Real-Time Implementation of Granular Synthesis and Artificial Reverberation

Graduate

Maurin Doswald

Stephan Oseghale

Introduction: Granular synthesis and artificial reverberation are powerful tools for transforming the temporal and spectral characteristics of sound. Granular synthesis segments audio into small grains, which can be manipulated in various ways to create complex textures. Artificial reverberation efficiently simulates natural acoustic spaces with high echo density and long decay times, a process that is computationally intensive with methods like convolution. This thesis presents a real-time implementation of both algorithms on a custom embedded system, designed for intuitive and expressive interaction, enabling users to quickly and easily produce interesting and versatile sonic results.

Approach: The system combines granular synthesis and artificial reverberation arranged in series. A key feature is routing only the granular synthesis output into the reverberation unit, enabling creative sound design by preserving the original signals clarity while adding depth. Unlike most products that offer only one effect, this unified system combines both, allowing seamless interaction and mutual enhancement. The granular module extensively uses stochastic processes and probability distributions to introduce musically controlled randomness, influencing pitch and other grain properties to produce rich and unpredictable sound textures. On the other hand, the reverberation module employs feedback matrices optimized via stochastic gradient descent, a relatively new approach in audio research. The signal chain also includes 4th-order Butterworth high- and low-pass filters, a detune module for pitch modulation and tap-tempo functionality for rhythmic synchronization.

Conclusion: In the context of this work, a fully functional audio unit was developed and successfully tested in various musical environments and by different musicians. The feedback confirmed the systems potential for creative sound design and its intuitive integration into existing workflows. This effect device offers unique possibilities for creative sound manipulation in a compact and affordable design, unlike anything currently available on the market.

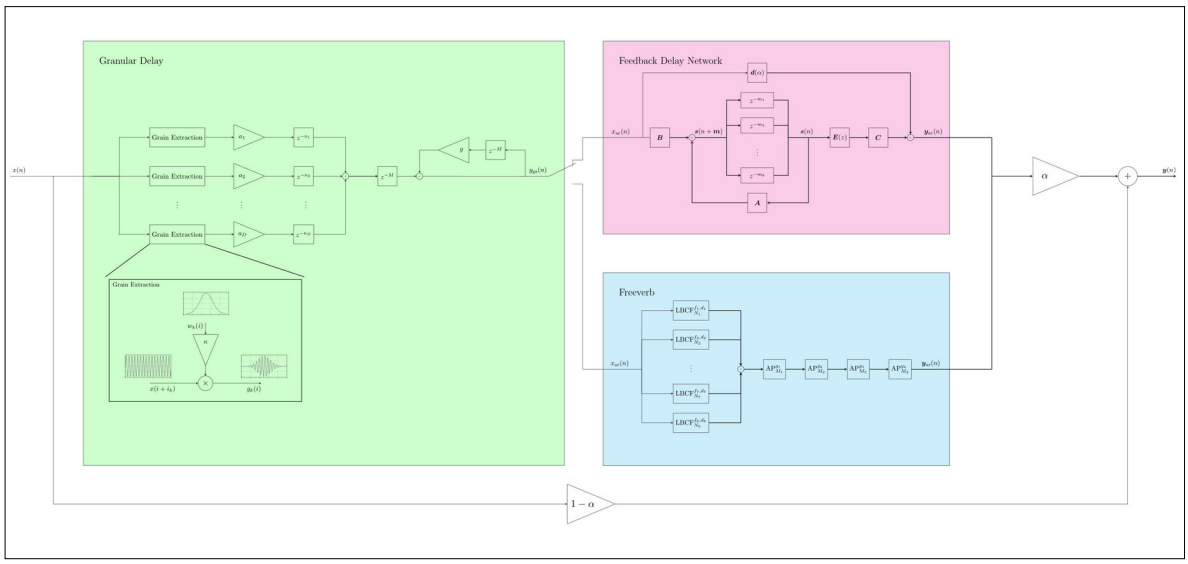
QR code linking to sound examples on SoundCloud
Own presentment

GranVerb Demo Sounds

GranVerb Demo Track

User Interface of the finished System
Own presentment

System Signal Flow
Own presentment



Advisor
Prof. Dr. Martin Weisenhorn

Co-Examiner
Jonas Schmid, Stettbacher Signal Processing, Dübendorf, ZH

Subject Area
Digital Signal Processing