MUSIC 424, Signal Processing Techniques for Digital Audio Effects

http://ccrma.stanford.edu/courses/424/

Catalog Description

MUSIC 424 Signal Processing Techniques for Digital Audio Effects—Digital signal processing methods for audio effects used in music mixing and mastering.

Topics

dynamic range compression, reverberation and room impulse response measurement, equalization and filtering, panning and spatialization; digital emulation of analog processors and implementation of time varying effects. Single-band and multiband compressors, limiters, noise gates, de-essers, convolutional and feedback delay network reverberators, parametric and linear-phase equalizers, wah-wah and envelope-following filters, flanging and phasing, distortion. Students develop effects algorithms of their own design.
3-4 units, Spr (Abel, Berners)

Prerequisites

An exposure to digital signal processing, including familiarity with the sampling theorem, digital filtering and the Fourier Transform at the level of Music 320 or EE 102B is required. An understanding of digital signal processing at the level provided by Music 420 or EE 264 is helpful. Familiarity with the use of audio effects in mixing and mastering, such as presented in Music 192 is also of benefit. Only a modest amount of Matlab or C programming experience is required for the homework and laboratory exercises.

Meeting Time and Place

Tuesdays and Thursdays, 1:30–2:50 PM, https://stanford.zoom.us/j/760371267

Instructors

Jonathan S. Abel, abel@ccrma.stanford.edu
David P. Berners, dpberner@ccrma.stanford.edu
Office hours after class and by appointment.

Teaching Assistant

Mark Rau, mrau@ccmra.stanford.edu
Office hours: by appointment

Grading and Credit

The course is given for three units credit; students successfully completing an optional project will receive one unit additional credit. Projects may be proposed in the first two weeks of May, and are due the day of the final exam.

Grading is based on performance on problem sets and laboratory exercises. Grading will be S/NC

100% Problem Sets and Labs

Collaboration on problem sets and labs is encouraged, but students must write up their submissions individually. Problem set and lab solutions will typically be available at the first class meeting after the due date. A total of 7 late days will be allowed for problem sets and labs, after which, no credit will be given.

Course Materials

Course notes are provided electronically. Lecture notes, reading materials and bibliographies will occasionally be provided as handouts and posted to the course web site or canvas.

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Tentative Schedule

date	*lecture topic*
	Introduction
4-7	Introduction
	Dynamic Range Control (Compression)
4-9	Definitions, terminology, architectures
4-14	Detection and gain computation, feed forward and feedback architectures
4-16	Attack and release, program dependence; analog detectors
	Equalization
4-21	z-Plane, s-Plane; bilinear transform; first order parametric filters
4-23	second order parametric filters, Time-varying filters
	Distortion Effects
4-28	Sampling rate conversion and antialiasing, anti–imaging filter design
	Filter Design
4-30	Filter phase, minimum and linear phase, Critical-band smoothing, frequency warping
5-5	IIR filter design and Prony's method; warped filter design
5-7	Canonical cut filter design
	Impulse Response Measurement
5-12	LTI Systems, statistics review; Impulse Response (IR) measurement
5-14	Golay codes, allpass chirp IR measurement, Sine sweeps
	Room Acoustics
5-19	Image method, Sabine theory, Room Impulse Response (RIR) statistics
5-21	Normalized echo density, T_{60} estimation, RIR synthesis
	Artificial Reverberation
5-26	RIR synthesis, low-latency convolutional reverberation
5-28	Feedback Delay Network (FDN) reverberation
	Modal Processing
5-2	Modal reverberation architecture, design, and implementation
5-4	Modal effects processing, pitch shifting, time stretching, distortion
5-9	Further Modal
	Other
6-11	Review, Special Topics