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The Impact of Reverberation Techniques on Immersion in Spatial Audio for Virtual Reality

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1 INTRODUCTION

Increases in available computing power, and great strides in research and development have brought a new surge of interest to virtual reality (VR) applications. With the introduction of improved VR systems using both high end graphics processors and mobile phone technology, next logical steps are being taken to provide users with complementary immersive sound environments. These environments may be created in an attempt to emulate real places, or to characterise fictional places.

A significant part of how humans identify with their surroundings is from the perception of the reverberant characteristics of the space they are in. Cues such as the timing and strength of early reflections, allow humans to perceive source size and direction, as well as how far from the nearest boundaries the perceivers are. Some early stage VR development platforms provide a very simplified model for how reverberation behaves in an audio system, and may be an oversimplification when attempting to create an immersive audio experience.

The aim of this report is to introduce a testing method, to allow for the evaluation of different reverberation methods with respect to immersive VR audio. Initially, some of the theory behind reverberation perception will be discussed. Following this, a brief discussion of current spatial audio techniques will be discussed. Finally, a testing framework will be proposed, in which subjects will evaluate different VR environments and reverb algorithms.

2 Reverberation & Perception

2.1 Reverberation

Reverberation in a simplistic description, is the diffuse scattering of sound energy in a space due to the reflection of that energy from boundaries. Specifically, the level of these reflections are such as to balance in level with the ambient noise floor, at or beyond the critical distance from a source. That is in contrast with strong early or late reflections, however these strong reflections are of significant interest in this study. It is also worth noting that in this description, reverberation level is a function of source level, distance (and therefore time), and the absorption of sound energy in the problem geometry.
The mathematical relationship between room characteristics, source level and reverberation time can be found below:

$$RT_{60} = \frac{0.161A}{Sa}$$

$$A = \begin{bmatrix} A_{11} & A_{21} \\ A_{21} & A_{22} \end{bmatrix} \tag{2.1}$$

2.2 Perception or Reverberation

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2.3 Reverberation Algorithms

3 Spatial Audio for Virtual Reality

3.0.1 Audio Spatial Perception

Some Text.

3.0.2 Ambisonics

Some Text.

4 Lists

4.1 Example of list (3*itemize)

- First item in a list

- First item in a list
  - First item in a list
    - First item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

4.2 Example of list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list

$$\begin{aligned}(x+y)^3 &= (x+y)^2(x+y)\\ &= (x^2+2xy+y^2)(x+y)\\ &= (x^3+2x^2y+xy^2)+(x^2y+2xy^2+y^3)\\ &= x^3+3x^2y+3xy^2+y^3\end{aligned} \tag{4.1}$$

Phasellus viverra nulla ut metus varius laoreet. Quisque rutrum. Aenean imperdiet. Etiam ultricies nisi vel augue. Curabitur ullamcorper ultricies