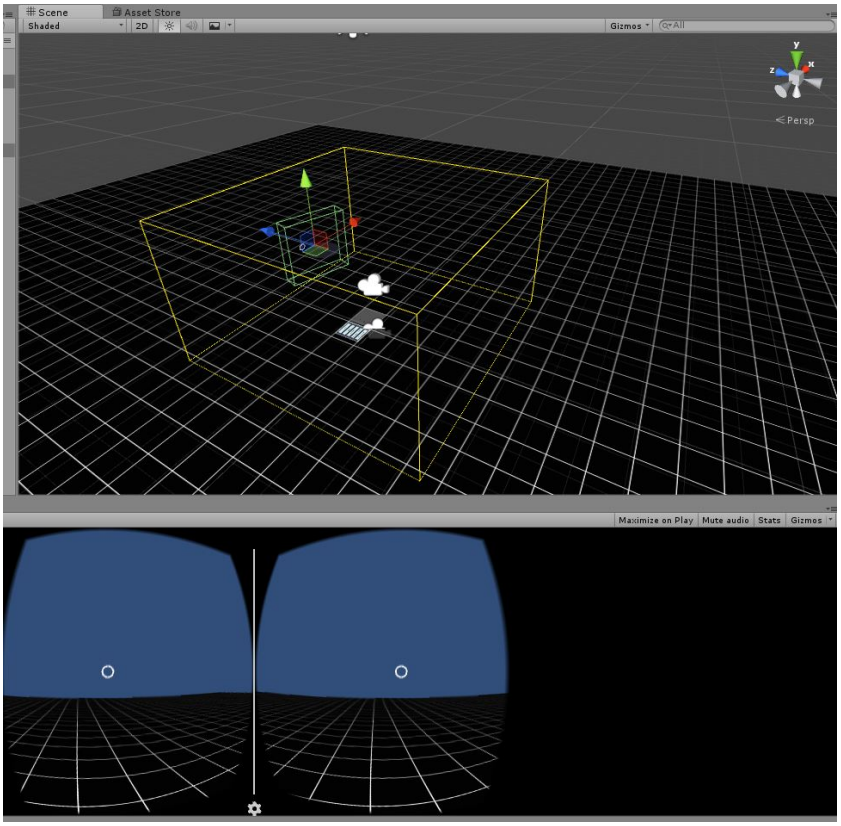

Figure 0.1: A screen-shot of the test interface design within unity, both in third person 'observer' and first person 'subject' views

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An Attempt to Implement a Listening Test to Quantify the Impact of Diffuse Reverberation Level on Localization in Modern VR Applications

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1 INTRODUCTION

As of the last few years a new wave of Virtual Reality(VR) technology has has become available, often utilising mobile devices as the playback medium. Along with development of the visual component of these VR systems, modern spatial audio techniques are often being used to create immersive '3 dimensional' sound experiences to match. In a previous report [**?**], details surrounding the localisation of sound sources within auditory scene were described. It was suggested that early reflection were a key component used in sound source localisation, and literature suggested that appropriate simulation techniques would be required for accurate sound source localization in VR [**?**].

1.1 RESEARCH QUESTION

Does the level of artificial diffuse reverberation have an impact on a listeners capacity to localise a sound source in a VR environment, with the use of a simple early reflection simulation method? When utilising a reverberation tool that combines direct reflection simulation and artificial diffuse reverberation, is it possible to counteract the effects of early reflections on localization accuracy by masking the direct reflections with an overly loud diffuse field?

The aim of this study is to determine if a tool that combines direct reflection, and diffuse reverberation simulation is appropriate from a sound source localisation perspective in VR applications. In this study the Google virtual reality software development kit (VRSDK) [**?**] for Unity was used for development of the listening test environment. The VRSDK version used was 1.0, and the version of unity used was 5.4.2f2.

2 Hypothosis

2.1 Spatial Perception

2.2 Google VR SDK Reverb Engine

3 Experimental Method and Results

3.1 Reverberation

3.2 Reverberation Algorithms

3.2.1 filter based reverb

7 REFERENCES

REFERENCES

[1] Jamie A S Angus and Andrew Caunce. A GPGPU Approach to Improved Acoustic Finite Difference Time Domain Calculations. *128th Audio Engineering Society Convention*, 2010.

[2] Stefan Bilbao. Modeling of complex geometries and boundary conditions in finite difference/finite volume time domain room acoustics simulation. *IEEE Transactions on Audio, Speech and Language Processing*, 21(7):1524–1533, 2013.

[3] Matthew Boerum, Bryan Martin, Richard King, Geroge Massenburg, Dave Benson, and Will Howie. Lateral Listener Movement on the Horizontal Plane: Sensing Motion Through Binaural Simulation. *Audio Engineering Society Conference: 61st International Conference: Audio for Games*, pages 1–11, 2016.

[4] D. Botteldooren. Finite-difference time-domain simulation of low-frequency room acoustic problems. *The Journal of the Acoustical Society of America*, 98(6):3302, 1995.

[5] David Oliva Elorza. *Room acoustics modeling using the ray- tracing method : implementation and evaluation.* PhD thesis, University of Turku, 2005.

[6] F. Alton Everest and Neil A. Shaw. *Master Handbook of Acoustics, 5th Edition*, volume 110. 5th edition, 2009.

[7] Adam J Hill. Analysis , Modeling and Wide-Area Spatiotemporal Control of Low-Frequency Sound Reproduction. (January), 2012.

[8] Siegfried Linkwitz. THE MAGIC IN 2-CHANNEL SOUND REPRODUCTION - WHY IS IT SO RARELY HEARD ? pages 1–22, 2015.

[9] B C J Moore. Masking in the human auditory system. *Collected Papers on Digital Audio Bit-Rate Reduction*, pages 9–19, 1996.

[10] Jelle Van Mourik and Damian Murphy. Geometric and wave-based acoustic modelling using Blender. *AES 49th International Conference: Audio for Games*, pages 1–9, 2013.

[11] Lauri Savioja. Real-time 3D finite-difference time-domain simulation of low- and mid-frequency room acoustics. *Proc Int Conf Digital Audio Effects*, pages 1–8, 2010.

[12] Samuel Siltanen, Alex Southern, and Lauri Savioja. Finite-difference time domain method source calibration for hybrid acoustics modeling. *ICASSP, IEEE International Conference on Acoustics, Speech and Signal Processing - Proceedings*, pages 166–170, 2013.

[13] Alex Southern, Damian T. Murphy, and Lauri Savioja. Spatial encoding of finite difference time domain acoustic models for auralization. *IEEE Transactions on Audio, Speech and Language Processing*, 20(9):2420–2432, 2012.