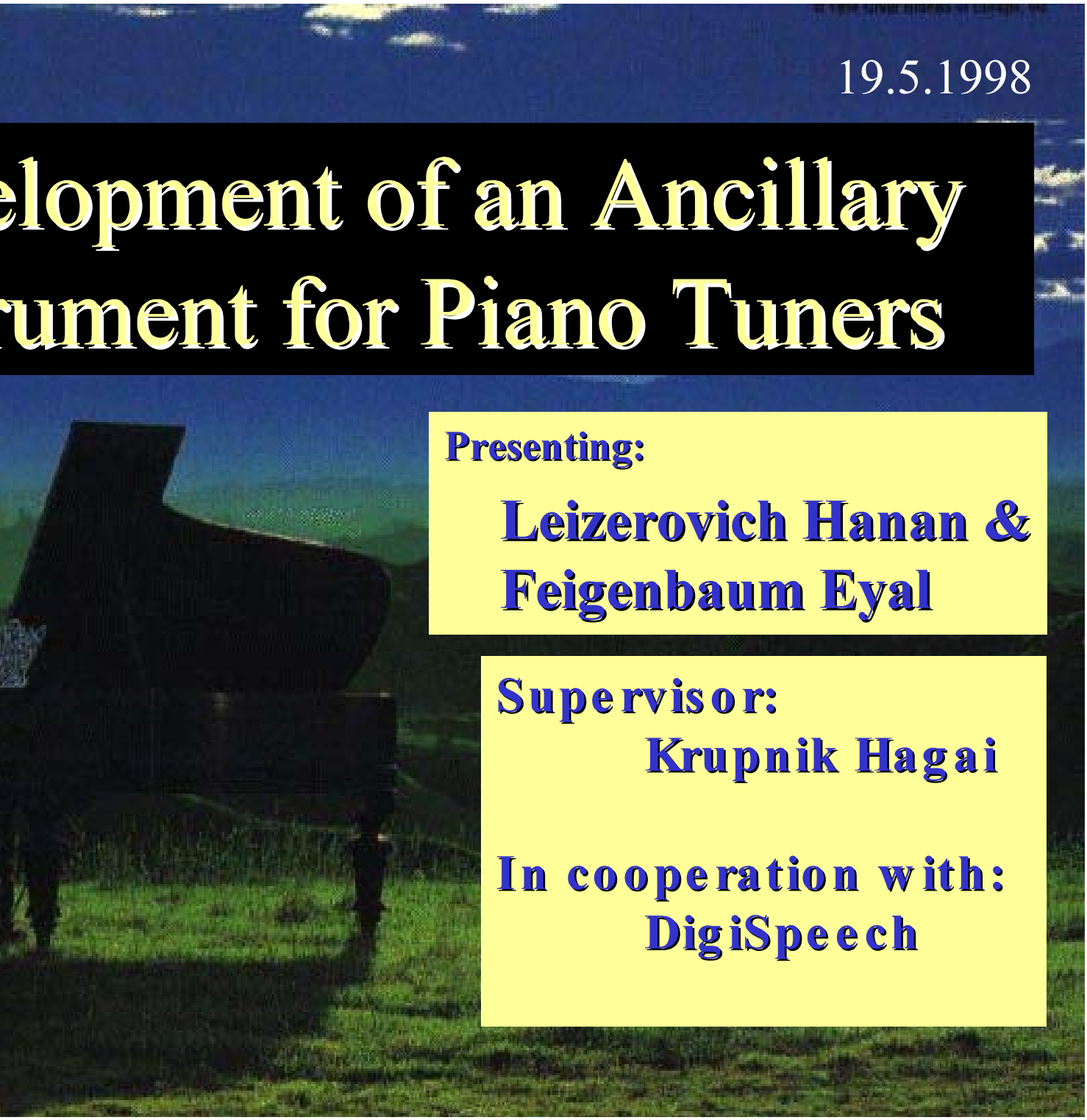
19.5.1998

elopment of an Ancillary rument for Piano Tuners



Presenting:

Leizerovich Hanan &
Feigenbaum Eyal

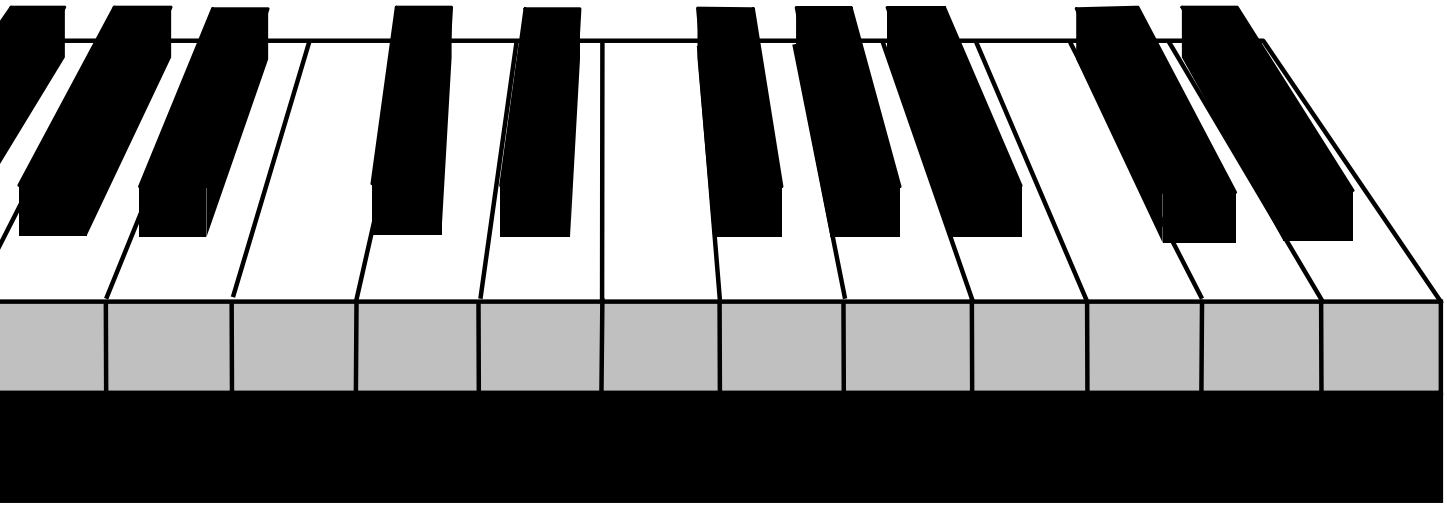
Supervisor:
Krupnik Hagai

In cooperation with:
DigiSpeech

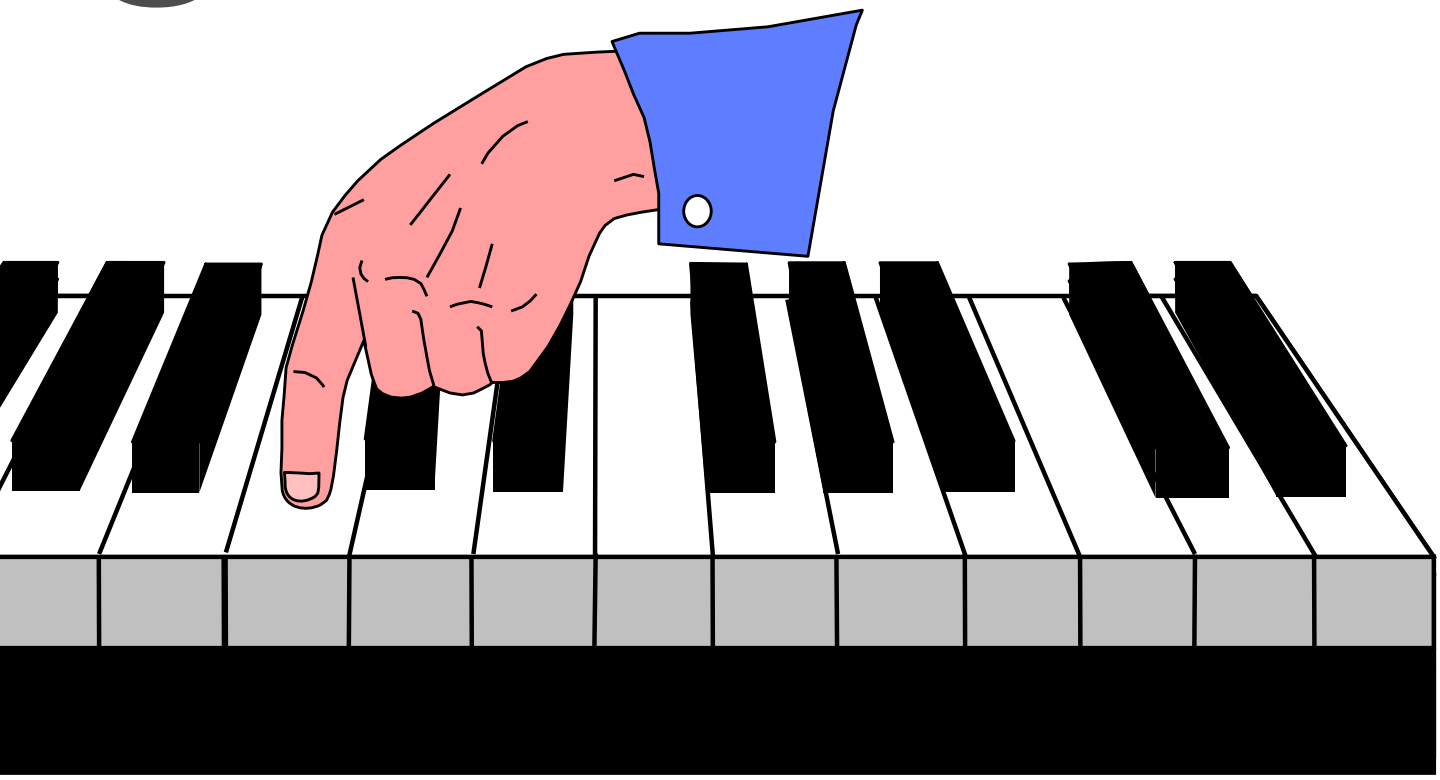
Agenda

- Theory
  - Piano Tuner
  - Piano
  - Beating
- Single Note Algorithm
  - Phase Accumulation
- Beating Algorithm
  - Beating counter Algorithm
- Demonstration

o Stages in Piano Tuning

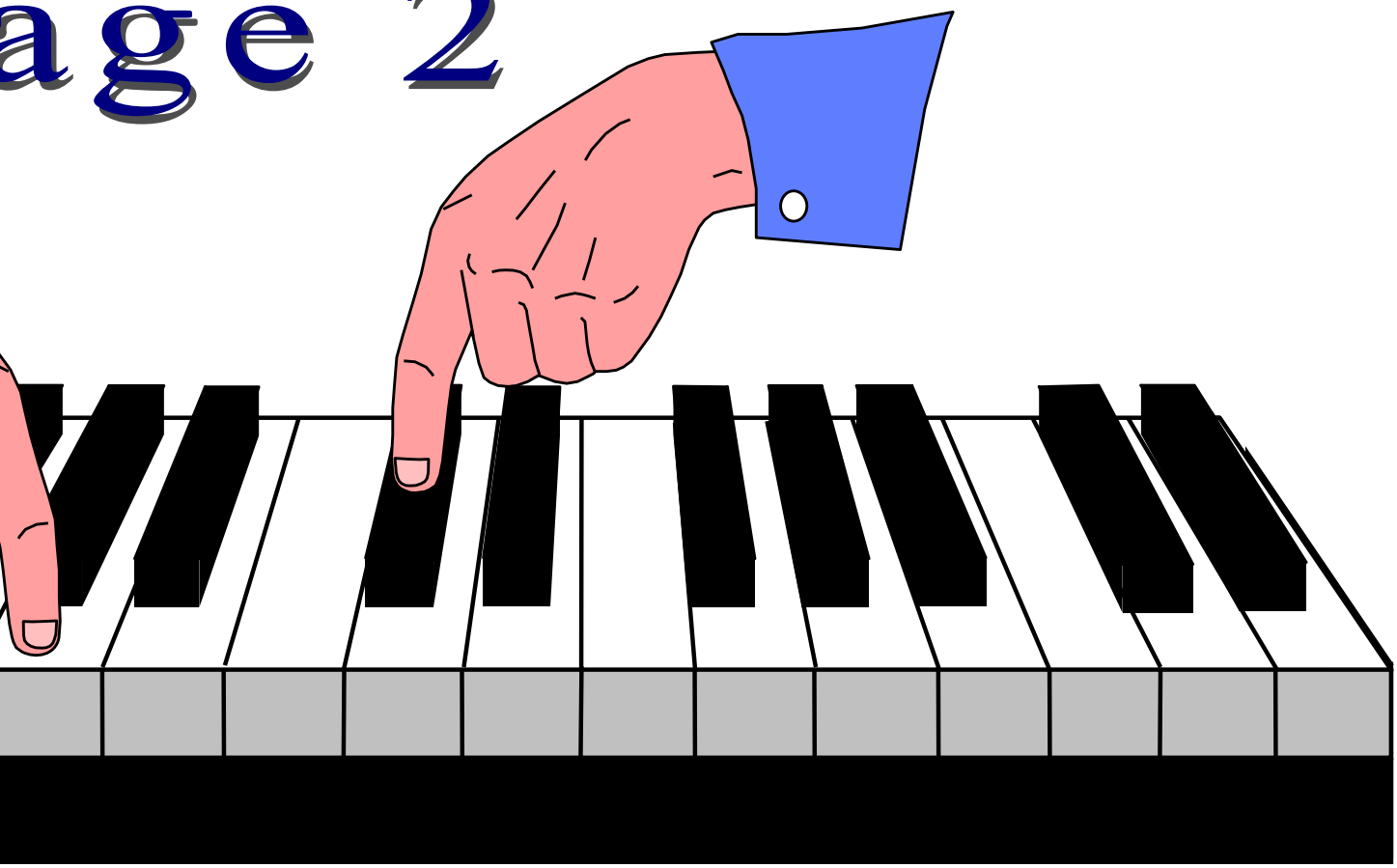


age 1



pitch tuning using one note

age 2



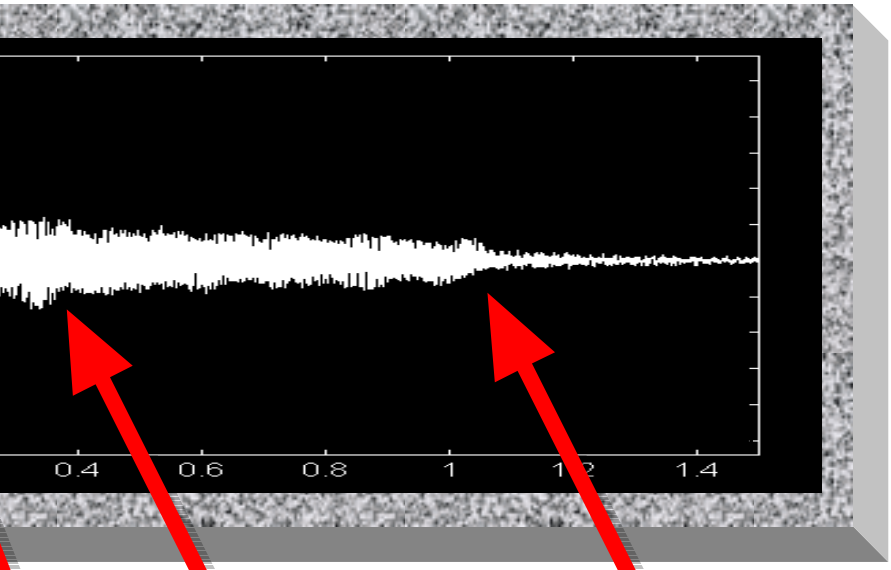
e tuning using two notes

ly Tempered Piano

1:2 proportion = 12 half tones

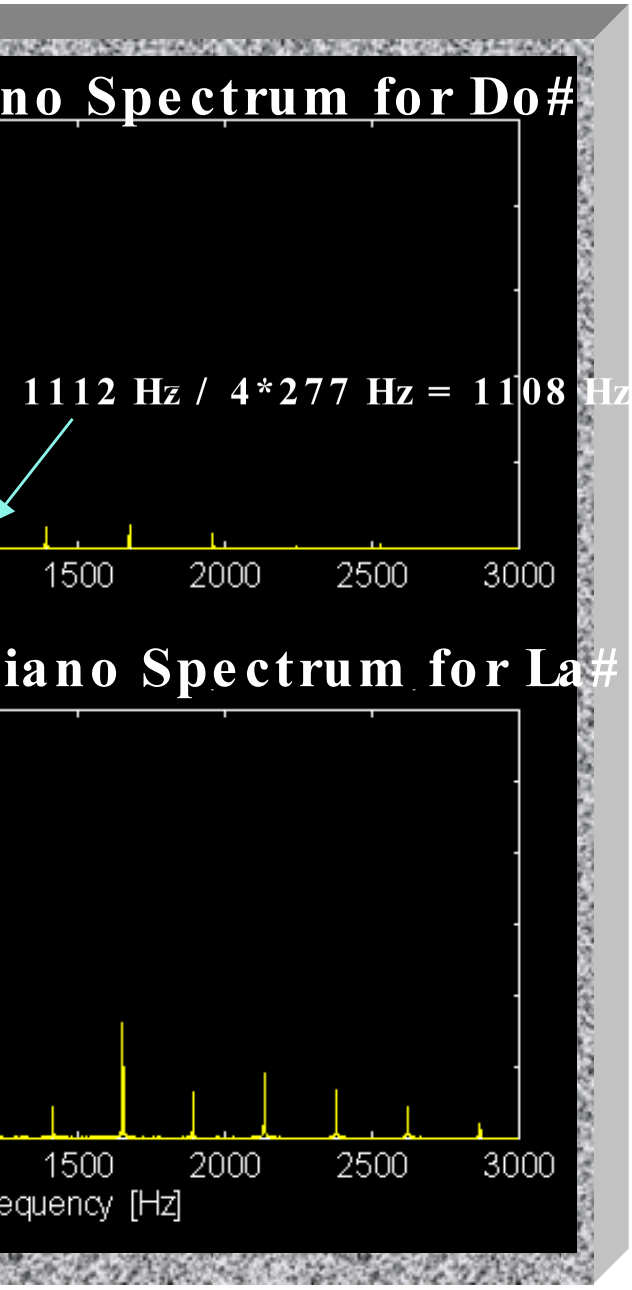
= 100 cents = $2^{1/12}$ proportion

ure



Decay Sustain Release

er Harmonies

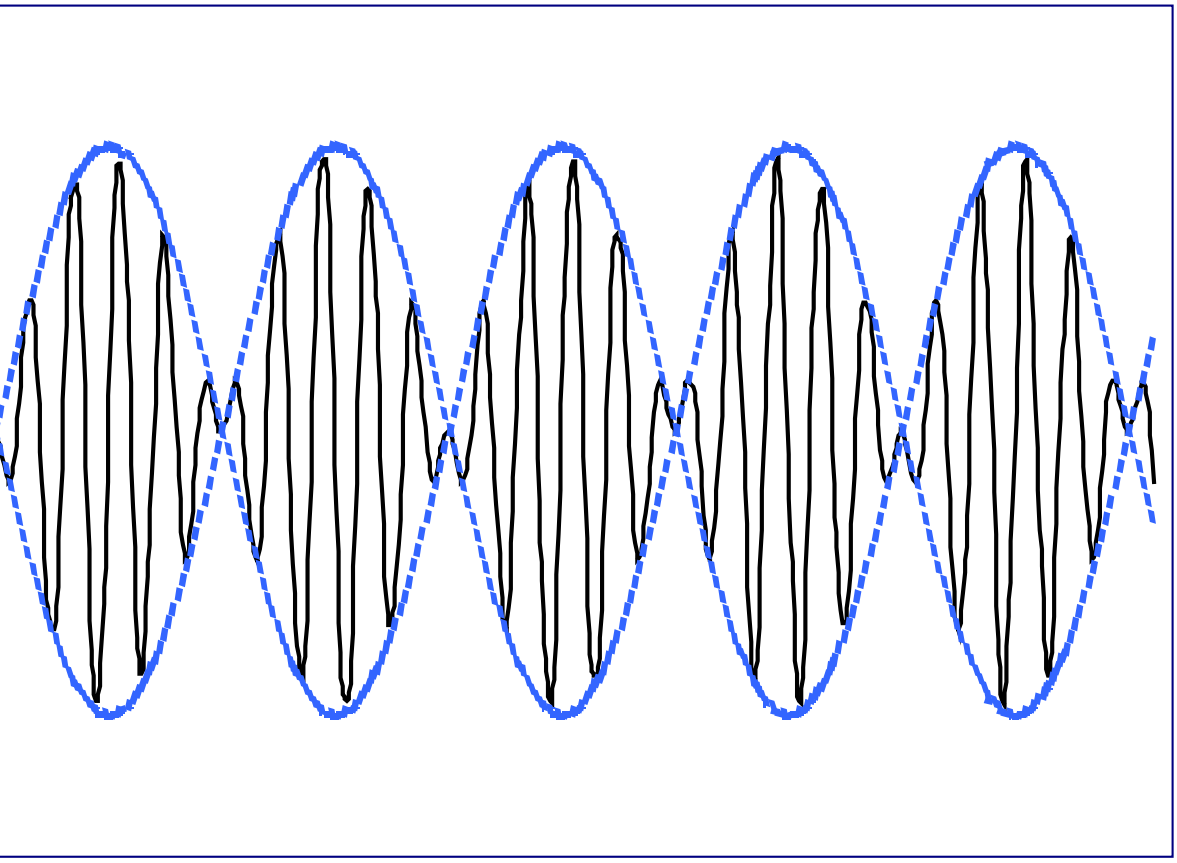


- Pitch
- Timbre
- Differences between pianos
- Inharmonicity

eating

$$\cos(\omega t) = 2\cos[(\omega + \tfrac{1}{2}\Delta\omega)t]\cos(\tfrac{1}{2}\Delta\omega t)$$

Beating Freq. = Δω



g Between Notes

ls : Major third = 4 half tones

g frequency changes with tone

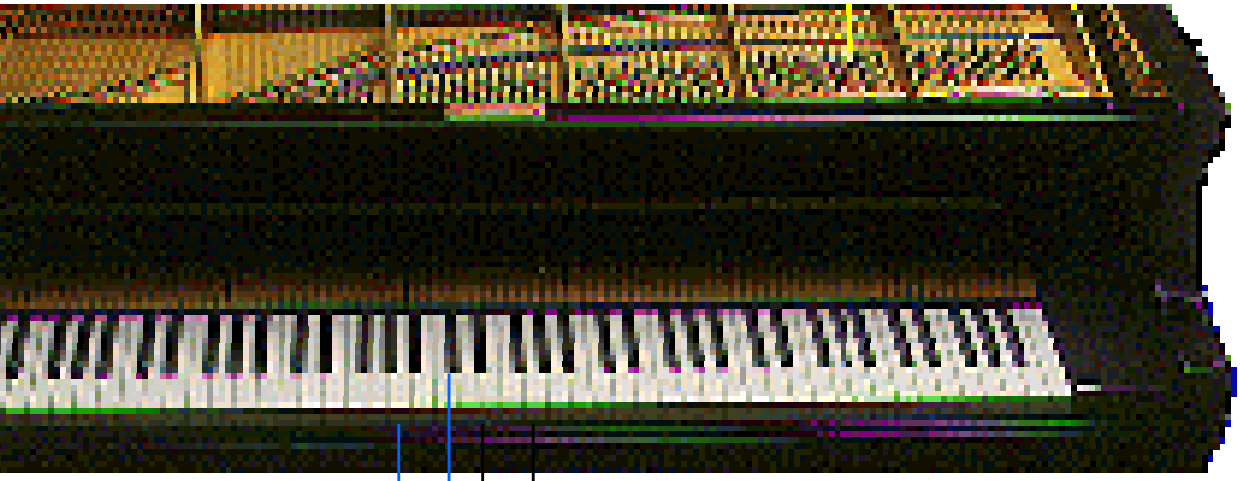
ch	2nd	3rd	4th	5th	6th	7th
	2fo	3fo	4fo	5fo	6fo	7fo
6fo	2.52fo	3.78fo	5.04fo	6.30fo	7.56fo	8.82fo

Fbeat = 0.04 fo

LA with DO #

Beating amplified

Beating only



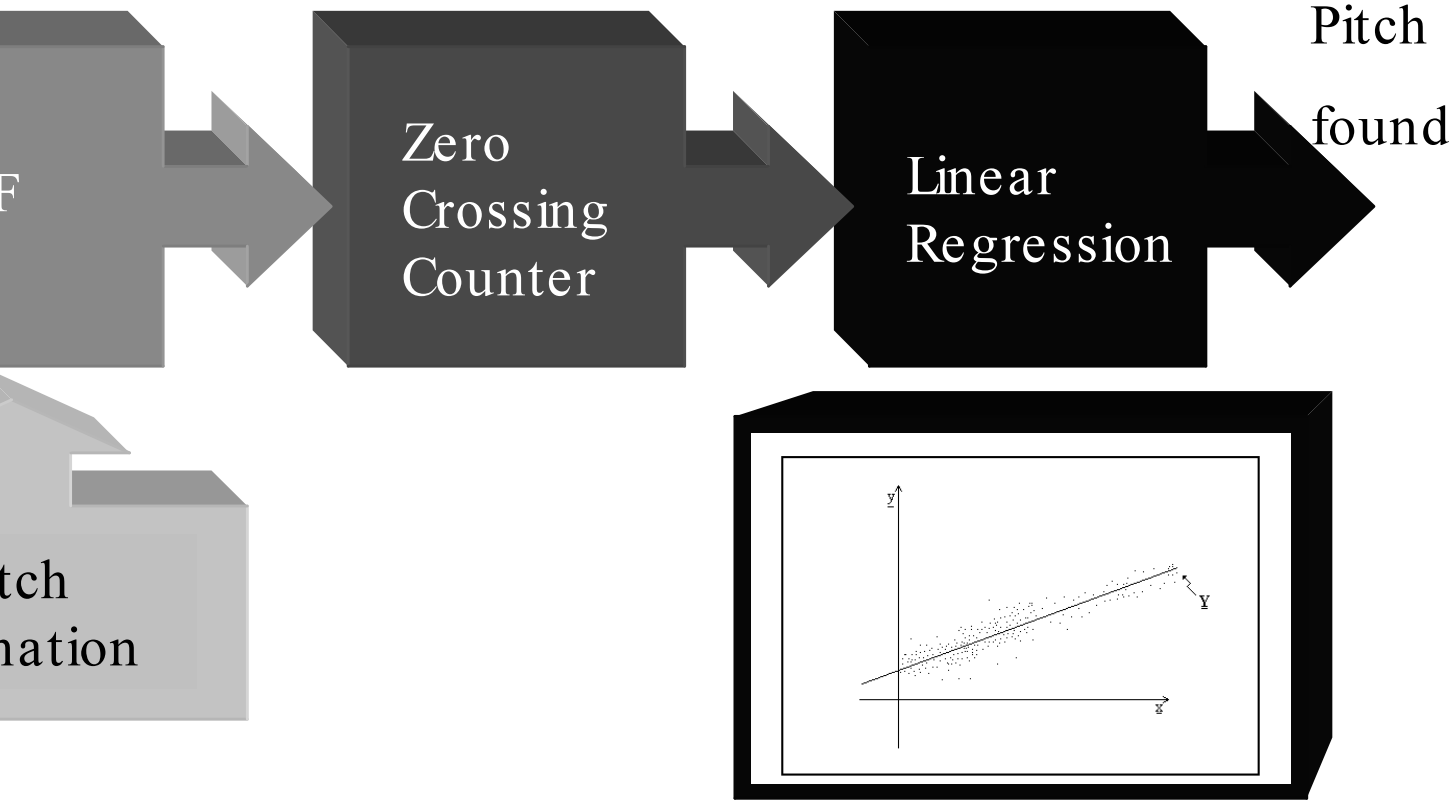
= 8.7 Hz

l - LA with DO #

Fbeat = 12.3 Hz

Major Third - MI with SOL

e accumulation



r LPF is approx. harmonic
g to actual value with time
ccurate algorithm

Crossing Counter

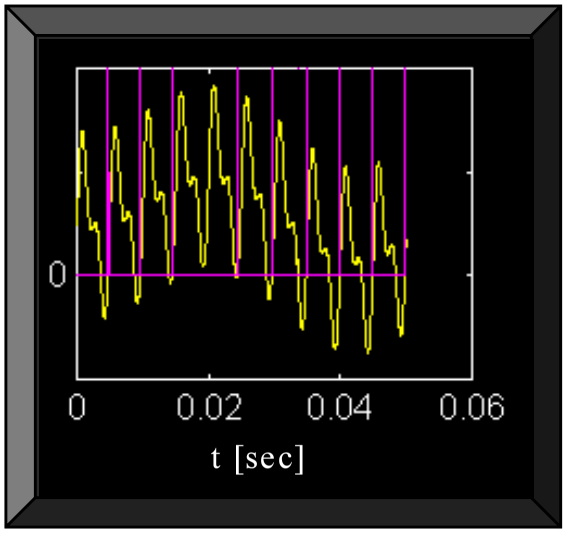
Dealing with Low Frequency Problems

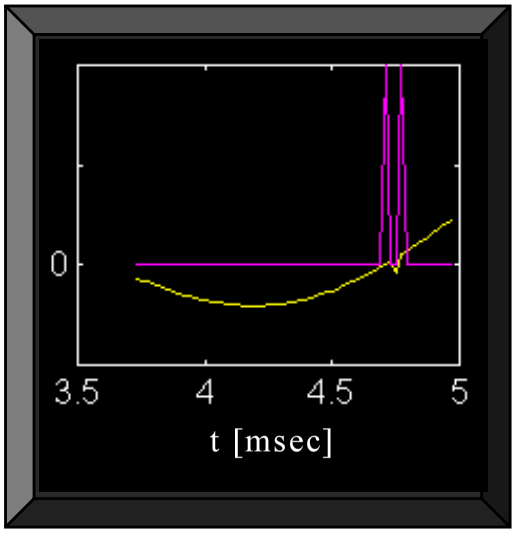
Dealing with High Frequency Problems

Zero crossing vector

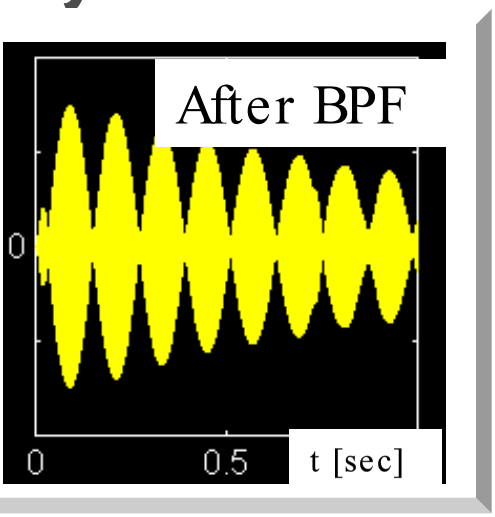
Fill in missing zero crossings in vector
by estimated period time

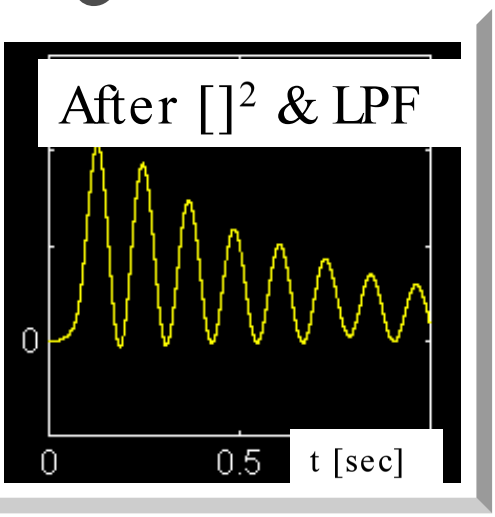
Eliminate redundant zero crossings
by estimated period time





nalalysis Beating Signals



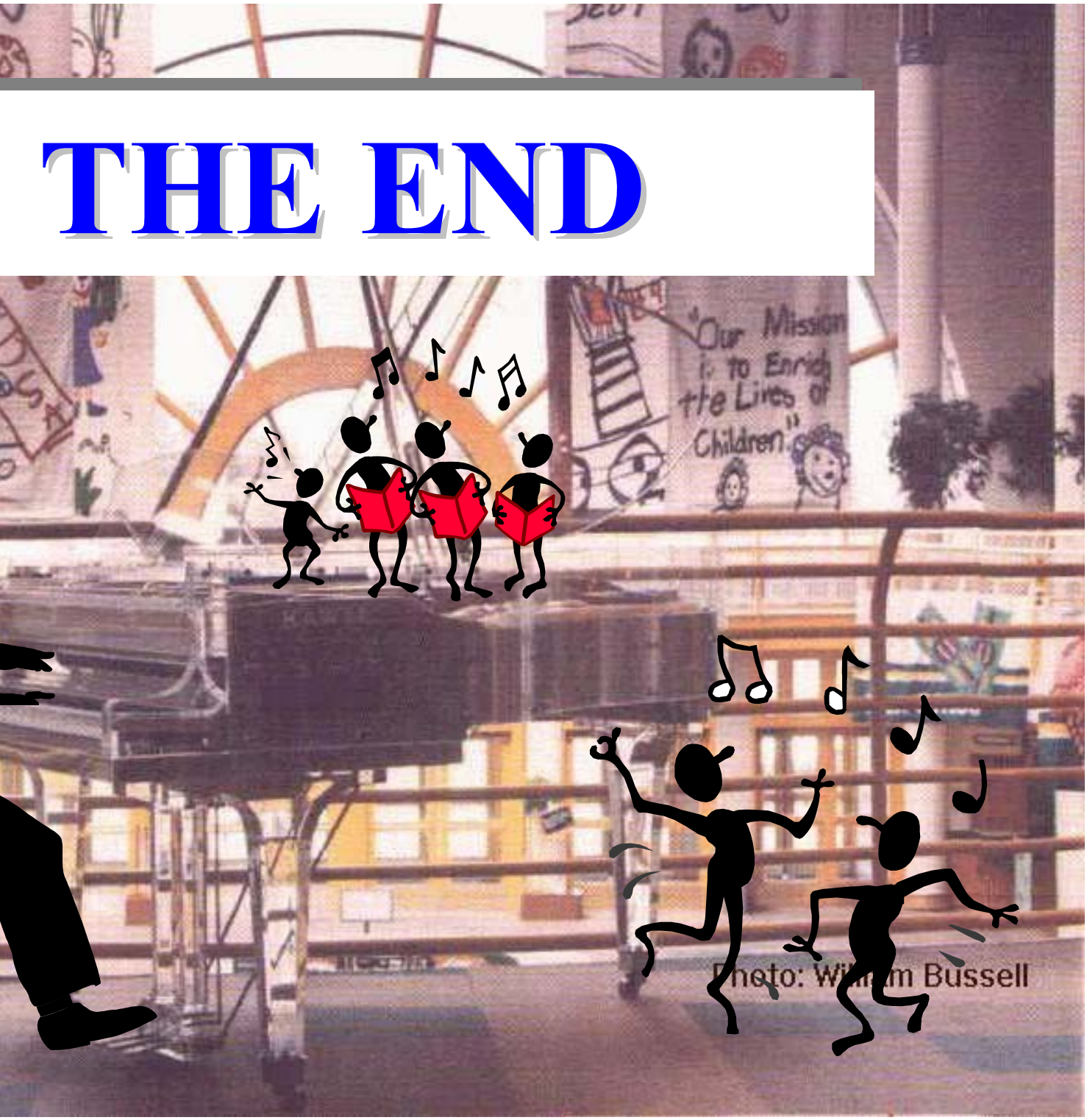


$[\ ]^2$ → LPF → Differentiator → Zero Crossing Counter

ency
ion

$$F_{beat} = \frac{\text{num. of crossings}}{t(\text{last}) - t(\text{first})}$$

THE END


Our Mission
is to Enrich
the Lives of
Children"
Photo: William Bussell