

ECE402 Lecture Topics

Electronic Music Survey Course – Prof. Haken

Introduction to Lecture, Introduction to Lab, Choose Lab Teams and Times [Lect 1]

An Incomplete History of Electronic Music Technology since 1900 [Lect 2]

Telharmonium, Theremin, Reproducing Piano, Ondes Martenot
Trautonium, Hammond Organ, RCA Synthesizer [Lect 3, Quiz]
Musique Concrète, Pierre Schaeffer, Classic Studio, Edgar Varèse
Hugh LeCaine, Robert Moog, Don Buchla, Mellotron, Walter Carlos, Isao Tomita [Lect 4]
Lejaren Hiller, Max Mathews, Iannis Xenakis
Phase Oscillator and Wavetable Synthesis, FM [Lect 5]
Samson Box, Dartmouth Synthesizer, Fairlight CMI, Yamaha DX7 [Lect 6]
IMS Synthesizer – Platypus – Kyma
Midi, Midi Sequencers and Timbre Editors, Digital Control of Analog Synthesizers
Software Synthesis, Physical Models, DSPs – CPUs – GPUs [Lect 7]

Music Encoding

Kyma, Max, Reaktor
Music Typesetting
MusicXML
Automated Music Transcription
Optical Music Recognition (OMR)
Braille Music [Lect 8]
MusicN
Midi Hardware Interface
Midi Encoding, Running Mode, 14-bit Controller Fail, Control-Rate Aliasing [Lect 9]

Four Aspects of Music: Pitch, Loudness, Timing, Timbre

Note Name, Pitch Class, Note Number, Cents, Frequency Ratios
Equal Tempered Scale, Just Tuning, Perfect Triads, Commas [Lect 10]
JND, Frequency, Accuracy Requirements for Phase Oscillator
Equal Loudness, Sones, Phons, Total Loudness, Musical Dynamic Markings [Lect 11]
Accelerando Formulae

Time-varying Spectral Analysis/Synthesis [Lect 12; Lect 13 Midterm]

Pitch-tracking Analysis (Short Windows)
McAulay-Quatieri Analysis (Long Windows) [Lect 14]
Noise Representation
Phase Representation
Time-Frequency Reassignment [Lect 15]

Psychoacoustics and Signal Processing

Outer ear - Middle Ear - Inner Ear
Shoulder, Head, and Pinna Effects
Place Principle
Otoacoustic Emissions
Critical Band, Masking Pattern, Temporal Masking Effects [Lect 16]
Barks and Mels
Total Excitation Pattern

Fixed Waveform Synthesis

No quasi-harmonic components
Avoiding Aliasing
Variable Duty-cycle Pulse Oscillator, Window Pulse Waveform
Bandlimited Impulse Train, Bipolar BLIT, Leaky Integration [Lect 17]
Phase Oscillator, Discrete Summation Formulae
Engineer's Sawtooth, Musician's Sawtooth

ECE402 Lecture Topics (continued)

Additive Synthesis with Complex Basis Functions [Lect 18]

Spectral Matching with Fixed Wavetables, Genetic Search
Properties of Group Additive Synthesis, Morphing Implementation

Sound Morphing and Cross Synthesis [Lect 19]

Additive Sound Morphing, Additive Cross Synthesis
Convolution
Talking Guitar Effect
LPC: Transfer Function, Number of Poles, Frame Rate, Stability, Error Function
Vocoder: Bandpass Filters, Amplitude Followers, Multipliers
Types of Inputs Useful for Vocoder and LPC

Pitch Processing [Lect 20]

Zero Crossings, Peak Detection
Comb Filter, 2nd Derivative
Autocorrelation
Cepstral Pitch Detection, Quefrency
Spectral Peak Labeling, String Inharmonicity Formula
How Not to Pitch Shift [Lect 21]
Pitch Shifting Using Lent's Algorithm

Synchronous Granular Synthesis

Serialized Lent's algorithm, Time stretching and Pitch shifting
Grain Spectra, Mixing, Morphing, Formant Preservation, Spectral Envelope Dilation

Asynchronous Granular Synthesis [Lect 22]

Sampled Grains, Synthetic Grains

IRCAM Chant Synthesis

Physical Models

Karplus-Strong (Simple Waveguide), Fractional Sample Delay (All Pass vs. Lagrange)
Connected Waveguide Models, Nonlinear Elements, Banded Waveguides, FDN [Lect 23]
Modal Synthesis, Nonlinear Feedback

Waveshaping (Nonlinear Filtering) [Lect 24]

Clip, Soft Clip, etc.
Feedback Impedance Functions for Physical Models
Polynomial Table Function, Brightness and RMS Matching

Modulation Synthesis [Lect 25]

AM, RM, Single-sideband
FM, Spectral Frequencies and Amplitudes, FM Recipes
Multi-operator FM, Formant FM

Musician's Filters [Lect 26]

Musician's Low Pass Filter, Q, Half-power Excursion, Transparency
Control Issues: Parameter Decoupling, Stability
All-pass Lattice, Regalia-Mitra Topology, Chamberlin Filter

AES3 Standard [Lect 27]

Biphase Encoding, Differential (Balanced) Signals
Block, Frame, Subframe, Time Slot, Channel Status

Lab Demos [Lect 28 & 29]