Active Noise Control of Speech in Headphones
using Linear Prediction

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Acoustics and Audio Technology - Fall 2016
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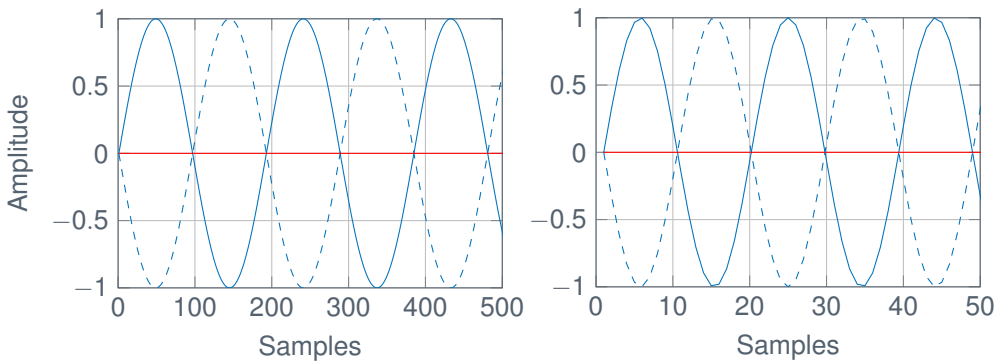
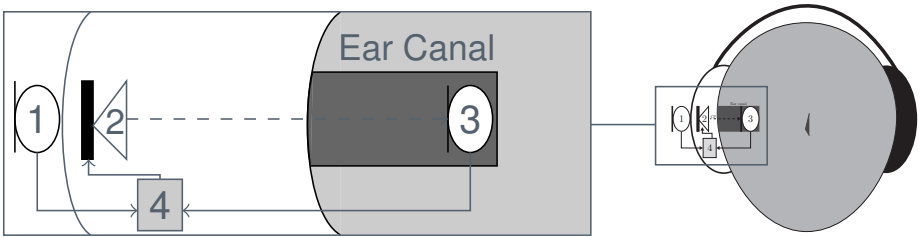
Agenda

- The basic theory of ANC
  - 250 Hz
  - 2500 Hz



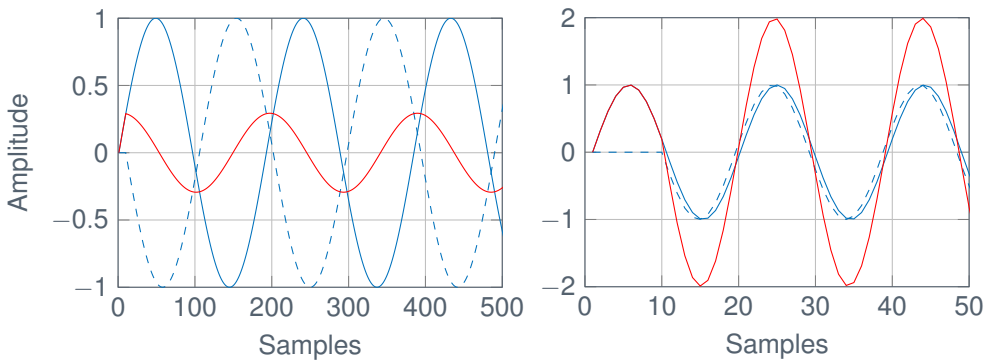
- Feedforward system
  - 1: Reference microphone
  - 2: Headphone loudspeaker
  - 3: Error mirophone
  - 4: Digital signal Processor (DSP)



- Feedforward problem
- Sampling and reconstruction delay.
  - Anti Aliasing filter
  - Reconstructions filter
- The measured delay of a Sigma Delta converter TLV320AIC3204

f_s [kHz]	48	96	192
Delay [μs]	900	450	225
Delay [samples]	43	43	43

- Counter phase signal delayed 10 samples
  - 250 Hz
  - 2500 Hz



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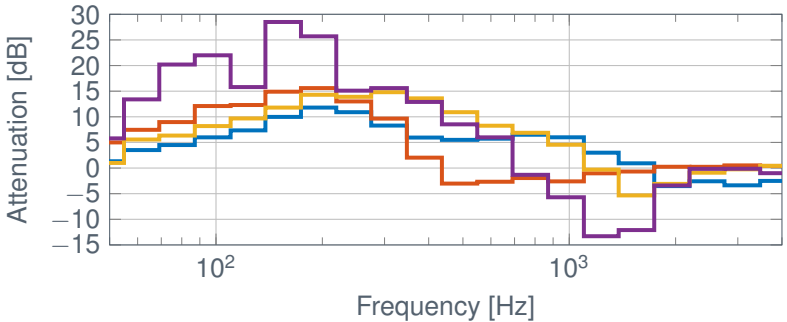
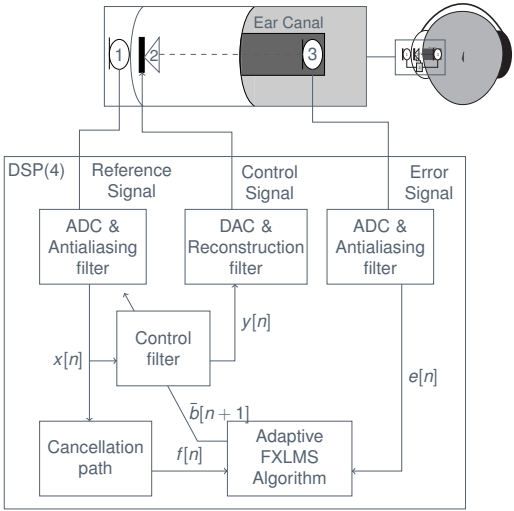
- Signal Characteristics
  - Periodic Signals
    - Periodic
    - Strict Sense Stationary (SSS)
  - Speech Signals
    - Quasiperiodic
    - Can be assumed Wide Sense Stationary for 20 ms – 30 ms
- Periodic noise is easy to cancel
- Speech noise is difficult to cancel

- How well does the consumer headphones attenuate?
  - Denon AH-GC20 2.200 kr (2016)
  - Bose QC25 2.799 kr (2016)
  - Bose QC15 2.696 kr (2011)
  - BeoPlay H8 3.495 kr (2016)



Combining a feedforward Filtered-x Least Mean Square (FXLMS) algorithm with Linear prediction (LP) scheme to compensate for delay.

- Control filter
  - Transfer function from (1) to (2)
  - Adaptive
- Cancelation path
  - Transfer function from (2) to (3)
  - Linear Time Invariant
- Adaptive FXLMS Algorithm
  - Transfer function from (2) to (3)
  - Linear Time Invariant



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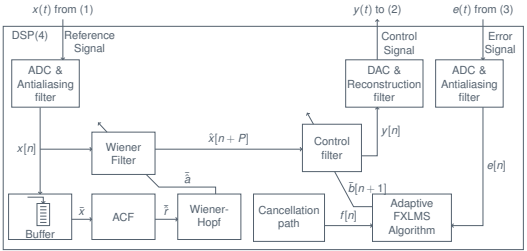

Methods
Optimal parameters

Questions?

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