Wayverb: A Graphical Tool for Hybrid Modelling Auralisation

A thesis submitted to the University of Huddersfield in partial fulfilment of the requirements for the degree of Master of Arts

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This is the abstract.

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Abstract

TODO

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Introduction

The aim of impulse response synthesis is to simulate the reverberant properties of a space without having to physically build anything. This is useful for a variety of applications: architects need to be able to evaluate the acoustics of a building before construction begins, sound editors for film sometimes need to mix in recordings which were not made on location, electronic musicians like to conjure imaginary or impossible spaces in their music, and virtual-reality experiences must use audio cues to convince the user that they have been transported to a new environment.

Unfortunately, software allowing accurate binaural impulse responses to be synthesised is not currently widely available. Often, software produced for research purposes is never made public. Such software that *is* available generally suffers from one or more of an array of issues.

Most software relies only on fast geometric methods, which are inaccurate, especially at low frequencies. Conversely, programs opting to use more accurate wave-modelling methods require long time periods, on the order of days, or significant computing power to run.

Licensing is also an problem. Most room-acoustics packages are the product of years of combined research by multiple contributors, which is only made viable by releasing the software commercially. However, this inhibits further research, as the code is not freely available. This model also limits users to those able to pay, restricting widespread adoption.

When software is made available freely, often the user experience suffers. Code requires manual compilation, or can only be run from a textual interface, or the project is outdated and unmaintained.

The Wayverb project provides a solution to these problems, by making available a graphical tool for impulse response synthesis. It combines several simulation techniques, providing an adjustable balance between speed and accuracy. It is also free to download, can be run immediately on commodity hardware, and the source can be used and extended under the terms of the GNU GPL license.

This thesis will begin by examining common methods of room simulation and the software which implements these methods, explaining why particular techniques were chosen for Wayverb. Then, each of the chosen techniques will be explored in depth, along with a description of their implementation. The procedure for producing a single impulse response from the outputs of multiple modelling techniques will be detailed. Finally, two extensions to the basic room acoustics model will be described, namely frequency-dependent reflections at boundaries, and microphone/head-related transfer function (HRTF) simulation.

1 Context

Acoustics Simulation Techniques

Existing Software

Room acoustics simulation is not a new topic of research. The first documented method for estimating a room impulse response was put forward by Krokstad, Strom, & Sørsdal (1968), who suggested a geometric method based on ray tracing.

TODO Since then...

Searching online uncovers a handful of programs for acoustic simulation:

Name	Type	Availability
Odeon ("Odeon," 2016)	Geometric	Commercial
CATT-Acoustic ("CATT-Acoustic," 2016)	Geometric	Commercial
Olive Tree Lab ("OTL," 2016)	Geometric	Commercial
EASE ("EASE," 2016)	Geometric	Commercial
Auratorium ("Audioborn – Auratorium," 2016)	Geometric	Commercial
RAVEN (Schröder & Vorländer, 2011)	Geometric	None
RoomWeaver (M. J. Beeson & Murphy, 2004)	Waveguide	None
EAR ("Ear," 2016)	Geometric	Free
PachydermAcoustic ("Pachyderm Acoustic," 2016)	Geometric	Free
Parallel FDTD ("ParallelFDTD," 2016)	Waveguide	Free
i-Simpa ("I-Simpa," 2016)	Geometric, extensible	Free

2 Image-source

Coming soon.

3 Ray-tracer

Coming soon.

4 Waveguide

Coming soon.

5 Microphone Modelling

Coming soon.

6 Boundary Modelling

Coming soon.

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