Immersive Multitalker Remote Microphone System

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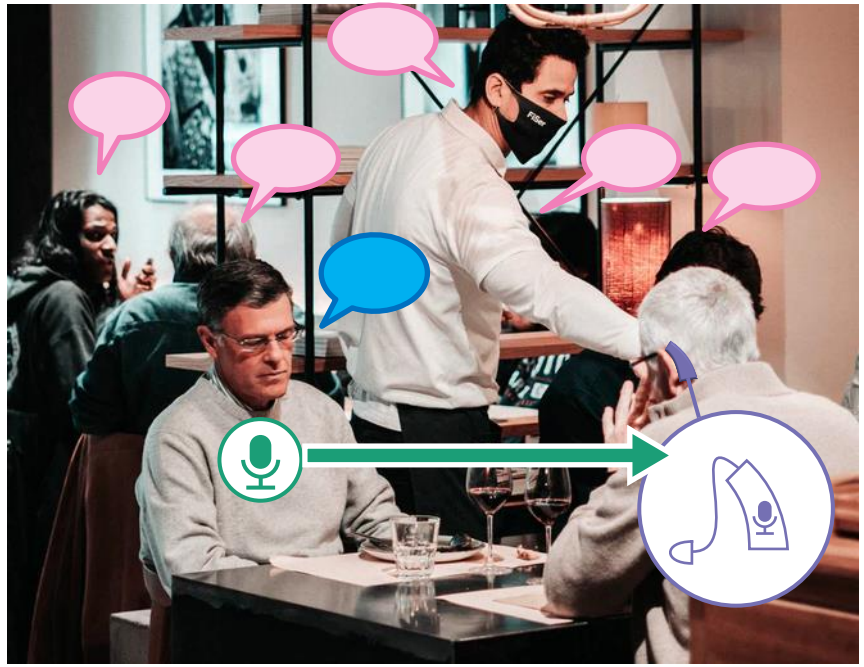
Remote Microphones

Problem: Hearing aids work poorly in noise



Remote microphone accessories:

- Transmit sound directly from talker to listener
- Best way to improve intelligibility in noise!

Limitations of current systems:

- Limited to one talker at a time
- Mono signal – no spatial cues or room acoustics

Widex

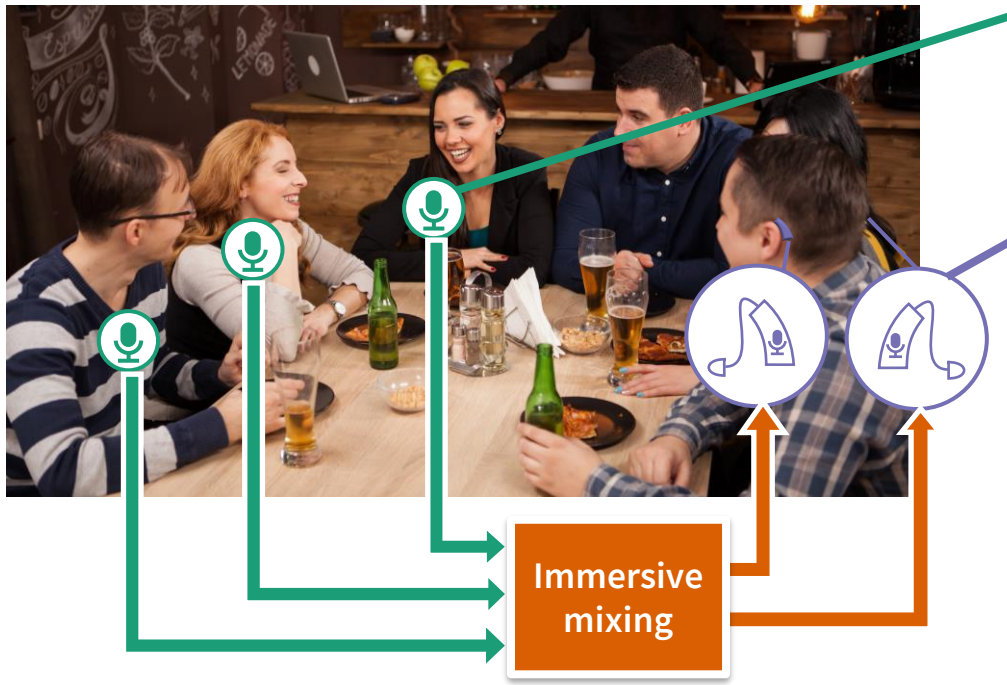
Starkey

Phonak

Remote Microphones

Goal: Immersive listening system for multiple talkers

- Multiple simultaneous talkers
- Preserve spatial cues
- Low background noise
- Track motion



Remote microphones
- ✗ No spatial cues
- ✓ Low noise

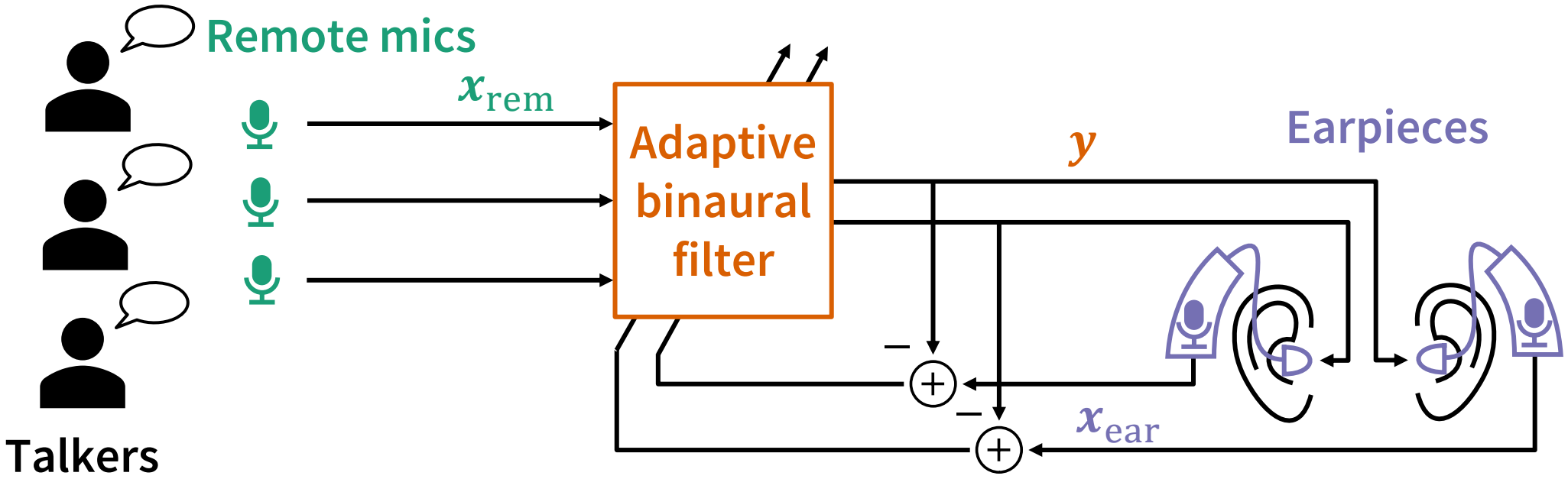
Earpiece microphones
- ✓ Spatial cues
- ✗ Noisy

Proposed system
- ✓ Spatial cues
- ✓ Low noise

Key idea:
Combine low noise of remote mics with spatial cues of earpiece mics

Adaptive Binaural Filter

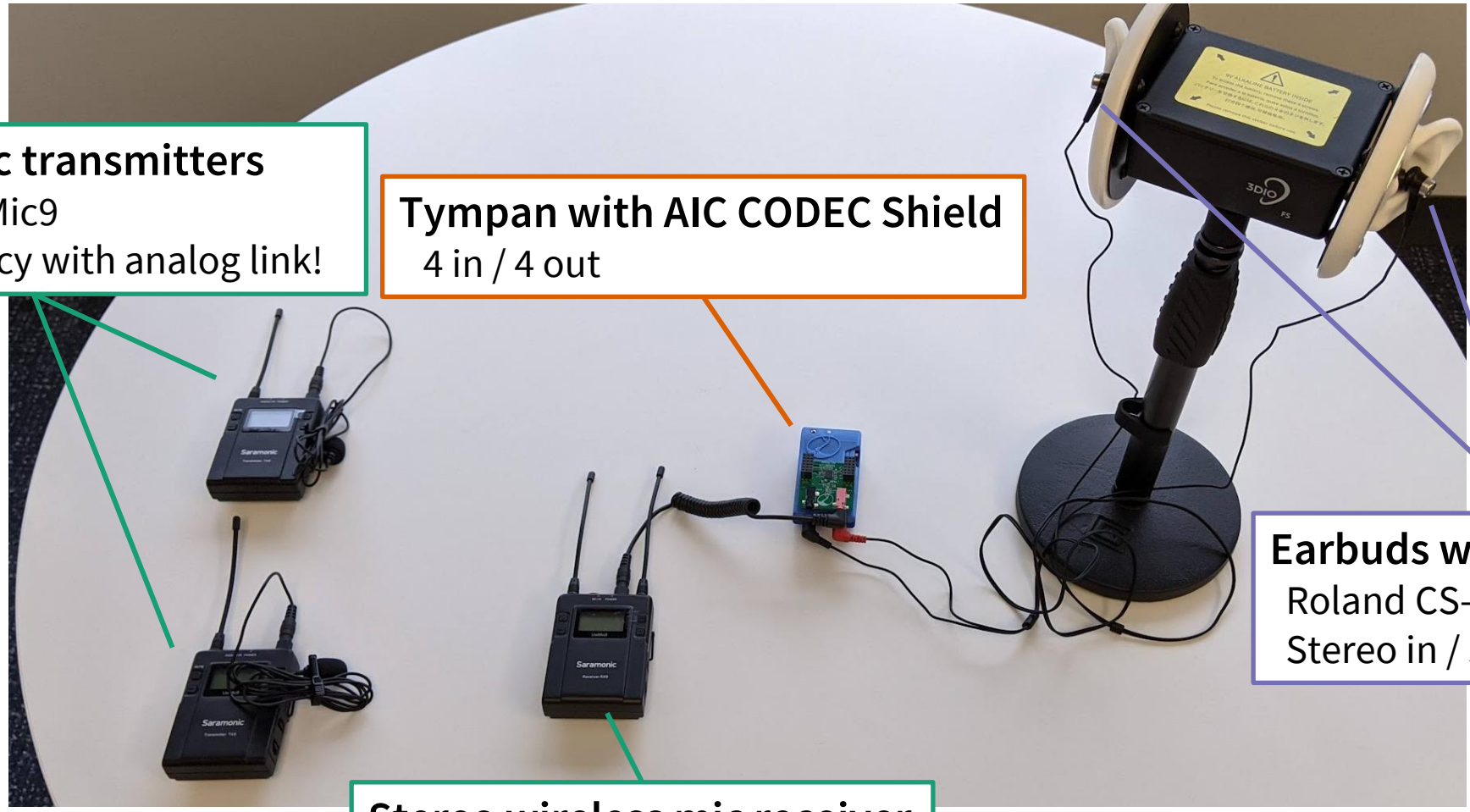
Solution: Filter remote mic signals to match magnitude & phase at earpiece mics



Filter adaptively minimizes error signal $|y - x_{\text{ear}}|^2$

R. Corey and A. Singer, "Adaptive binaural filtering for a multiple-talker listening system using remote and on-ear microphones," *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (WASPAA)*, October 2021.

Tympan Implementation



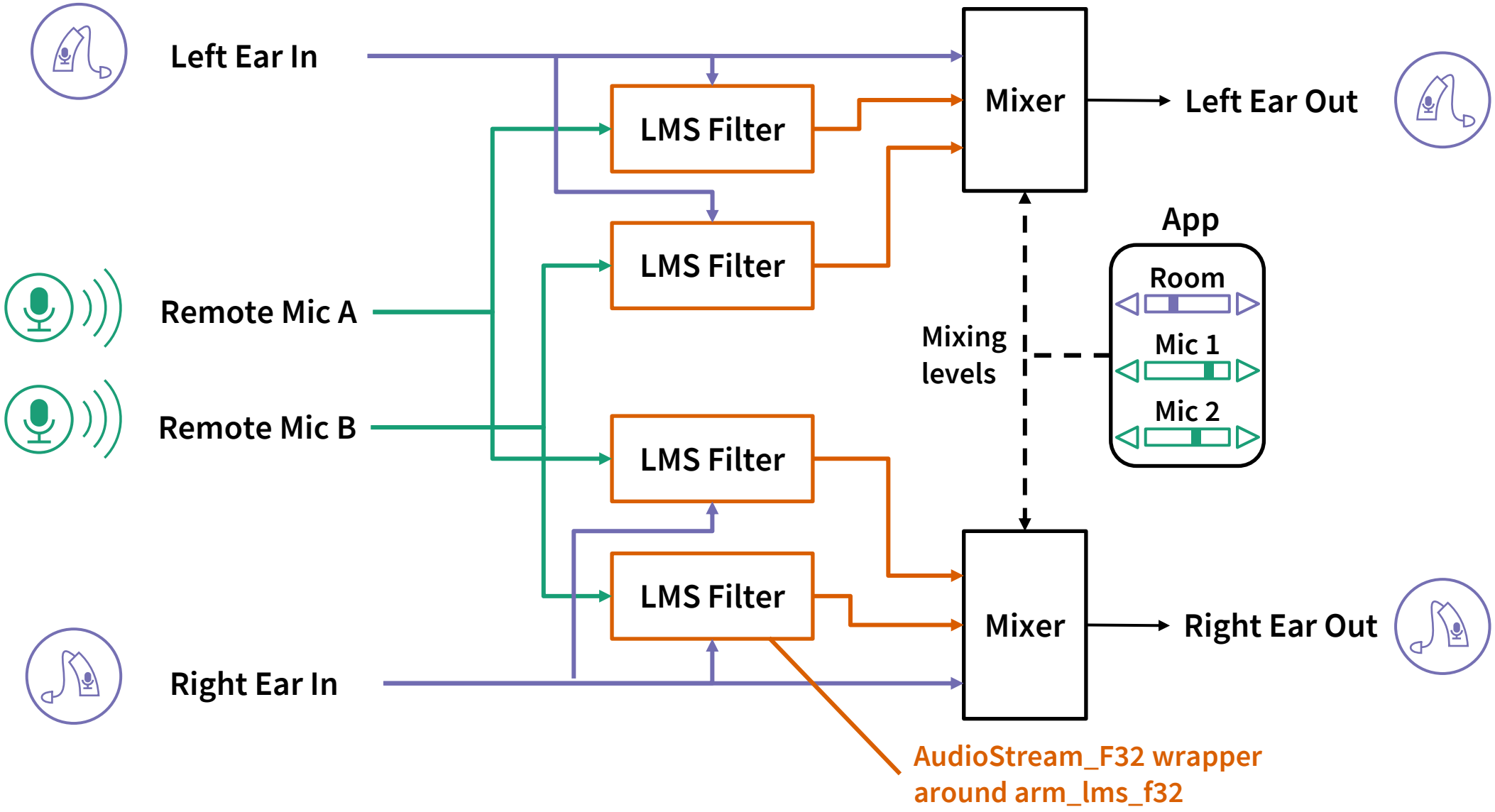
2x Wireless mic transmitters
Saramonic UwMic9
Near-zero latency with analog link!

Tympan with AIC CODEC Shield
4 in / 4 out

Earbuds with binaural mics
Roland CS-10EM
Stereo in / stereo out

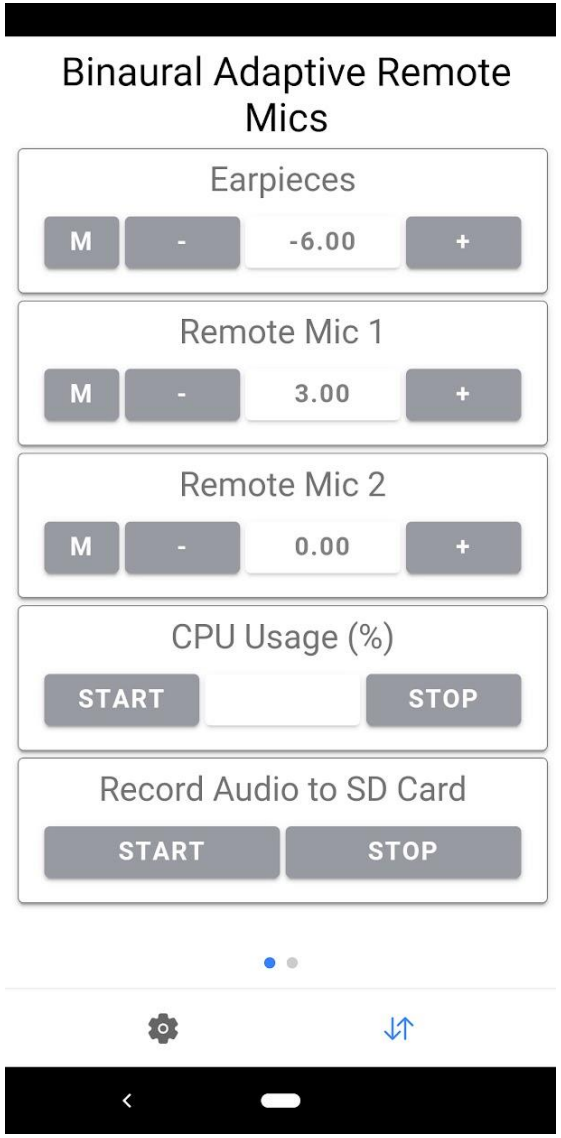
Stereo wireless mic receiver
Mic A → “left” channel
Mic B → “right” channel

Tympan Implementation



Tympan Implementation

- Rechargeable battery
  - First fully portable prototype I've built!
- Android app
  - User control of mixer levels
  - Performance monitoring
- Multichannel recording to SD card
  - Compare processed & unprocessed binaural signals
  - Quantify filter performance using known signals



Demonstration

Binaural demo

Best experienced with headphones

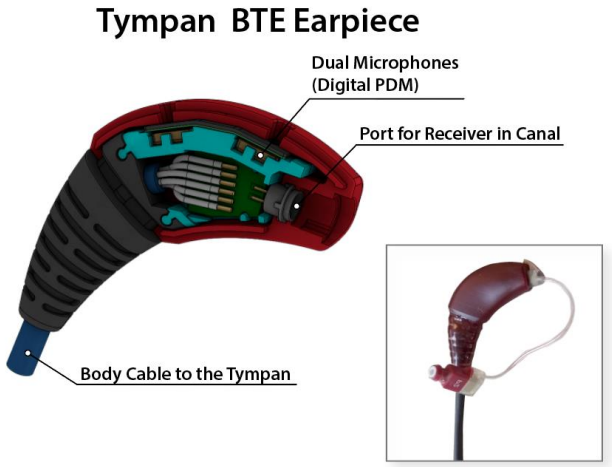
go.illinois.edu/AugmentedListening

Future Extensions

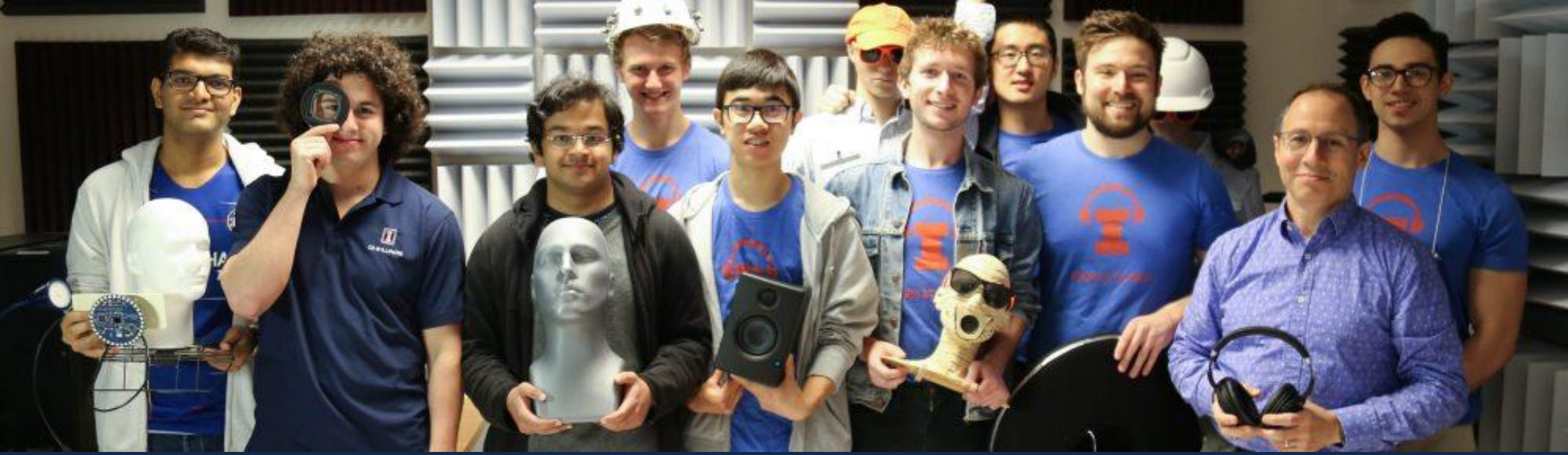
- Adaptive filtering improvements
  - Parameterized model using fewer coefficients
  - Refine adaptive filter for faster motion tracking
  - Multiple-input filter for arrays (see WASPAA paper)

- Hearing aid features
  - Frequency-selective gain, feedback control
  - Per-talker dynamic range compression

- Tympan BTE earpieces
  - Modify to work with external mics



github.com/Tympan



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