WAVE – A Virtual Audio Environment: An immersive musical instrument using a low cost technological system

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German Abstract

Das Projekt »WAVE – A Virtual Audio Environment« realisiert den Aufbau einer immersiven virtuellen Umgebung in der Musik und 3-D-Audio die Hauptrolle in Form eines virtuellen Musik- bzw. Soundinstruments für Performance, Ausbildung, Unterhaltung oder musikalisches Experimentieren haben. Dieses virtuelle Instrument ermöglicht es einfache Gesten in musikalische Klänge umzusetzen, wobei gleichzeitig die Positionierung und Lokalisierung von Sound mit einem großen Freiheitsgrad unterstützt werden. Damit wird dem Benutzer die Fähigkeit gegeben seine Kompositionen durch intuitive Mensch-Maschine-Interaktion zu kreieren. Diese intelligente Vereinigung neuester Technologien mit der Kunst der Musik eröffnet dem Benutzer neue Dimensionen in der Soundbearbeitung. Das Projekt wird in der Abteilung Informationssysteme der Universität von Minho, in Kooperation mit der Forschungsgruppe des Centro de Computação Gráfica in Guimaraes, entwickelt.

Introduction

The rapid evolution of technology has opened up new areas of knowledge and new approaches to age-old issues. Yet, it has fallen short in creating new models of instruments that can respond to the current demands in musical creation and performance.

Therefore, it is necessary to come up with solutions that can bring together the art of music with a new art involving the intelligent manipulation of sound by means of new visual, auditory, cognitive, and interpretative techniques.

The project aims to set up an immersive virtual reality environment, where music and 3D audio play an important role in a virtual musical/sound instrument for performances, education, entertainment, or musical experimentation.

The Project

Two main issues have been identified in the WAVE – A Virtual Audio Environment project that need to be addressed and for which solutions need to be found; namely:

– The inadequacy of traditional musical instruments to cope with the challenges of electro-acoustic music, both at the levels of performance and of conceptualization,
– the relative scarcity of music for solo instruments, since most written and/or recorded music calls for the use of an ensemble of players.

The WAVE project proposes a multi-disciplinary investigation in order to create a model-prototype of a virtual immersive instrument using audio, visual technologies, and virtual reality. This model will open up new horizons for the processes involved in music making by dealing not only with relevant technological issues, but especially with meaningful research in the areas of human-machine interaction and sound.

Expected Results

The expected results are the creation of a model-prototype of an immersive musical instrument that is played with tracking systems and that can include the following features:
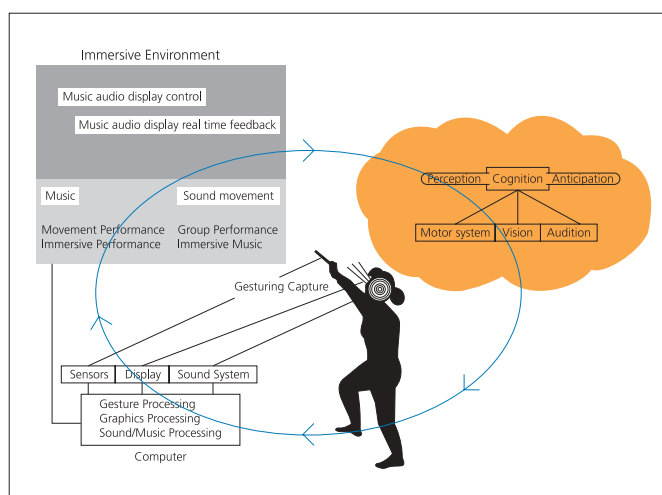

Figure 1:
Model of interaction in WAVE

Figure 2:
WAVE Screen

– Scalability and mobility of the immersive environment,
– repeatability of musical performance by the user,
– visual feedback of the interaction with musical objects,
– control of musical notes and sound files at the same time,
– three-dimensional sound reproduction including the vertical direction,
– cognitive real-time musical and motor-skill decisions.

The methodology used in the execution of the project is a typical research methodology with the following sequential approach:
– Study of the state-of-the-art technology,
– design and creation of model and concepts,
– implementation of the prototype,
– validation of the prototype,
– correction of the model(s),
– final prototype(s) and final report.

At the time of writing this article, the implementation of the prototype is in its final phase.

The WAVE System is visually based on a big screen that can be viewed with active stereoscopic glasses to give the user a perception of immersion.

The implementation achieved allows the use of different kinds of visualization devices such as CRTs, DLP video projectors, head mounted displays, 3D displays, and high performance projection tables.

One of the requirements defined in the WAVE project was the use of low cost technology, so all of the programming was optimized in order to use only one Intel CPU computer with a Linux operating system that uses OpenSG and VR Juggler as the basis of the application.

The main reasons why we chose these kinds of resources for the project were that they are easily portable to other platforms and that they are open source.

WAVE can use different kinds of tracking systems at the same time. To test the prototype, the Flock of Birds by Ascension was used along with a wireless USB presenter in order to interact with the virtual musical instrument. However, the system can at same time use open air batons like the Lightning II by Buchla.

Many people use the surround sound systems with computers from four or five years ago. Surprisingly in Linux systems, the open source audio APIs do not yet implement surround sound or 5.1 sound cards. The APIs found with this kind of feature are very expensive and used or licensed as proprietary systems. Even in the world of games, few titles actually use real surround sound.

Faced with this, the OpenAL API was chosen to control the audio sources. However, the OpenAL handles threedimensional sound techniques, but only for stereo sound systems.

This was a significant problem, because there is no really convincing non-expensive technology (for musicians) that can handle sound with three co-ordinates. As a solution, a modified version of OpenAL was utilized that permits the use of four speakers and also allows the location of the speakers to be defined.

Despite these limitations, good quality sound was achieved using standard sound cards with low cost professional near field speakers.

In terms of visualization, the application allows users with different kinds of skills to interact with the system in terms of performance, music-sound exploration, or entertainment. The display presents groups of music-sound objects:
– A simple scale (pentatonic),
– four sets of chromatic scales with three sets of effects and one of musical patterns,
– one set of selectors of audio files of different styles,
– a slider for the use of glissando with sounds,
– a transport control and
– some additional buttons to change the sound patches and general values.

The movement of the sound sources in the real environment is possible by dragging and zooming the musical objects in the virtual environment.

This paper presents a musical instrument in a virtual audio environment based on affordable standard hardware components and using the three musical elements pitch, timbre, and space, while trying to give the user an environment of great freedom and at the same time some entertainment or experimentation.

In the final phase of the project, WAVE will be tested as an instrument for musical performance, as an entertainment instrument during cultural and artistic events, and as a tool for the development of educational components in the artistic domain and in corporal expression.

Points of contact

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