Project Sauron

Midyear Design Review

Senior Design Project

Fall 2015

The Team

Advisor:
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EE

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CSE & CS

Omid Meh
CSE & EE

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EE

MDR Deliverables

- Demonstrate voice isolation between two individuals speaking simultaneously.
  - Components needed:
    - Microphone Array (SDP14 Array, Wolf Array)
    - Calibration System to identify time shifts needed to isolate a particular location ("delay learner" in PDR)
    - Beam-forming via time shifting
    - Additional filters to clean up final signals

Demos

- Acoustic Beamformer Array (from SDP14)
  - Calibration
  - Real Time Recording
- Wolf Array
  - Script Recording
  - Outdoor Test Results
  - Demo Beamforming on Script Recording

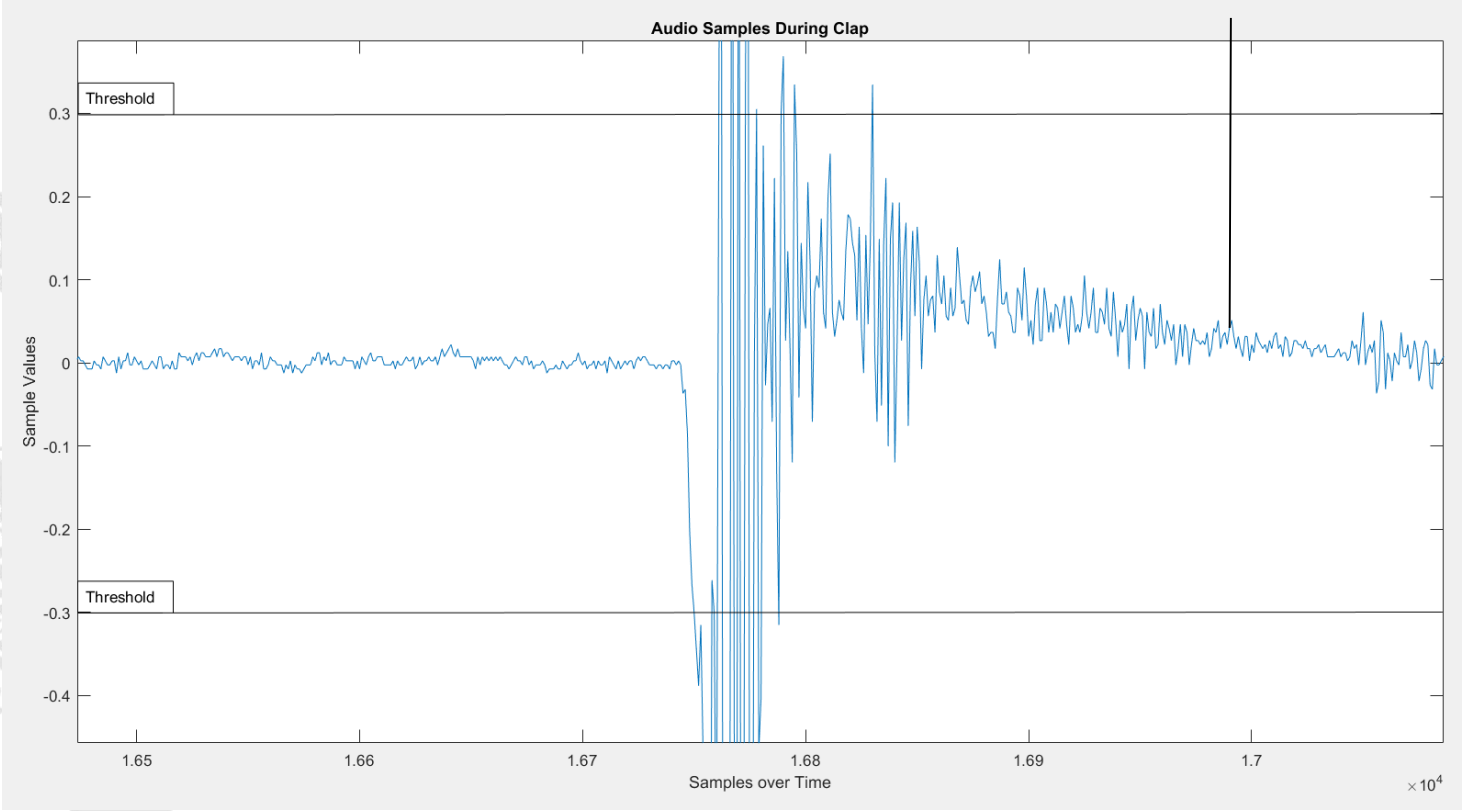
Beamformer Array Interface

Specifications

- Can import audio to Matlab
- Can operate continuously in real time
- Audio isn't skipped
- Can report delays of an impulse
- Allow relative ease in swapping arrays

Beamformer Array Interface

Detect Calibration Claps



Beamformer Array Interface

Real Time Recording

- Can import to Matlab

No Skips

- Current demo

Can read into

Wolf Array – Script Recording

Script 1 (Hollot)

"Inaccuracies between a physical system and its mathematical model are often accounted for via the introduction of uncertain parameters."

Script 2 (Moritz)

"We hope to provide insights in how performance is affected by the interaction of architectural aspects, various programming models and communication styles, and resource managing schemes."

Wolf Array – Outdoor Test

Setup:

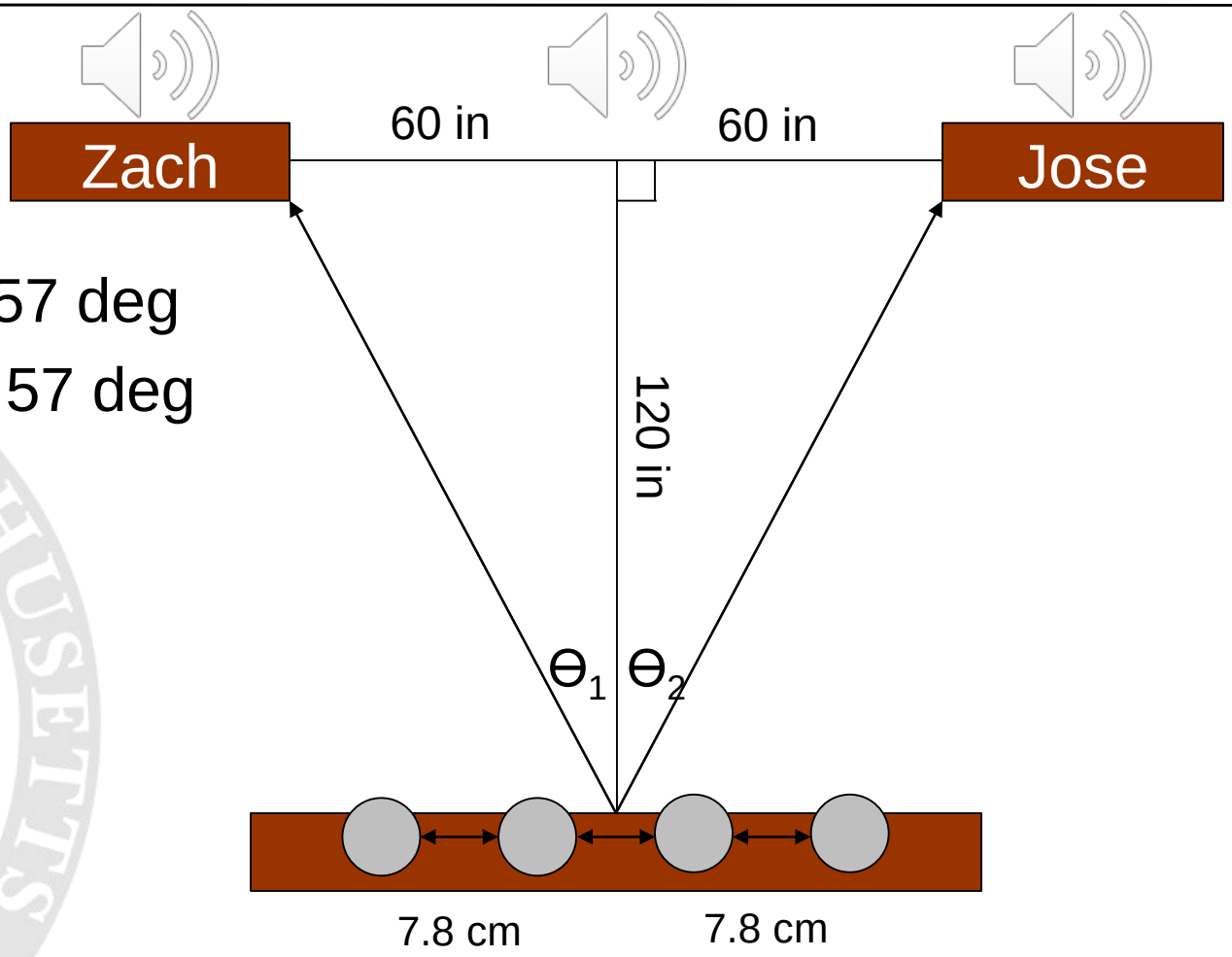
Mics: 4 cardioid linear array, 7.8cm Spacing

Zach @ -26.57º, 3.4m from array

Jose @ +26.57º, 3.4m from array

Wolf Array – Outdoor Test

Setup:



Θ_1 = -26.57 deg

Θ_2 = +26.57 deg

Wolf Array – MDR Demo

Setup:

Mics: 4 cardioid linear array, 7cm Spacing

Prof. Moritz @ -30º, ~2m from array

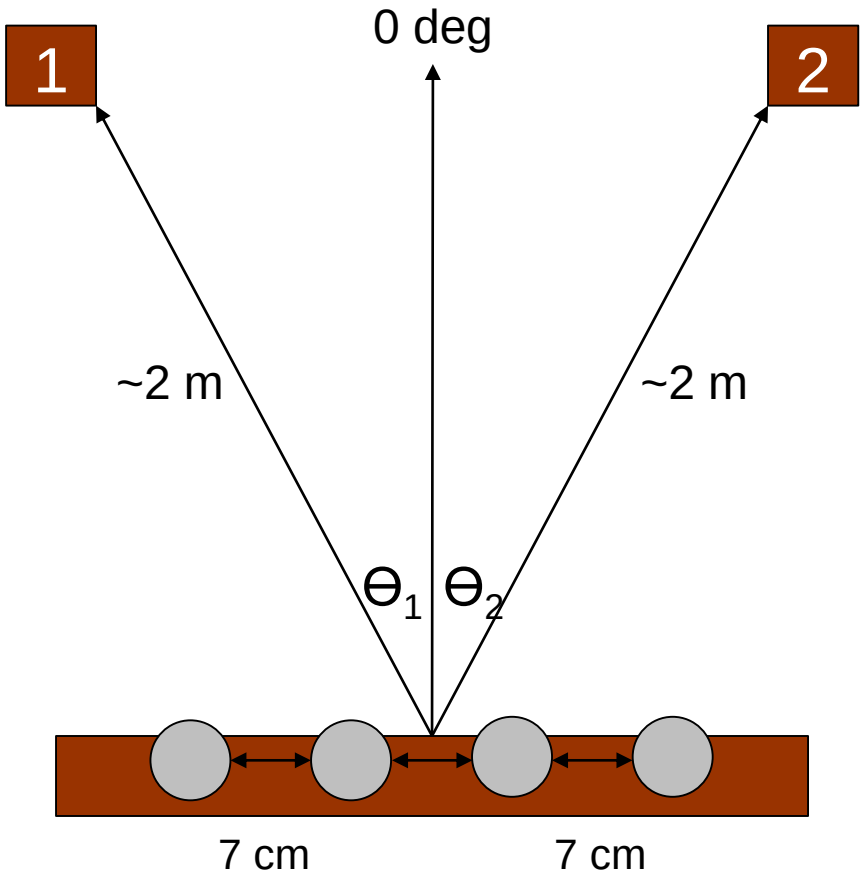
Prof. Hollot @ +30º, ~2m from array

Wolf Array – MDR Demo

Setup:

Θ_1 = -30 deg

Θ_2 = +30 deg

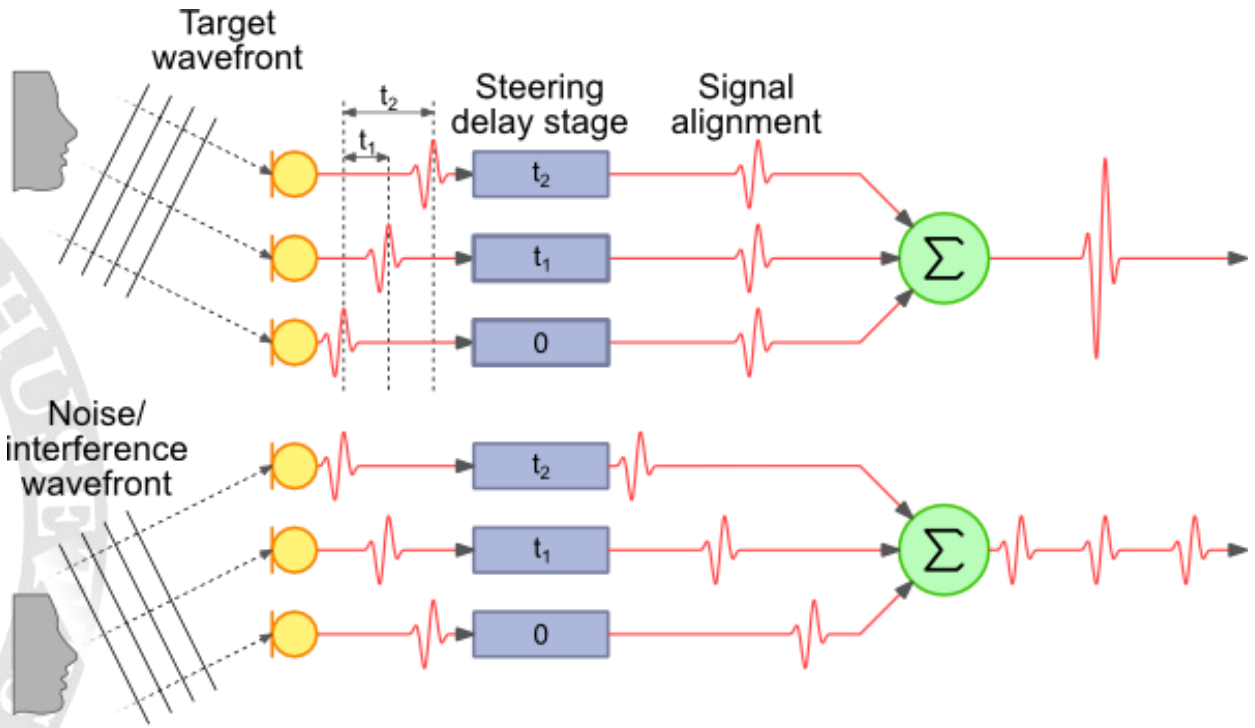


Explanations

- Time-Delay Beamforming
- Reverb
- Specifications
- Hardware
- Noise/Interference Removal

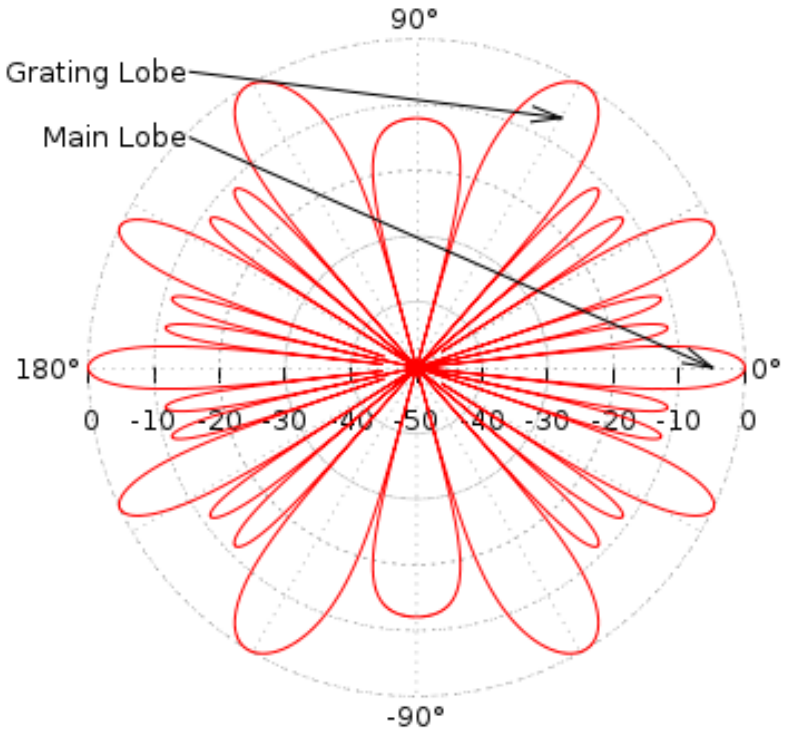
Time-Delay Beamforming

Delayed Interference



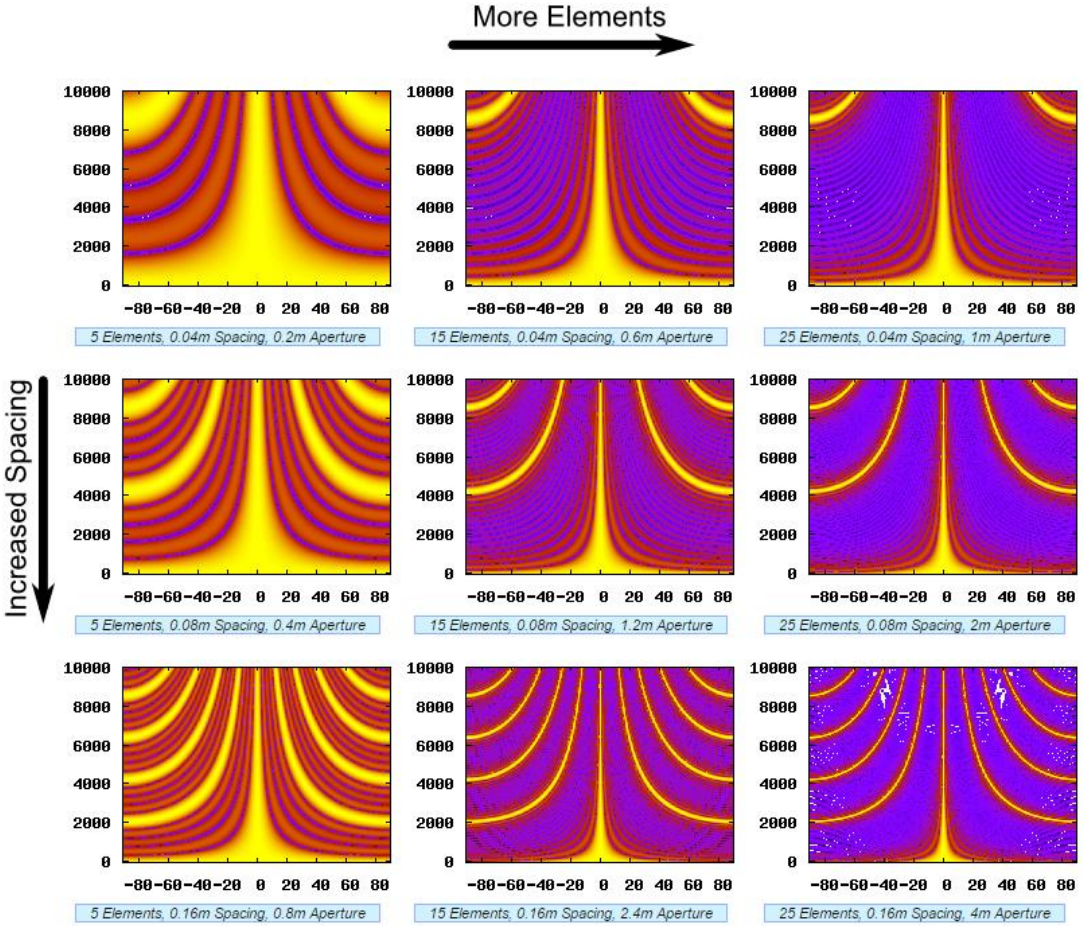
Time-Delay Beamforming

Main Lobe vs. Side Lobe



Time-Delay Beamforming

Element Count / Spacing vs Beam

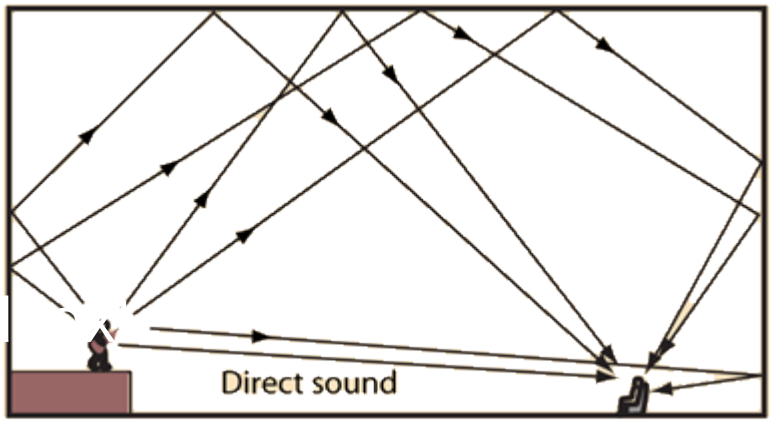


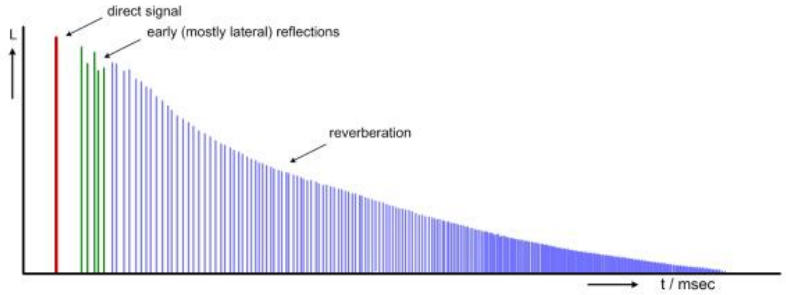
Reverb A Note On Reverb

The persistence of sound after a sound is produced

All sounds coming from all Directions

Makes Beamforming less useful as





Reverb Impulse Response

Specifications

Min Distance: 1m

Max Distance: 3m

Spanning Angle: 130º (-65º to 65º)

Beamwidth: 40º

Frequency: 500Hz-3.5kHz

Hardware

Microphones

- High Sensitivity, Frequency Response

Amplifiers

- High slew rate, low distortion, and low noise are desired for high quality audio and high performance instrumentation applications.

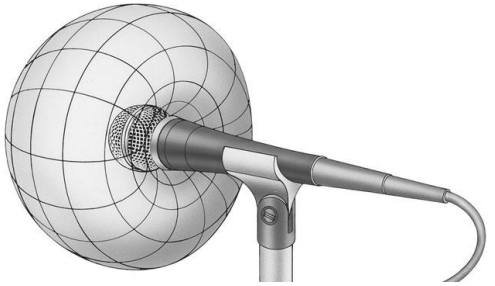
Transmission Lines

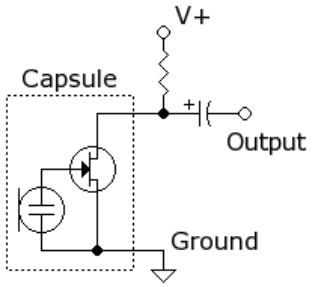
- Electrical wire vs. XLR cable
- Shielding resists RF and EM interference

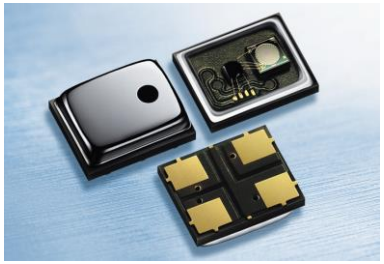
Hardware

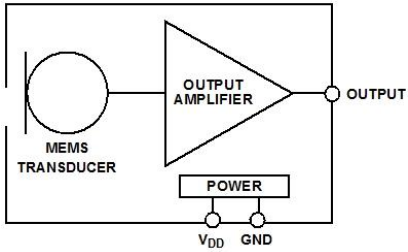
Microphones

- Cardioid
  - -54dBV sensitivity
  - 50-15kHz frequency range
- Electret
  - -44dBV sensitivity
  - 20-20kHz frequency range
- MEMS
  - -38dBV sensitivity
  - 100-15kHz frequency range









Hardware

Amplifiers

- LM386
  - High Distortion
  - High Noise
  - Sensitive to variations in power supply
- ADA4075
  - Low Distortion
  - Low Noise
  - High Slew Rate
- AD8273
  - Low Distortion
  - High Slew Rate
  - Single-Ended to Differential

Hardware

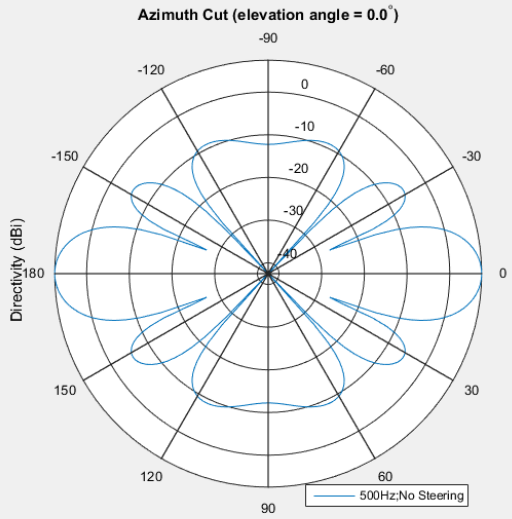
Transmission Lines

- Unshielded Wire
  - Sensitive to EMI and RFI noise
- XLR
  - Quiet
  - Durability
  - Three-pin (differential audio signal & ground)

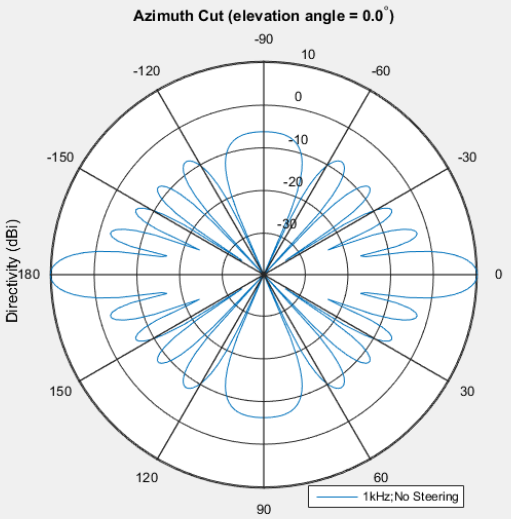
Directivity Plots

Acoustic Beamformer

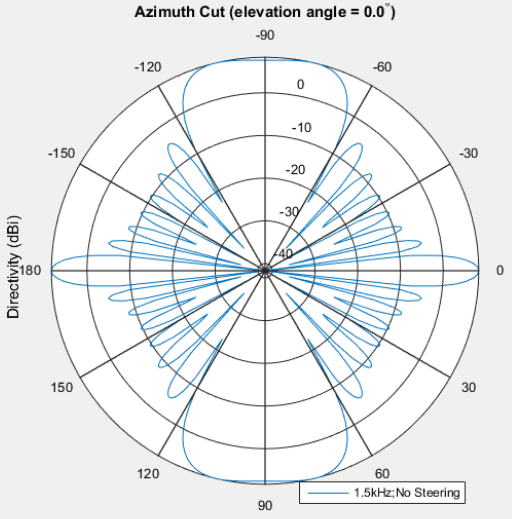
- 8 electret mic linear array, 23.5cm spacing
- 500MHz, 1kHz, 1.5kHz, 2kHz



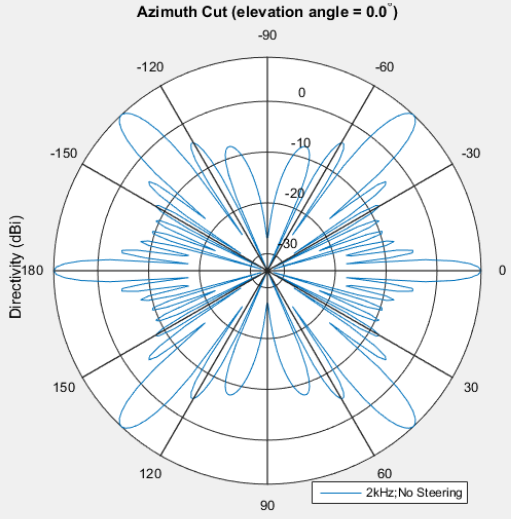
Directivity (dBi), Broadside at 0.00 degrees



Directivity (dBi), Broadside at 0.00 degrees



Directivity (dBi), Broadside at 0.00 degrees

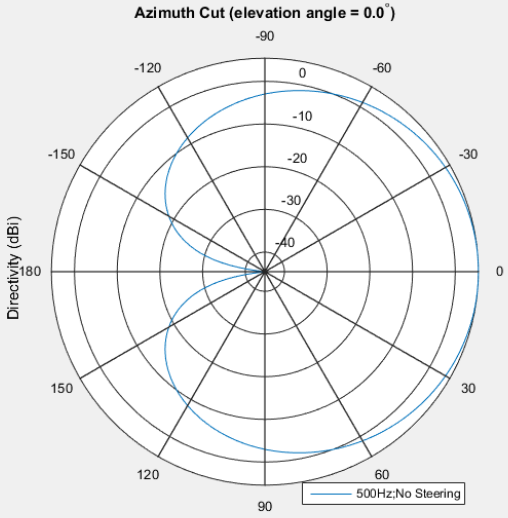


Directivity (dBi), Broadside at 0.00 degrees

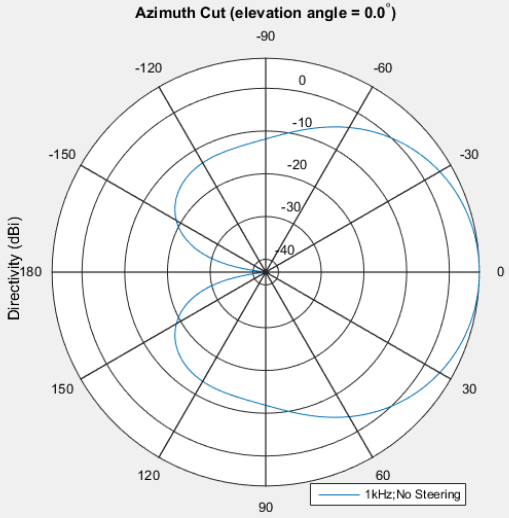
Directivity Plots

Wolf Array

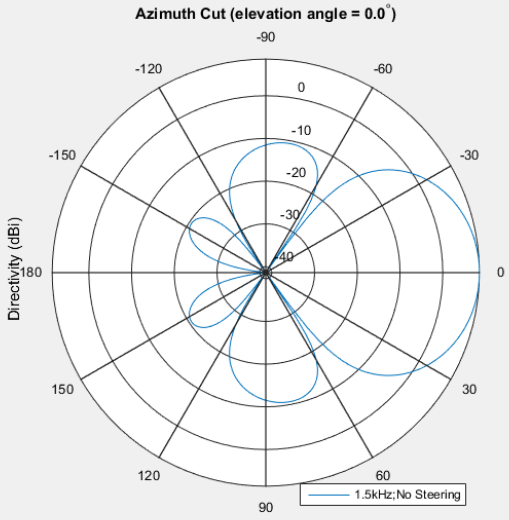
- 4 carotoid mic linear array, 7cm spacing
- 500MHz, 1kHz, 1.5kHz, 2kHz



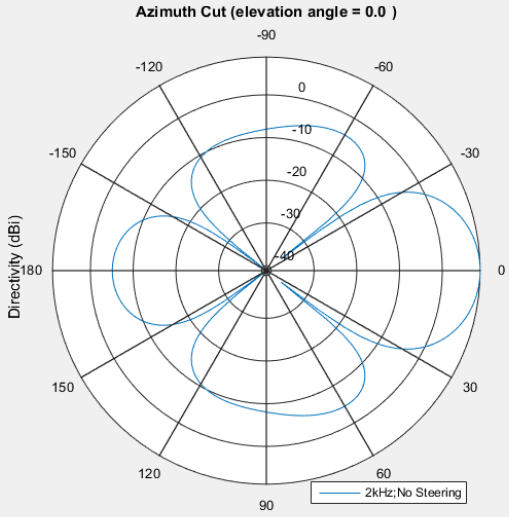
Directivity (dBi), Broadside at 0.00 degrees



Directivity (dBi), Broadside at 0.00 degrees



Directivity (dBi), Broadside at 0.00 degrees

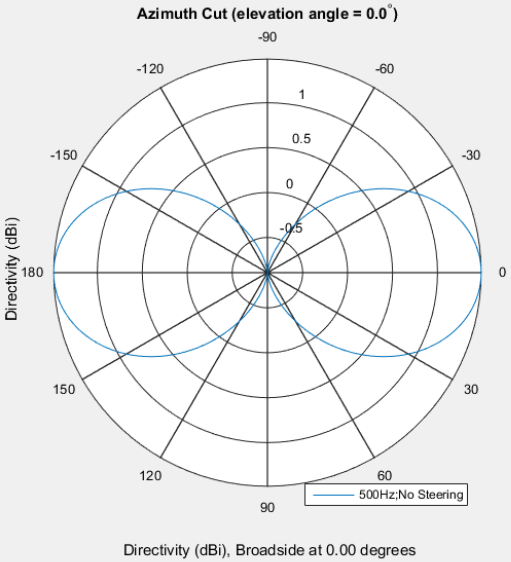


Directivity (dBi), Broadside at 0.00 degrees

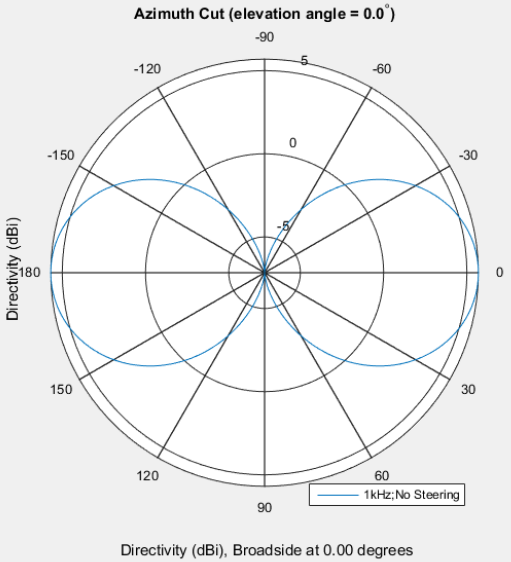
Directivity Plots

Proposed Array

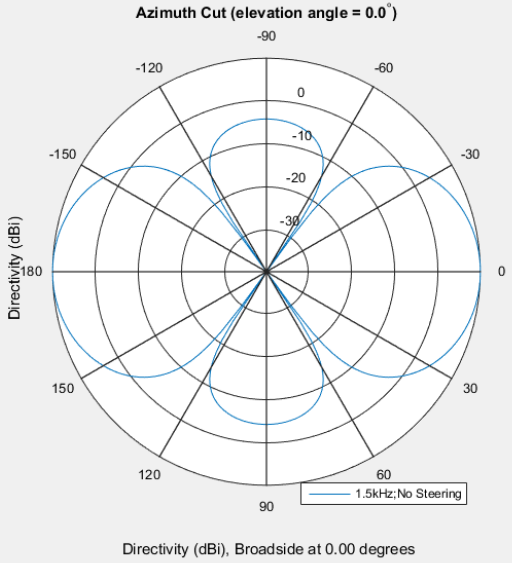
- 16 mems mic square array, 7cm x 7cm
- 500MHz, 1kHz, 1.5kHz, 2kHz



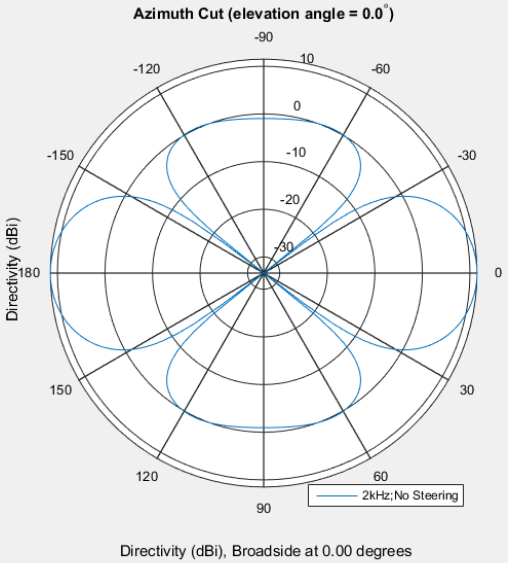
Directivity (dBi), Broadside at 0.00 degrees



Directivity (dBi), Broadside at 0.00 degrees

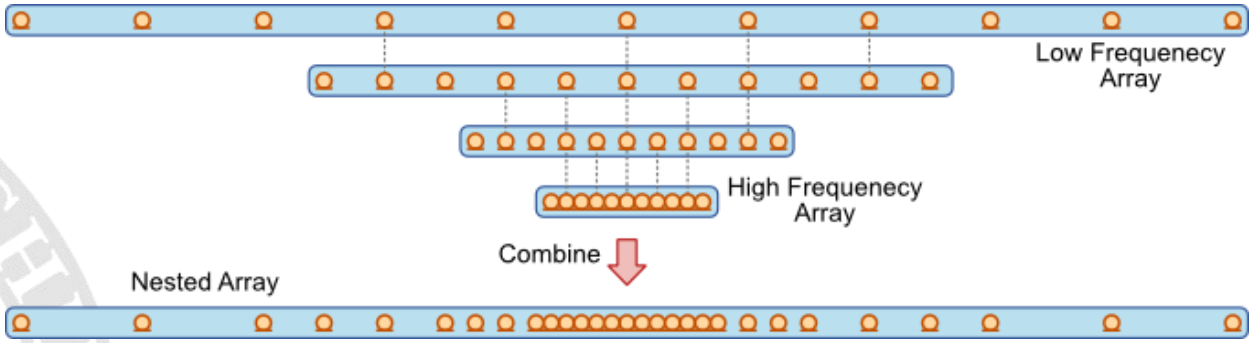


Directivity (dBi), Broadside at 0.00 degrees



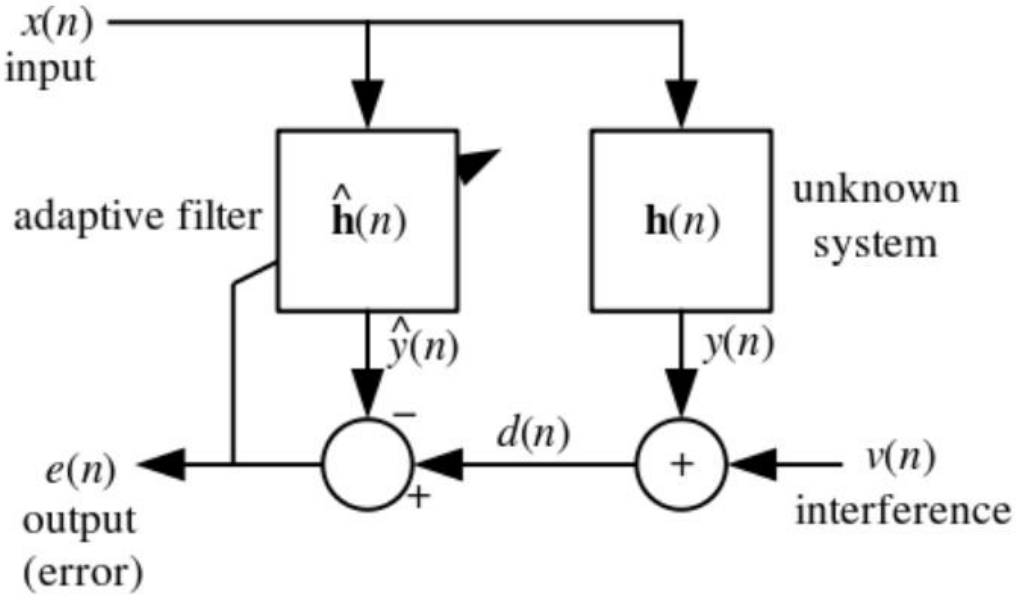
Directivity (dBi), Broadside at 0.00 degrees

Compound Mic Array

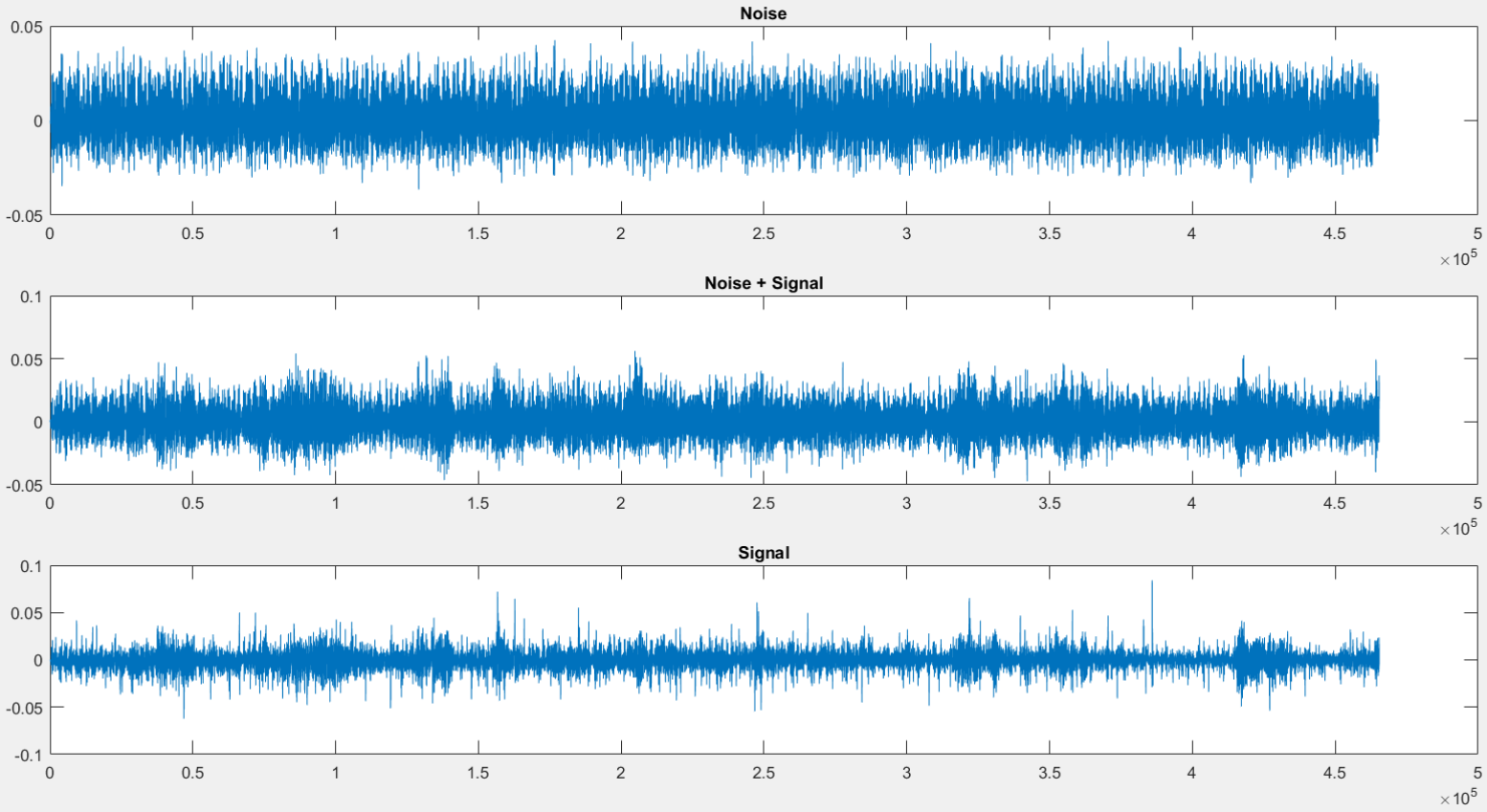


Noise/Interference Removal

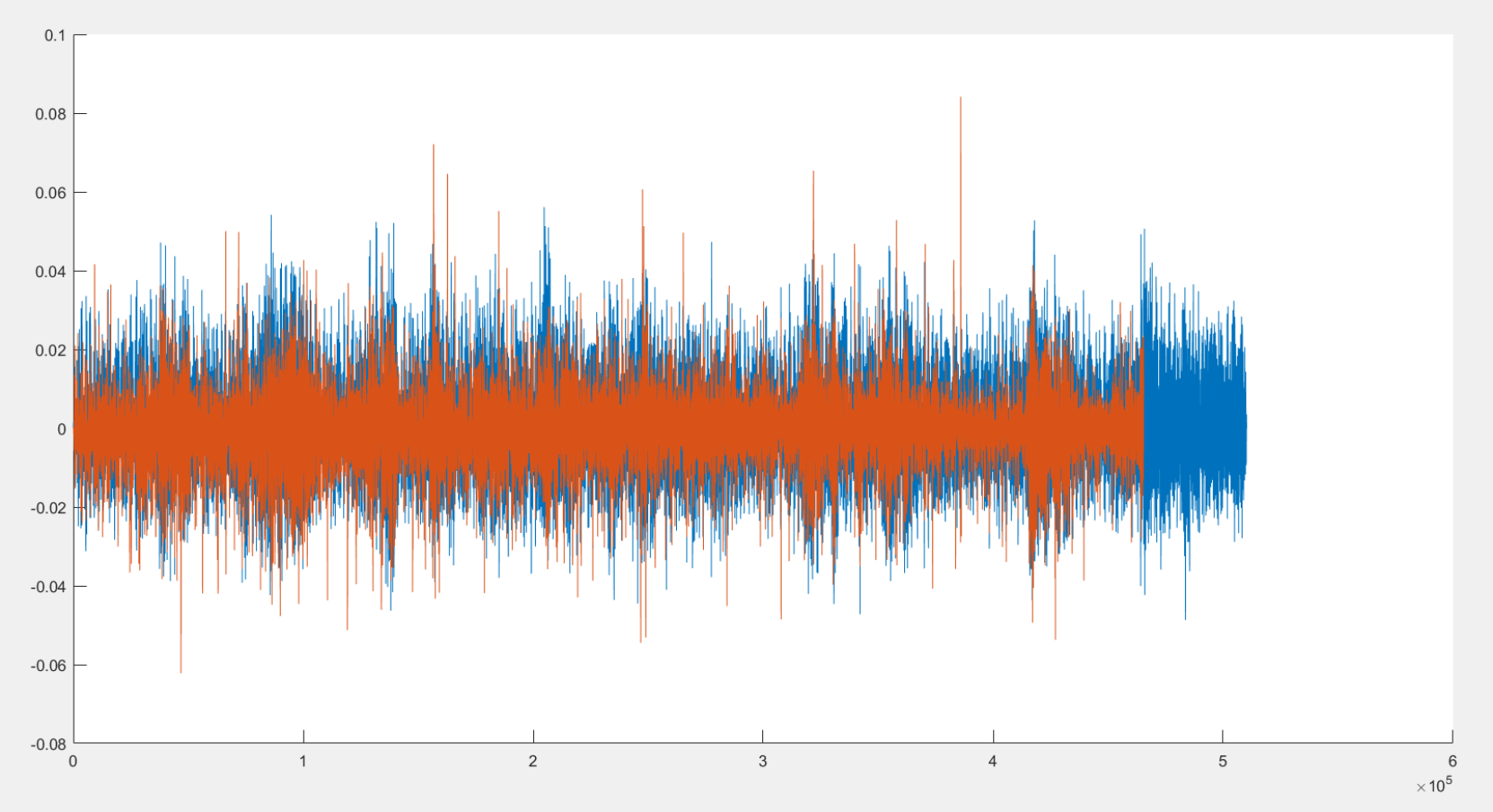
LMS Adaptive Filter



Noise/Interference Removal



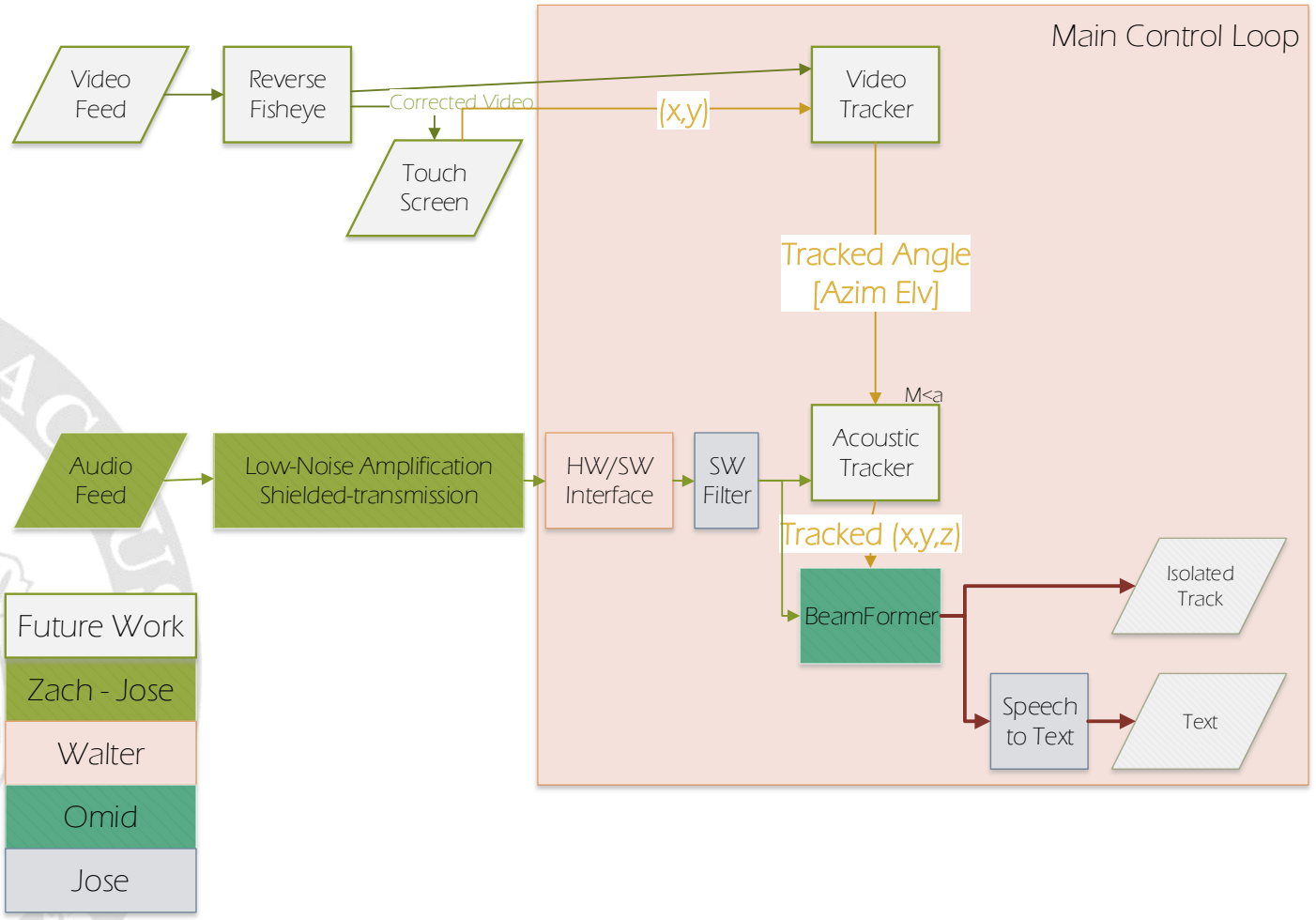
Noise/Interference Removal



Looking Forward

- End of Winter
  - Array Assembled, H/S Interface modified
  - Get Fish Eye
- End of February:
  - Database
- End of March
  - Video to Angle
- End of April
  - Video Tracking

Block Diagram (Current)



Block Diagram (Future)