HOERSPIEL – a platform for acoustic adventures

(Platform for acoustic scene creation)

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1. Abstract

The development environment HOERSPIEL provides a platform for interactive applications based on sounds. It allows the creation of virtual acoustic worlds for user interaction with sound objects. A special interface detects the user's movements for controlling his avatar. HOERSPIEL can be used to realise various applications:

- **Innovative computer games**
  HOERSPIEL can create virtual reality without any visual output. The idea is to build virtual worlds through sound only, which stimulates the player's fantasy and offers completely new gaming dimensions. Furthermore, it is possible to create computer games for visually handicapped people.
- **Sound database browser**
  Browsing a database can be easily done via HOERSPIEL. A user could, for example, choose music from a database in the same way he chooses a preferred stage at a music festival. To select the desired music within HOERSPIEL, the user just walks in its direction. Exploring audio information in this manner can also be used for innovative product presentations at exhibitions.
- **Audio guide**
  Museums can use the platform to build a new kind of audio guide: Visitors can easily explore meta information like sound samples by walking through a virtual version of the museum.

Fig. 1: Logo of the project HOERSPIEL

This paper explains the concept of HOERSPIEL and provides an insight into the technical components of the user interface, the software engine and the multichannel sound system.

Furthermore, the first user experiences are presented and an outlook on the project's next steps is given.

2. Introduction

The ever increasing performance of modern computer technology enables game developers to create photo-realistic virtual worlds. State of the art computer games provide the players with a high grade of interactivity so they can move around and interact within these worlds. As multichannel sound systems reached the consumer-market, computer games began using this technology to produce even more realistic experiences. These systems support the visual perception by using realistic spatial sound sceneries and special effects which raised the impact of optical impressions. The focus of the game, however, always stayed on the screen. Sound only served a supporting role. Interaction with sound or possibilities to control the game through sound have not yet been explored.

Because graphic rendition has reached such high levels, game developers are seeking new challenges. Instead of mere Game-Pads and joysticks, modern games use a multitude of different controllers which detect the player's movements through more then their hands and thumbs. As computer games have become an important element of global culture during the last years, it is getting more and more important to provide barrier-free accessibility as is almost standard for web applications. Today, visually handicapped kids play the current games and try to orientate themselves within these games just by the sound of their stereo-speaker-system. This resolves in a trial and error gaming and has got nothing to do with the possibilities sighted kids have. Creative solutions based on modern technologies can help to bridge this gap.

The idea for HOERSPIEL evolved at the beginning of the new era of controllers and aimed at combining the possibilities of surround sound and a new way of man-machine communication. On this new kind of platform it should be possible to create virtual acoustic worlds in which users can interact through full body-movements.

3. Technical realisation

HOERSPIEL was developed in the context of a diploma thesis [1] in "Media Technology" at Hamburg University of Applied Sciences. Within the bounds of a budget, it was necessary to find creative technical solutions and to create the project based on consumer technology.

Fig. 2: The prototype of HOERSPIEL (without the roof in left picture)

As HOERSPIEL should be an open platform for sound-based applications like acoustic adventure games, the concept was to build a defined environment optimised for the application. A special "event-room" was designed and equipped with a multichannel sound system, a special controlling interface and the required acoustic characteristics. The control system was designed as a "floor-interface" which detects the user's leg movements to re-enforce the

impression of being a part of the virtual acoustic world and to interact within this world through said movement.

3.1. The multichannel sound system

Due to the specification to run the application on consumer technology, there were only three options in setting up the multichannel sound system: 5.x, 6.x or 7.x. These systems can be driven by state of the art sound cards using the DirectX programming interface with all its features for 3D sound. The decision for using a 6.x system was rooted in the symmetrical set-up of the sound system that can be achieved with this configuration. As the platform has to support a high degree of interactivity, there should be no main direction in the sound axis as it is usual for set-ups in cinematic applications. Due to the fact that the quality of computer games is linked to their grade of interactivity, HOERSPIEL should provide a maximum grade of interaction. In adventure games, one indicator for interactivity is the independence of the avatar's movement. This aspect, combined with the consideration that discreet sound signals are easier to locate than virtual sources, led to the decision that the main movement directions in the software should correspond to the positions of the sound sources in the event-room. As creating virtual worlds is easily possible by attaching hexagonal elements, the decision was reached to set up HOERSPIEL on a 6.x multichannel sound system.

To realise this set-up, the following components were available for the project: a 6.0 sound set-up with 6 full range speakers and 3 stereo amplifiers. The low cut-off frequency of the applied speakers is 70 Hz, at 55 Hz the attenuation is 10 dB. As the small dimensions of the event-room affect the bass response negatively anyway, this value was acceptable. To interact with sound objects, the focus had to lie on good localisation and, as described before, the use of discreet signals. Therefore, the beam-width characteristics were more important. Here the midrange is especially interesting. The following figure shows that the applied speakers provide good performance in these parameters [2]:

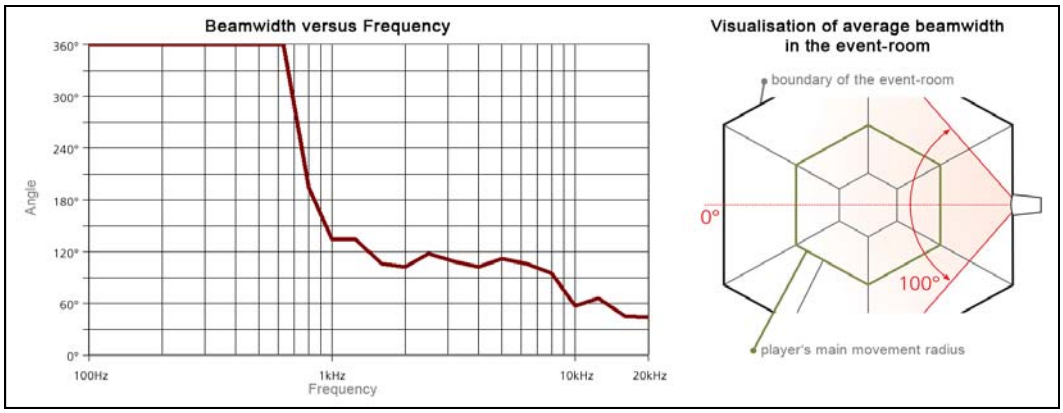

Fig. 3: Beamwidth of a single speaker in HOERSPIEL

3.2. The "event-room"

The specification of a symmetric 6.x sound system and its correspondence to the virtual world lead to the concept of building an event-room with a hexagonal base area. Each wall had one speaker at a height of 1.65 m (measured at the tweeter). To focus the user's attention on sound events, the room was to be completely sealed off from light. The symmetric

architecture supported this focus: since the room itself lacks any point of reference, the only orientation is provided by the acoustic scenery.

A special “floor-interface” was designed to detect the user’s position within the room. For this the floor was divided into 14 sections. Each section was equipped with a sensor that sends a signal to a computer interface when sufficient pressure is applied. To give the user a required minimum of orientation, the floor slopes towards the centre of the room. This marks the point of origin from where every new action during a game is started.

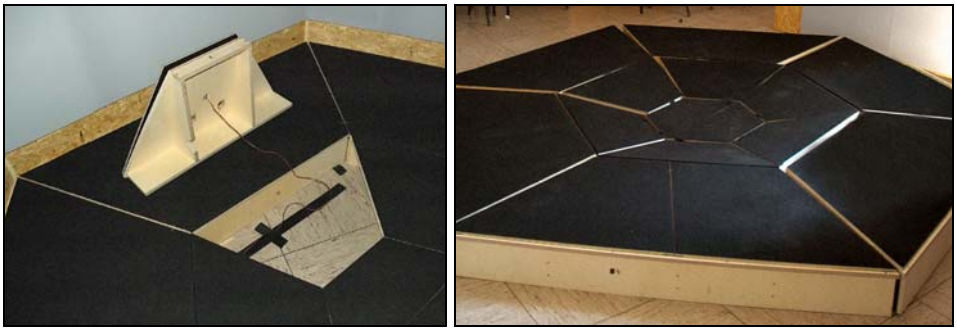

Fig. 4: The ‘floor-interface’ of HOERSPIEL

For example, in an adventure game the user can move his avatar in a certain direction by physically moving in that direction and then stepping back to the centre point. The outer ring of sensor fields is used to control the entire application. If the user moves to one of these fields he has the option, among others, to quit the game. In this case, a voice leads him to the exit of the dark room.

For security reasons the event-room is also equipped with a night vision camera on top of one side wall. Five infra-red clusters lighten up the room for this camera but are invisible for the player.

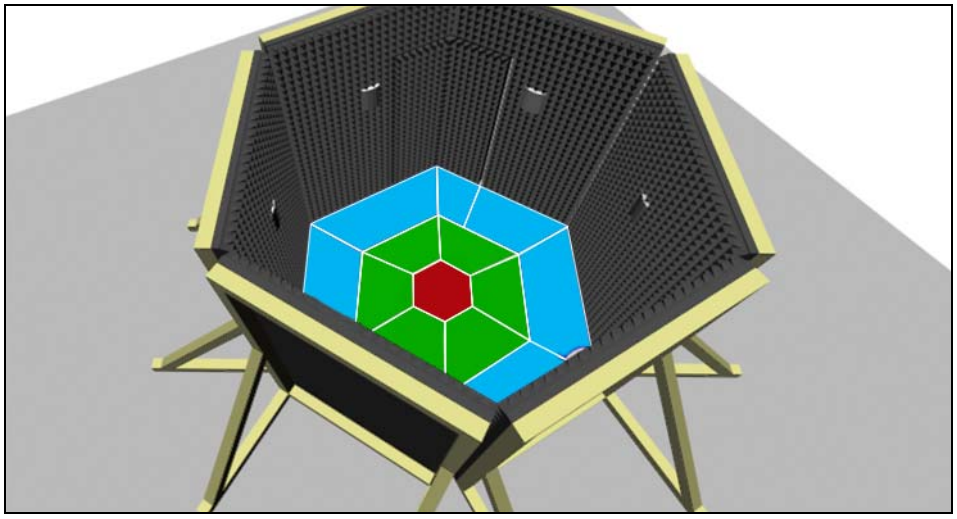

Fig. 5: 3D rendering of the event-room (view from the top)

The symmetric shape of the room caused some problems in room acoustics. The three pairs of parallel walls with respective speakers face to face at a distance of 3 m produced a high rate of stationary waves beginning at 57.17 Hz. Without modifications in room acoustic, the sound characteristics were very problematic, especially at the centre point, where most of

the stationary waves interfered. Due to this fact, the walls were equipped with an open cell foam made from 4 cm thick melamine resin.

This foam provided an absorption coefficient of 90% for frequencies above 1500 Hz[1]. At 800 Hz 60% absorption was also reached [3]. These figures were good enough to fix the largest problems in room acoustics. Further optimisation was achieved within the system itself. Very low frequencies, for example, should be avoided altogether. The grade of decorrelation between the speakers should also be as high as possible.

3.3. The game engine

The game engine was created in Visual Basic .NET and DirectX. The following figure shows how complex virtual worlds can be set up with the basic hexagonal shapes:

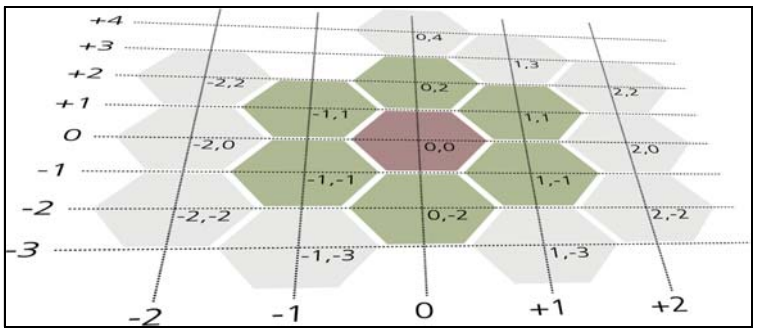

Fig. 6: Basic coordinate system of the game engine

Every cell in this world can be linked to a special event and fitted with its own sound. The players can make their avatar move to adjacent cells. This might cause a special event, like the opening of a door and entering the next room or starting a conversation with a virtual person standing in that cell.

With this basic engine, many different kinds of applications can be created. Apart from adventures, for example, quiz-games can be played with different answers placed in different directions. Sound database contents can be mapped onto the cells and users can walk through this content and access it with just one step. Even acoustic jump'n'run's are possible on the basis of this engine.

4. First user experiences

HOERSPIEL was first presented at the diploma colloquium in March 2007. On the 9th of June 2007, HOERSPIEL was exhibited at the Hamburg Night of Science.

Both events demonstrated that the preliminary considerations were right: Interacting with sound and playing acoustic games was something completely new to the players and most of the visitors had a lot of fun playing. Nonetheless, these experiences also showed that it is very difficult for most people to accurately locate sound events and to react on them. To countervail the biggest problems, a qualification game came into operation. This very simple game helped to introduce the players to the HOERSPIEL platform and to the location of sound.

[1] according to DIN 52215

5. Discussion and outlook

HOERSPIEL was designed as an experimental project. The goal was to generally demonstrate the merit of the idea of playing with sound and creating virtual acoustic worlds. The project showed that this gaming concept can find resonance in the player community and is fun to play. However, most users would need to first get accustomed to this extraordinary contact with sound.

As described before, HOERSPIEL had to be created on the basis of consumer technology. Professional systems might produce a higher quality in sound as well as a better resolution in tracking the user's movements. But using consumer technology was also a benefit as the project showed that sound could play a bigger role, even on standard computer systems. The next step would be to unlink the system from its defined environment. As the first user experiences showed that players have difficulties in locating sound, this step will not be easily reached. The HOERSPIEL environment supports applications with defined acoustic values and an optimised interface. Applications can be built around these specifications. To recreate this for the consumer market, standards like the speaker set-up need to be established.

As the technical process is bringing more and more surround systems to the computer gamers and their PCs, this idea is likely to grow. The completed project is already working and can be used as a prototype for further development. There is still a high capability for creative applications such as innovative computer games, sound database browsers and virtual visitor centres or sound exhibitions. These applications might be an eye-catcher for certain exhibitions or museums. Here, HOERSPIEL could provide an additional level of information and work as a gate for visually handicapped people to explore the information.

Further information about the project can be found at *http://hoerspiel.freudy.de*.

6. Acknowledgements

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7. References

[1] Diploma thesis "HOERSPIEL – Eine Plattform für akustische Adventures", Tobias Freudenreich, Hamburg University of Applied Sciences, 15.02.2008

[2] Technical specifications JF 60 *http://www.eaw.com/Info/EAW/Loudspeaker_Product_Info/Legacy_Loudspeakers/JF_Series/JF60/JF60_polar.pdf (link last visited on 2008-11-03)*

[3] Product brochure "Basotect – Foam made from melamine resin" *http://www.plasticsportal.net/wa/plasticsEU~en_GB/portal/show/content/literature/basotect (link last visited on 2008-11-03)*