

Real-time acoustics modeling in games

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Abstract This paper evaluates algorithms for modeling the acoustic properties of sounds in real time in games, and in particular evaluates J. Borish' "Extension of the image model to arbitrary polyhedra" [1] through implementation inside the RMS game engine.

Introduction

Background It's common for today's games to use the geometry surrounding the listener (that is, the player) to calculate occlusion and some dampening, but they still often use more traditional methods for applying echo and reverb, through DSP effects instead of real simulation; mapping regions in space to presets of DSP settings.

Motivation As gaming hardware and commonplace PCs grow ever faster, however, and get multiple execution units (such as in the Intel Core Duo/Quad), it is becoming more and more realistic to do a more sophisticated modeling of the acoustics of the player's environment, simulating the environment in real-time without "cheating" with DSP.

Moreover, creating a "real", realistically-simulated sound environment has been a dream for me for many years; I first envisioned it maybe seven years ago, although I could hardly code then.

Goals I expect to find that real ray-tracing of the environment is still not feasible even with current hardware. Furthermore, I expect the algorithm in [1] to suit the task performance-wise and quality-wise to work as the sound engine in RMS.

I will try to answer the following questions:

- Is real-time sound ray tracing even remotely possible?
- What methods of acoustic modeling are used in games today?
- What methods are available (apart from [1] and ray tracing) for DSP-free acoustic modeling?
- How can the image model be implemented inside the RMS game engine¹?
- Will the image model perform within realistic performance requirements (that is, be able to run concurrently with the rest of the game engine while still having a smooth, fluid gaming experience)?

Hypothesis

True realtime ray tracing is impossible or prohibitively computationally expensive for use in game engines, since computation grows exponentially with every ray bounce. However, approximative methods will bring performance requirements down enough to simulate realistic acoustic environments in real-time together with the rest of a game engine on a modern personal computer.

Available Sources

[1] describes the method I will implement.

[2] describes a number of different methods and also talks about both ray tracing and the image model.

¹ See glossary for "RMS Engine"

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Apart from [1-2], Mikael Swartling at BTH has promised to help with any technical problems I run into. However, as he is in the wrong department, he can't supervise this thesis.

Other possible sources:

- *A Scalable System for 3D Audio Ray Tracing* at <http://citeseer.ist.psu.edu/131758.html>
- *Real-Time Acoustics Simulation using Mesh-Tracing* at <http://ccrma.stanford.edu/~bschiett/pubs/icmc2003-schiettecatte.pdf>

Time Plan

Deadline Contents

- Feb 12** First seminar; presentation of introduction, hypothesis and plan
- Mar 09** Researching the subject thoroughly, finding more models than the image model, hopefully making ray tracing unfeasible without having to implement it (someone must have researched it before)
- Mar 30 Implement the image model
- Apr 05 Evaluate the image model with profiling tools
- Apr 13 Enhancing the algorithm with dampening and optimization
- Apr 16 Re-evaluate/profile
- Apr 20** Collating the data, preparing a presentation of the data
- May 18** Write and submit report
- June 04** Prepare presentation and defense

Glossary

RMS Engine The RMS engine is the game engine used in Friendly Stapler's "Rymdvarelser Mot Soldater" (third year group project in BTH's Game Programming's class of 2004, in which I work). See also friendlystapler.se.

References

- [1] J. Borish, Extension of the image model to arbitrary polyhedra, Acoustical Society of America Journal Vol. 75, 1984.
- [2] L. Savioja, Modeling Techniques for Virtual Acoustics, <http://www.tml.tkk.fi/~las/publications/thesis/>, 1999