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Camera Musica, 2000

A Virtual Sound Installation

Conceptual Background

The articulation of architectural and musical space, as it is put forward in this project, is motivated by a compositional approach rooted in the idea of open form. In this context, composition is not any longer understood as an activity yielding a musical text, which needs to be interpreted by musicians in order to become perceivable by the audience. Music is not any longer conceived in form of finite units (i.e. (recordable) pieces) but in terms of models capable of generating a potentially infinite number of variants of a particular family of musical or sonic ideas. Such models or meta-compositions represent a new type of musical artifact which redefines the way music may be conceived and perceived. Performing such music is closer to exploring an object or space than to interpreting a text. The problem of open form, which has a long tradition in twenties century music, is reformulated through this conception of composition inspired by the possibilities offered by new media technology, in particular immersive virtual environments. By using navigable visual representations of architecturally organized space, Camera Musica enables the audience to interactively explore an open composition. Sensible connections between the visible and audible space guide the exploration and suggest directions to be taken.

Motivations Driving the Creation

The creation of Camera Musica went through several phases of sketching and prototyping. Preliminary results were presented at ACM Multimedia in Boston in 1996 and at ISEA in Chicago in 1997. After having experimented with high-end immersive virtual environments for several years at GMD, the final shape of Camera Musica was born out of the desire to create a very simple but highly interactive and sensually engaging environment. From experience with several larger VR productions, which are usually developed in teamwork, I knew that I could reach this goal only by controlling (and therefore extensively experimenting with) all components of the work myself. These include the visual (modeling), the auditory (composition), the kinetic (physical simulation), and the tactile (low-frequency vibration) aspects. Therefore I decided to do all the software development myself and bare with the compromises and limitations this naturally incurs. The goal shifted from producing a stunning VR demo to creating a

In some cases the movements of the objects are used to control the sound generation and projection. Position and speed of the objects control certain parameters of the granular sound synthesis or the sound spatialization. In other cases synthesis parameters are determined by the distance of the user from special spatial locations. These relationships are composed such that they provoke a playful engagement of the audience with the piece. In some cases the reactions of the objects to the movements of the hand are very obvious, in other cases it takes a while until the visitors will discover the way the objects react. In other cases the physical models are parameterized such that they produce chaotic phenomena and therefore unpredictable variations of movement and sound.

World Premiere

Camera Musica was premiered in fall 2000 at Animax (<http://www.animax.de>) as part of a registered Worldwide Project of the Expo2000. Based in Bonn and run by BEC (Bonner Entwicklungswerkstatt für Computermedien), Animax is a multimedia theater specialized in media art productions. Camera Musica was co-produced by GMD and BEC. A CyberStage system (a 4-sided CAVE-like VR display) was installed at Animax by GMD and BEC took care of the 9-week presentation period, during which about 1500 people have visited the installation. A guide from BEC briefly instructed the visitors in how to use the shutter glasses and the steering wand. Then they explored the installation on their own. Up to 5 visitors could experience the piece at a time, all of them wearing shutter glasses. The pair of tracked shutter glasses defining the visual reference position and the steering wand used for navigation were passed around among the visitors such that every visitor could drive the installation for a period of time during which the others were sharing the driver's experience. The groups stayed in the installation between about 15 and 45 minutes, depending on their curiosity and the amount of people waiting in the queue. It turned out that smaller groups or single visitors spent more time to explore the piece. BEC put a reservation system in place for visitors to book time-slots in advance and avoid tedious queuing up at Animax. Many visitors returned to see the piece again and spent more time with it than the first time. Special guided tours were organized by BEC for school classes and other bigger groups. The NDR (North-German Broadcast) produced a 5-min feature about the installation which was broadcast in the Expo2000 Journal by 5 TV stations.

meaningful piece of art. Experiments with advanced light simulation techniques to create environments very pleasing to our eyes (see Camera Musica Sketch) were dropped in favor of a much more minimalist and pragmatic approach. Spatial readability became the main concern behind the design of the visual environment, which uses a grid structure to create a strong sensation of space through perspective.

The very concept of space became the actual interface to the music and sound in Camera Musica. Virtual reality was used for what it can do best and not for mimicking reality. The old dream of looking and moving through walls - something usually avoided by all means in virtual environments - became a central idea of the piece. In an immersive display, where we can actually sense the presence of virtual objects, we can also experience penetrating objects and being penetrated by them. We move through walls and planes cut through our body (even the most extreme case of a plane cutting right through the middle of our head, so that one eye sees one side of the plane and the other eye the other side, can be experienced).

Description of the Work

Camera Musica is an immersive virtual environment in which the audience explores a musical space. This space is visually defined by a simple virtual architecture. The effortless visual orientation in this architecture is the basis for the navigation through the music. Visitors are visually and auditorily immersed in this space which they navigate with their body movements and by means of a hand-held steering wand. The Camera Musica virtual environment is displayed stereoscopically in a surround-screen display system (e.g. a CAVE). The music is created in reaction to the visitor's movements. It is projected on an 8-channel spatial sound system. Tactile feedback is produced by an active vibration floor. Subsonic vibrations are perceived through feet and legs.

In Camera Musica the visitors freely float through spaces delimited by partially transparent cubes, some of them producing sounds when traversed by the head, others marking auditory regions in the soundscape composition. This is how the body becomes an index in the composition, allowing for a direct experience of formal openness. Whereas the head is the reference for the rendering of the visual and auditory scene, the role of the hand is to navigate and interact with the virtual objects. All objects are surrounded by invisible force fields which – as long as they are in equilibrium – keep them in a stable position. The user's hand holding the navigation wand disturbs this equilibrium by its own force fields attached to the wand's 6-degree-of-freedom sensor. This is how the hand attracts and repulses the other objects and interacts with them through the kinetic simulation which it becomes part of. This form of interaction highly increases the sense of presence because the environment reacts plausibly to the behavior of the visitor. Camera Musica plays with the different forms of this type of interaction acknowledging the presence of the visitor. Since the

Technical Realization

Camera Musica was produced for the CyberStage system, which is a CAVE™-like display system developed at GMD. The CyberStage is a 3m x 3m x 3m cubic display where stereoscopic images are displayed on 4 faces of the cube (left, center, right and floor). The visitors stand inside the cube and observe the 4 images through active shutter glasses to obtain stereoscopic vision. A shutter rate of 120 Hz avoids image flicker. The images are rendered for the position and orientation of one visitor's head in order to seamlessly combine into one panoramic image without geometric distortion. This type of tracked stereoscopic vision results into a high level of immersion and a strong sense of presence in the virtual environment. The tracked visitor can freely move within the 3m x 3m real space of the installation, which is directly mapped into the virtual space, i.e. making a step forward in the real space displaces the visitor by the same amount and in the same direction in the virtual space. For displacement beyond the bounds of the physical installation space, the steering wand is used. With two buttons the speed of forward and backward movement is controlled. The visitors simply move in the direction in which they point the wand.

Camera Musica was developed with the Avango toolkit, an object-oriented framework for virtual reality applications developed at GMD. Avango is closely integrated with the CyberStage Sound Server, a spatial sound rendering system driving the CyberStage Auditory Display. The auditory display consists of 8 speakers, mounted at the 8 corners of the CyberStage and pointing towards the center of the cube. The speakers are complemented by an active vibration floor equipped with 4 vibration emitters. For Camera Musica, the CyberStage was driven by a cluster of Silicon Graphics Onyx and O2 computer systems.

One of the big advantages of presenting virtual environments with surround-screen displays (SSDs) rather than head-mounted displays (HMDs) is the ease of group communication, which is very important for group experience. Since people can see each other through the shutter glasses and talk to each other, discussions about what they see and hear and negotiations about where to move next in the space happen naturally and don't need technological mediation. Another advantage of SSDs is the higher display resolution as several screens are combined into a big panorama. Furthermore, much lower rates of cyber-sickness are observed than with HMDs, which still suffer from time lag between the user's head motion and display update – a problem that does not exist with SSDs which display a much wider field of view.