# Interactive Virtual Reality Orchestral Music

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## ABSTRACT

The authors developed a VR orchestral application for interactive music experience, allowing virtual musical instruments in an orchestral piece to be repositioned spatially, dynamically and interactively in VR space. This can be done for changing environments where 3D audio technology is used to restructure traditional orchestral pieces into a new music art form. User experience surveys were undertaken on two kinds of users, with the results showing that the VR orchestral system developed in this paper could bring some special advantages in the musical experience.

## CCS CONCEPTS

• **Applied computing** → **Media arts**; **Sound and music computing**;

## KEYWORDS

VR, orchestral, interaction

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## 1 INTRODUCTION

Since Kant, it has often been claimed that music is an art of time [Alperson 1980]. Music flows with time, and the composer exploits time as a formal element by controlling certain features of temporal ordering of tones for musical perception. On the other hand, audio is the essential formation and content of music. It has a physical spatial property, that has an important effect on the music.

Traditional orchestras have spatial characteristics in the arrangement of the instruments. However, under physical limitations, it is impossible for a traditional orchestra to have a 3D arrangement on music instruments even if the new arrangement may result in better musical effects.

Allosphere in the University of California Santa Barbara (UCSB) is a three-story metal sphere in an echo-free chamber where 20 researchers can stand on a bridge suspended inside the sphere, and be completely immersed in their data after visualization. It could allow users to experience 3D music in real space in a fully immersive environment while seeing immersive virtual imagery [Amatriain et al. 2007], but it is a unique scientific instrument for research purposes and not for normal audiences.

Some virtual orchestra application (such as http://virtualplaying.com/) could simulated sound of a real instrument, but it don't provide spatial interaction for users.

3D audio technology in VR could simulate audio's spatial physical behavior in virtual space and thus provide people with a natural hearing experience. With 3D audio in VR, users can hear audio cues of sound sources from all directions around them while interacting with objects within virtual environments in real-time as though they are in a new world. In the new media era, it is important to keep the art alive and relevant today.

In this paper, the authors tried to develop an interactive VR orchestral application for users to achieve an interactive spatial music experience. The aim is to bring a new possibility for users' music experience and also bring a new possibility for music creators.

## 2 DESIGN AND IMPLEMENTATION

In order to place different musical instruments of an orchestral into a VR space, the music score of the symphony is first deconstructed into separate parts. The orchestra music score has the following abbreviations representing a variety of musical instruments (in score order): 1. Woodwind instruments 2. Brass instruments 3. Percussion instruments 4. String instruments (violin). Music scores for each of the music instruments can be separated from a piece of orchestra music. In this paper, Standard MIDI files of orchestra music were used and imported into a Digital Audio Workstation (DAW) program to modify each instrument, and render each track into individual audio files.

After each instrument was modified, all audio tracks were rendered out into individual music clips which were imported into Unity 3D to construct a virtual orchestra in VR space. Google's Resonance spatial sound plugin was used to render music tracks


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in 3D space in Unity3D. As sound objects are invisible, in order to label and distinguish each instrument that is part of a VR orchestra, a 3D instrument model was imported into unity as a game object. The corresponding audio file was attached to the object as a spatial audio source. Additionally, a script was created that displays the name of the instrument whenever it is activated by the user. It automatically rotates the 3D model in order to provide users with a better sense of depth of the instrument. When a music instrument emits sound, there is a glow effects around it to indicate its state.

Three kinds of interaction modes were designed for users to experience the VR orchestra: classic mode, extended mode, and Game mode, in which the users are at the first person perspective. In all the three modes, user could change the performing environments to achieve different spatial echo effects. Five kinds of environments were predefined. The first is a natural environment without spatial echo effects. The remaining four, (Room, Hall, Cave and Cathedral) could provide reflections and reverb effects to make music more realistic as if it was playing in different scenes. The user could interactively transform the orientation that he/she is in the VR orchestra space by rotating the first-person perspective camera. Any of the above interactions would directly affect and change the 3D sound effects of the VR orchestra.

The authors tried to arrange virtual music instruments following the traditional orchestra's instrumental arrangement to simulate the effect of traditional performances. Users could walk closer to the orchestra, and could change the performing environments, such as concert hall or cathedral, to achieve different spatial echo effects, which is impossible for a traditional performance.

In some music, the spatial movement of musical instruments could make the narrative of music more immersive. A music buffs, also one of the authors, designed the spatial arrangement and movement of instruments according to the scenes and narrative features depicted in the music. Based on aesthetic judgement and artistic imagination, this made the 3D spatial music more alive. In this mode, users were allowed to interactively place virtual musical instruments in VR space. The user could select a virtual musical instrument and move it to another position, or change the direction and distance from him/her. Different people have different music preferences [Schwartz and Fouts 2003], so the user could also select some specific instrument and replace it with another instrument that he/she preferred. In the resultant customized music, the new instrument played the same score but in its own tone. The result could be better or become strange, but it is just an experiment and could bring fun to users.

## 3 USERS' FEEDBACK

Two surveys, each with 25 participants, were undertaken to collect the user feedback. For comparison, one group consisted of participants who have been to orchestral performances and the other of participants who hadn't. The first survey consisted of all the 50 participants in both groups.The process of obtaining information took place in a laboratory where participants were comfortably seated next to a computer. Participants first listened to an mp3 audio of a stereo recorded orchestra on a media player. They then experienced the VR orchestra system on the same music and filled out a survey questionnaire. The second survey consisted of the 25 individuals who had been to orchestral performances more than once in the past and were familiar with live orchestral concerts.

Question 1 for the first survey of all participants: "Between the stereo recorded orchestra and the VR orchestra, which audio experience did you like?" The first hypothesis investigated whether users preferred a traditional orchestral audio experience or 3D audio. Forty-four participants chose the VR orchestra, most of them enjoyed the VR orchestra experience. While the remaining six out of the 50 participants chose the stereo recorded traditional orchestra, this was because they just wanted to relax and doing nothing when they listen to music. Therefore, the results tell us that more people preferred the spatial audio experience of the VR orchestra over the stereo recorded traditional orchestra.

Question 2 for the second survey: "What are the advantages of the VR orchestra over a traditional orchestra? Responses in this survey were: "More variety of sounds, more control over experience." "It helps to better understand the contribution of each instrument to the whole and better understand what type of sound you appreciate most, it might be useful in music teaching and imagination improvement, it might help to improve level of sound of some instruments." "VR orchestra has the advantage of providing a better 3D audio experience than traditional orchestra. " "It's amazing that different reflections and reverb effects could be easily achieved by changing the environment." "I feel that I am in the middle of the instruments, I feel that I am one of them. This kind of experience is very wonderful." "I feel I am sitting in the music and surrounded by sounds, I am able to follow the movement of the instruments, and I can even feel the speeds of their movement."

## 4 CONCLUSIONS AND FUTURE WORK

VR orchestra technology, as described in this paper, could turn traditional orchestral works into interactive and immersive spatial 3D music with the audience at the center of the music, thus achieving a superlative immersive music experience for users. The VR orchestra is not only an innovation of technology but also an innovation for the communication of music art. It can be also used as a music educational tool and users can learn for themselves about an orchestras before going to a real orchestral concert.

According to the survey results, the VR music system could appeal to more people than just playing traditional music. However, as the system currently focuses on classical western music, the authors intend to support other music genres such as traditional music of the orient, Rock, RB, Hip Hop and so on, thus appealing to a larger audience with different personal musical preferences.

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