Poster ID: 8

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Genetic Reverb: Synthesizing Artificial Reverberant Fields Via Genetic Algorithms

General Background

Definitions

Reverberation is created when sound is reflected off of and absorbed by various surfaces, creating an effect of sound persistence. A room reverberation can be characterized by an **Impulse Response** (IR), i.e., the response to a special signal that captures how energy is modified at different frequencies by the room. **Convolution reverb** is an audio effect that simulates how a sound changes in a room via convolution with its IR. A **genetic algorithm (GA)** is a meta-heuristic algorithm within the field of artificial intelligence (AI). It searches for the most optimal solution to a problem using operations modeled after Darwin's theory of evolution.

Keywords

Convolution Reverb, Digital Signal Processing (DSP), Genetic Algorithms, Impulse Responses, Room Acoustics

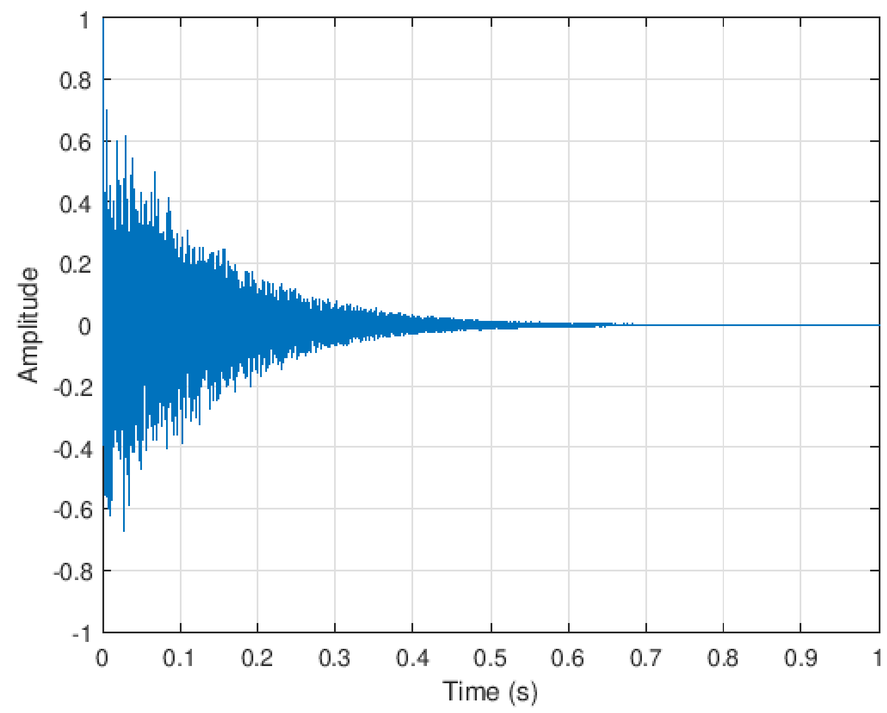

Figure 1: Example of an impulse response.

Synthesizing Artificial Reverberant Fields via Genetic Algorithms

Motivation

- Most popular reverb plugins have been implemented in such a way that does not allow complete control over the reverb effect, limiting the ways the reverberation can be modified.
- Other plugins that do offer more control also come at the cost of increased number of parameters and increased complexity to the end user.
- GAs and evolutionary programming as a whole are not explored as much in AI research compared to machine learning and neural networks, especially in musical applications.

Proposal

We implemented a VST 2 audio effect plugin that generates random IRs via a classic GA, which is controlled by various parameters that the end user can easily understand and tweak to their liking. These IRs can then be convolved with an input audio signal to produce reverberated audio.

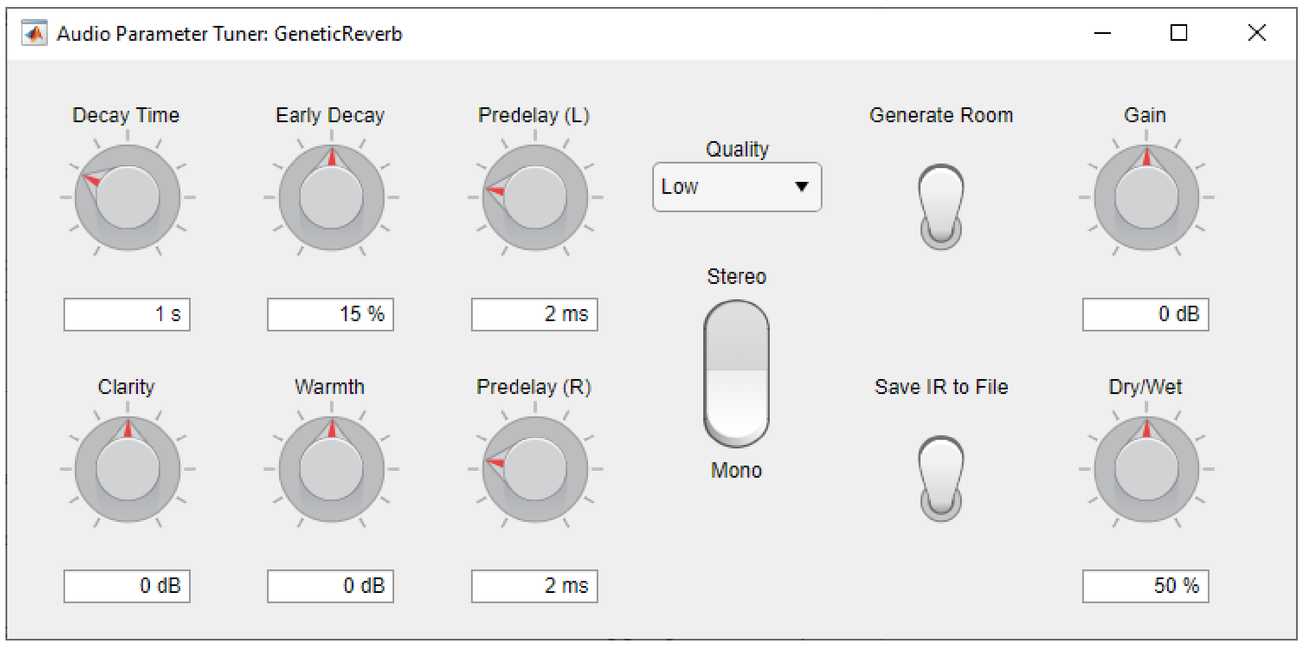

Figure 2: User interface of the plugin.

Made with **MATLAB**

Plugin Implementation and Genetic Algorithms Explained

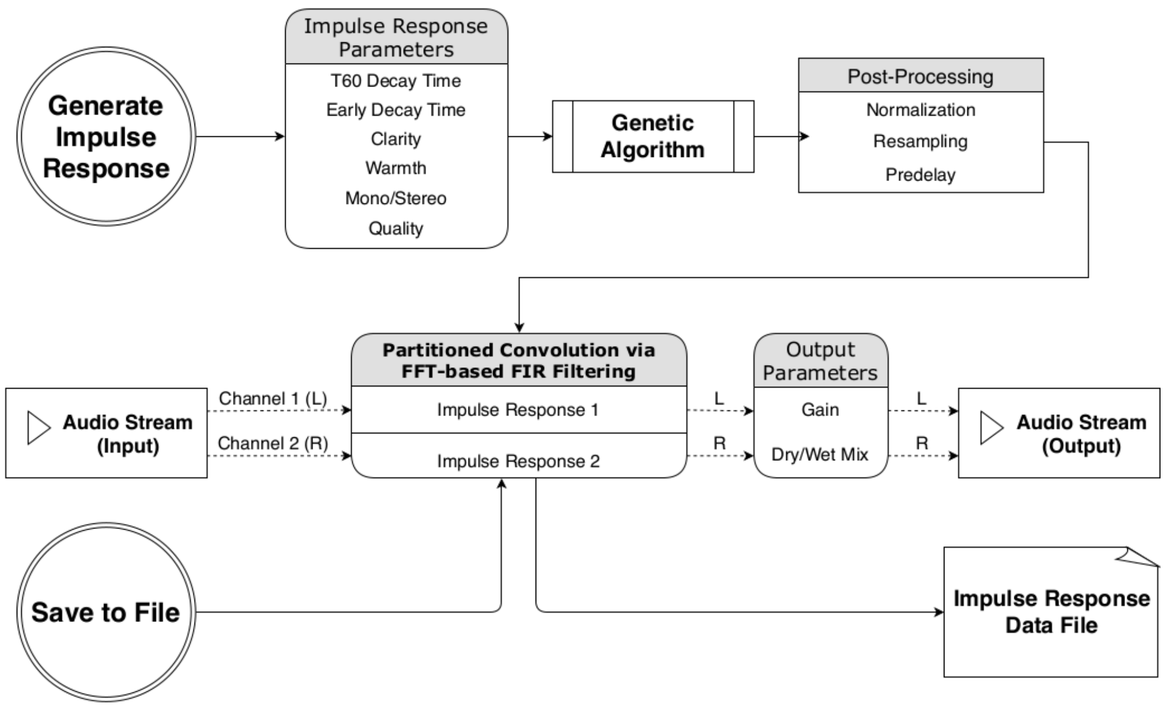

Figure 3: Flow chart illustrating plugin functionality.

Project source code repository:
https://github.com/edward-ly/GeneticReverb

Genetic Algorithm Implementation

Our plugin starts with a set of parameter values that specify the characteristics of the desired reverberation. Our genetic algorithm is initialized with a population of random IRs, which are then modified (evolved) through truncation selection, random weighted average crossover, and Gaussian multiplication mutation. Each IR is given a fitness score and the algorithm stops when we achieve an IR whose descriptor values are close enough to the expected descriptor values, or after a number of generations has passed.

Fitness Evaluation Based on Acoustics Parameters

- **T60**: the amount of time for the reverberant sound to decrease by 60 dB
- **EDT** (early decay time): the amount of time for the reverberant sound to decrease by 10 dB
- **C80** (clarity): difference in dB between all reflections <80 ms and >80 ms after initial sound
- **Warmth**: ratio of reverberation sound in low vs. high frequencies

Evaluation & Results

Participants were asked in a survey to identify differences in reverberated music and speech audio signals (generated from real and artificial IRs) via an ABX test. Early results suggest that there is a significant perceptual difference between such signals, but the difference is more noticeable in musical audio over speech due to their differences in frequency content.