Chapter 14
Spatial Sound for Computer Games and Virtual Reality

David Murphy
University College Cork, Ireland

Flaithrí Neff
Limerick Institute of Technology, Ireland

ABSTRACT

In this chapter, we discuss spatial sound within the context of Virtual Reality and other synthetic environments such as computer games. We review current audio technologies, sound constraints within immersive multi-modal spaces, and future trends. The review process takes into consideration the wide-varying levels of audio sophistication in the gaming and VR industries, ranging from standard stereo output to Head Related Transfer Function implementation. The level of sophistication is determined mostly by hardware/system constraints (such as mobile devices or network limitations), however audio practitioners are developing novel and diverse methods to overcome many of these challenges. No matter what approach is employed, the primary objectives are very similar—the enhancement of the virtual scene and the enrichment of the user experience. We discuss how successful various audio technologies are in achieving these objectives, how they fall short, and how they are aligned to overcome these shortfalls in future implementations.

INTRODUCTION

In the past, sound has often been a secondary consideration in visually intensive environments, such as Virtual Reality (VR) systems and computer games. However, hearing and several other perceptual modalities are now considered equally relevant to the user-experience within artificial and simulated domains. Linear soundscape composition, especially within computer games, has been facilitated with advancements in computer hardware and storage capacities. The sonic contribution of linear music to the virtual scene is extremely important, especially during gameplay, as it adds atmosphere, drama, emotion, and sometimes fantasy to the overall scene. However, interactive sounds and environmental acoustics are also important in enhancing the user-

DOI: 10.4018/978-1-61692-828-5.ch014

Copyright © 2011, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

experience by immersing the user in the gameplay or VR scene. These types of sounds at present are still used mostly as effects rather than as authentic references to the virtual landscape. Accurate spatialization and real-time interactive sonic elements are essential if the user-experience is to be brought to the next level in future developments.

Many of the recently developed audio tools are based on well-established theory, but remain limited in their implementation of true spatial sound by hardware constraints. Some of the theory that has been successfully implemented to varying degrees are techniques such as Interaural Time Difference (ITD), Interaural Intensity Difference (IID), the Doppler Shift, and Distance Attenuation. However, many more spatial attributes remain difficult to render in real-time, such as high fidelity simulation of ear geometrics and head/shoulder shadow.

As mentioned earlier, some of the basic principles and techniques are now readily available to developers, but the underlying theory in this field indicates that for true spatial sound to be delivered to the listener, individualization[1] of the listening experience is key to its success. Despite the advances in hardware in recent times, all of the current spatialization techniques used within gaming and VR environments remain focused on a generalized listening experience, and, as of yet, no commercially viable method has been successfully implemented that achieves true individualized spatial sound. The generation of individualized Head Related Transfer Function (HRTFs) for commercial dissemination is one of the remaining milestones to be affected by hardware limitations. Many in the industry argue that generic solutions are sufficient in achieving an accurate sense of immersion in virtual environments for most users. This argument may well indeed hold true, except for the fact that it cannot truly be tested until we can compare it to individualized spatial sound on a commercial scale.

In addition to the limitations of implementing individualized spatial listening, there still persists the problem of rendering accurate room and outdoor acoustics. This is, again, down to the constraints of available hardware resources. Rendering what may be considered a simple scene in the visual domain could easily entail several very complex models of various acoustically dependent elements. For example, an accurate rendition of the listener closing a room door would need to model the room itself, the door's material and structure, and the change in acoustic space during the act of closing the door (from a coupled space to a singular space). In addition, other very important factors such as the material on the floor, walls and ceiling, and reflective and absorbing objects within the space also need to be modelled. All this, of course, in real-time!

In spite of the current limitations to implementing commercial solutions for individualized spatialization, the industry is employing very interesting and creative workarounds. It has not only tackled the distribution of sound in virtual space intuitively, but it has also efficiently tackled problems relating to large audio data file sizes and bandwidth. Therefore, in this chapter, not only do we review sound spatialization techniques, but in tandem, we also discuss audio compression technology and how this theme goes hand-in-hand with spatialized sound for VR and computer games.

PERCEPTUAL PROCESSING OF SOUND

The cognitive mechanisms involved in the aural perception of space are highly evolved and complex, and can be categorized into two distinct groups–direct analyses of physical/sensory information, and higher cognitive influences (see Figure 1). Both groups play a crucial role in our everyday hearing processes. Even in cases of perceived silence, background noise stimulates auditory spatial awareness by communicating spatial information about the surrounding environment to the listener based on both acute sensory

24 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/spatial-sound-computer-games-virtual/46797

Related Content

Using Leap Motion and Gamification to Facilitate and Encourage Rehabilitation for Hand Injuries: Leap Motion for Rehabilitation
Jamie Taylorand Kevin Curran (2016). *Handbook of Research on Holistic Perspectives in Gamification for Clinical Practice (pp. 183-192).*
www.irma-international.org/chapter/using-leap-motion-and-gamification-to-facilitate-and-encourage-rehabilitation-for-hand-injuries/137828

Assassin's Creed and Transmedia Storytelling
Connie Veugen (2016). *International Journal of Gaming and Computer-Mediated Simulations (pp. 1-19).*
www.irma-international.org/article/assassins-creed-and-transmedia-storytelling/147349

Corporate Psychopathy and Internet Video Game Addiction in the Workplace
Youngkeun Choi (2020). *International Journal of Gaming and Computer-Mediated Simulations (pp. 18-36).*
www.irma-international.org/article/corporate-psychopathy-and-internet-video-game-addiction-in-the-workplace/263769

The Risks and Rewards of Collegiate Esports: A Multi-Case Study of Gamers in the United States and Italy
Julie A. Delello, Rochell R. McWhorter, Paul B. Roberts, Tonia De Giuseppeand Felice Corona (2023). *International Journal of Gaming and Computer-Mediated Simulations (pp. 1-22).*
www.irma-international.org/article/the-risks-and-rewards-of-collegiate-esports/317115

Monster Mischief: A Game-Based Assessment of Selective Sustained Attention in Young Children
Karrie E. Godwin, Derek Lomas, Ken R. Koedingerand Anna V. Fisher (2019). *Exploring the Cognitive, Social, Cultural, and Psychological Aspects of Gaming and Simulations (pp. 171-205).*
www.irma-international.org/chapter/monster-mischief/218800