http://www.opensg.org/>

⁶ OpenAL/EAX – <http://www.openal.org/>

⁷ HRTF – Head-related Transfer Function

⁸ VRPN – Virtual Reality Peripheral Network (<http://www.cs.unc.edu/Research/vrpn/>)

environment. Care has to be taken in the design of these methods, as they should integrate seamlessly. All techniques have to be implemented to perform in real-time, otherwise the orientation and navigation would become extremely difficult. The tracking system allows the emulation of several listening and interaction behaviours, and therefore an easier and more intuitive orientation and navigation. It also permits an easy integration of gestures into the system, such as nodding or the drawing of symbols. A real advantage is the possibility of interacting within a spatial environment that allows the positioning of information and menus using a ring metaphor, sounds and intractable objects arranged 360° around the user. Additionally we use a regular gamepad for user interaction and positioning.

For the sonification techniques, we distinguish two different groups: The ones that are bound to interaction techniques, and the ones that sonify the scene. The first group consists of methods such as radar, sonar or an auditory cursor, in which the user probes and explores the environment and receives feedback through sonification. The second group describes the sonification of (non-interactive) scene objects and the display of additional information using auditory textures, earcons, beacons and soundpipes [9].

10.3.4 Designing interactive Audiogames

The first experiments using this framework included spatial sonification and interaction techniques that led to the implementation of several action and adventure audiogames. Figure 10.4 shows the principle and an action shot of the *Matrix* game, in which the player has to detect and avoid virtual acoustic bullets. We conducted several user tests to compare our implementations with other available audiogames, to investigate playability, usability as well as the quality of the sonification and interaction. Almost none of the participants had any prior experience with audiogames, but everyone liked the idea and the concept of play. Difficulties occurred in the estimation of distances and the mapping of sounds to certain events.

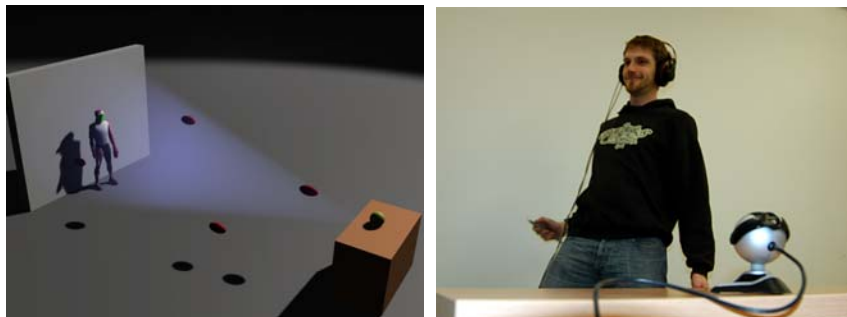


Figure 10.4: *Matrix* Audiogame: a) Principle b) User Interaction

Interactive Audiobooks is a project that aims to unify the interactivity of computer games with the narration of books and radio plays. In a first attempt we

developed an auditory adventure game to research the possibilities of storytelling within an auditory presentation. The story and the game were simple, linear and non-adaptive, leaving the user every freedom to explore the 3D environment. This caused several problems, as one can easily get lost. Thus the spatial representation with free user movement had to be replaced by a dramaturgical representation that only allows a certain movement depending on the storyline. The current implementation is based on this project, but also bound to a storytelling engine, which allows us to have a non-linear gameplay with a varying degree of interactivity. Now it is possible to either play it as game, or just listen to it as a radio play. The presentation of the story has many similarities to common adventure games, but some differences exist, especially with the interaction and the user interface design.

Augmented Audiogames can also be designed using this system. Therefore it was made portable and extended by techniques to allow a mobile tracking and positioning of the user. Augmented auditory reality combines a real world environment with an artificial auditory presentation. The interaction and sonification is similar to other auditory displays, with the extension that the user can now freely walk around within the “virtual” scene. This narration in the real world largely increases the level of immersion, as more senses are addressed now. The calculation of the player’s position is important, but as the scene is described acoustically, an accuracy of 1m has proven to be sufficient. For the positioning we use the GPS outside, and WLAN hotspots within buildings to track the user. The use of WLAN emitters for position tracking is not easy, as the signals strengths might vary a lot, depending on the room size and material. As solution we use a pre-sampled radio map that shows the signal strength for all WLAN spots. Another challenge is the combination of the real sound environment with the artificial game world and the latency effects that are introduced by the tracking system. As application we explore several game related possibilities along its potential for edutainment and guiding purposes.

10.3.5 Rethinking Audiogames

Although the programming of simple audiogames is relatively easy, several guidelines should be observed to make the interface more intuitive and the game more enjoyable. Most important is to immerse the player in a virtual auditory world and that the sonification and interaction methods used support this perception. The display must not be cluttered with too much information and should be designed to keep the right balance between aesthetics and function. The quality of the sound and music used is of the utmost importance, as a poor sound design will otherwise ruin the game.

Even as the design of the sonification and interaction leaves several room of freedom, a careful selection of techniques that concentrate on an intuitive listening and interaction will deliver a better performance. This needs also be incorporated for the game and story authoring. The most interesting genre here is

the adventure game, as it strongly focuses on narration and storytelling. A rethinking of audiogames and their design will move them to the next level. Audiogames are not just acoustic adaptations of visual computer games; instead they present a new genre with different advantages and possibilities.