

DSP for Digital Artists

by Perry R. Cook, PhD

a 3-Day CalArts Intercession Short Course, January 14-18, 2019

Day 1: Basics, Definitions, FIR Filters, LTI Systems, Convolution, Sine Waves

Digital

Sampled/quantized signals
At regular intervals,
hold signal, convert to
digital number.

Signal

Values (pressure, voltage, etc.)
that change as function of time
Continuous: $x(t)$ t = time
Digital (discrete): $x(n)$ n = sample #

Processing

Do various math on
sampled digital signal.
 $y(n) = F(x(n))$
Gain, Filter, Analysis

Delays (t, x, θ)

Acoustics, speed of sound
Causality (and non-causality)
(block and hop sizes)

Sinusoids (sine, cosine, exp)

Fundamental in nature
Solution of $\delta^2 x / \delta^2 t$
"Eigenfunctions of LTI Systems"

Parameters (Gain, θ)

Gains, Weights, phases,
(SRate), time delays, block
(window) and hop sizes

PsychoAcoustics: Definition

(a branch of PsychoPhysics)

Physical Correlate(s)

How to compute it

Loudness	Percept, Intensity	Power	Square of signal (RMS) $\sum_n x^2(n)$
Pitch	Percept, Low <-> High	Frequency	Cycles per second (spectral peak)

Log Perception and non-linear Scales

Timbre	Difference	Spectrum+	Many factors, centroid, peaks, time
Time & Timing, Tempo vs. Pitch, Resolvability of events (the 30ms boundary)			

The Just Noticeable Difference (JND) Smallest perceived (better than guessing) change

Filters:

$$y(n) = F(x(n))$$

Operations on Digital Signals

Popular Simple Filters:

Linear Gain:	$y(n) = g x(n)$	where g = some constant
Moving Average:	$y(n) = 0.5x(n) + 0.5x(n-1)$	(low-pass)
High-Pass Cousin:	$y(n) = x(n) - x(n-1)$	(digital differentiator)
Also called	OneZero Filter , Averaging more samples: More Zeroes!!	
Also type of	Finite Impulse Response (FIR) Filter	

Sinusoids (Sine Waves) Mass/Spring Damper, Pendulum, Rotations (Trig!), RLC Circuits

Code and Demos:

0-SamplingMore In Processing, Demonstrates Sampling, Quantization
Pendulum MassSpring RotateSine Processing Code for Physical Systems
0c-Quantize.ck 0b-PhoneBandwidth.ck Quantization and SRate Demos
ZeroX P rocessing Code to demonstrate zerocrossings
5-ZCNative.ck 6-ZCUGs.ck 7-ZCPitch.ck Zeroes2.ck ZeroXing "Pitch" Demos
1-PeakNative.ck 1b-PeaksGUI.ck Track (and display) waveform peaks
OneZero.ck FIRNthOrder.ck FIR Filters
2-SparsePower.ck 3-RMSPowerNative.ck Sum of Squares Power

Assignment: 1) Some PsychoAcoustic Metric: Measure something about you. Use JND Paradigm.