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Designing Remote Listening Experiments for the Partially Muted Word Impairment

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OVERVIEW

- Background
  - Intelligibility
  - Access Time Impairments
  - Motivation
- Remote Listening Experiments Design
- Current Experiments

QUALITY OF EXPERIENCE (QoE) MEASUREMENTS

- QoE KPIs for Mission Critical Voice (MCV)
  - Mouth-to-Ear Latency
  - Access Time
  - Voice Quality/Intelligibility
  - Probability of Successful Delivery
- Intelligibility
  - Describes whether information was actually received

INTELLIGIBILITY

- Modified Rhyme Test (MRT)
  - Used to test intelligibility of SCBA masks[1]
  - Batches of six words
    - *went, sent, bent, dent, tent, rent*
    - Words: consonant-vowel-consonant
    - Each batch: Either leading or trailing consonant varies
  - MRT Trial
    - Carrier phrase + word
    - "Please select the word *went*"
    - Success (identified) or Failure (mis-identified)
  - Over lots of trials, scores are generated
    - Score is value between 0 and 1
    - Corrected for guessing
  - High time cost

1: NFPA 1981 Standard on open-circuit self-contained breathing apparatus (SCBA) for emergency services (2007)

INTELLIGIBILITY

MRT: Standard Use Case Examples

Batch: *fun, sun, bun, gun, run, nun*
Distortion: Background noise + system

- Extreme
- Moderate
- Mild
- None

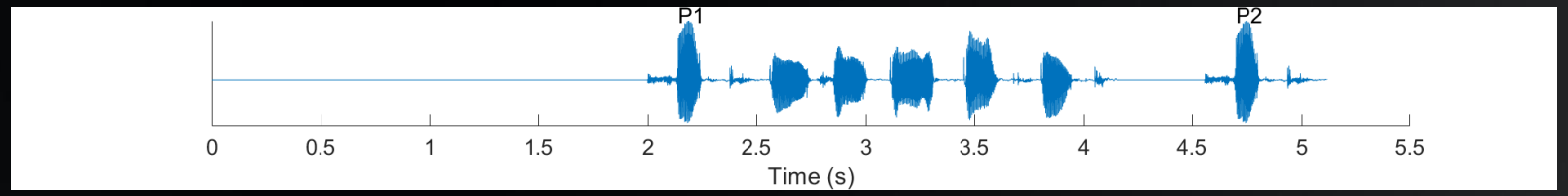
INTELLIGIBILITY

- Articulation Band Correlated Modified Rhyme Test (ABC-MRT)
  - Objective algorithm to provide estimates of true MRT scores
  - Most recent version is ABC-MRT16
  - Relies on temporal correlations within articulation index bands
    - Break speech into a “musical score”
    - Representation of speech in time and frequency
  - Costs: Cheaper and faster
    - Relatively low time cost
      - Can get estimated MRT scores “on demand”
    - Much lower infrastructure cost

ACCESS TIME MEASUREMENT CONCEPT

Audio Clips

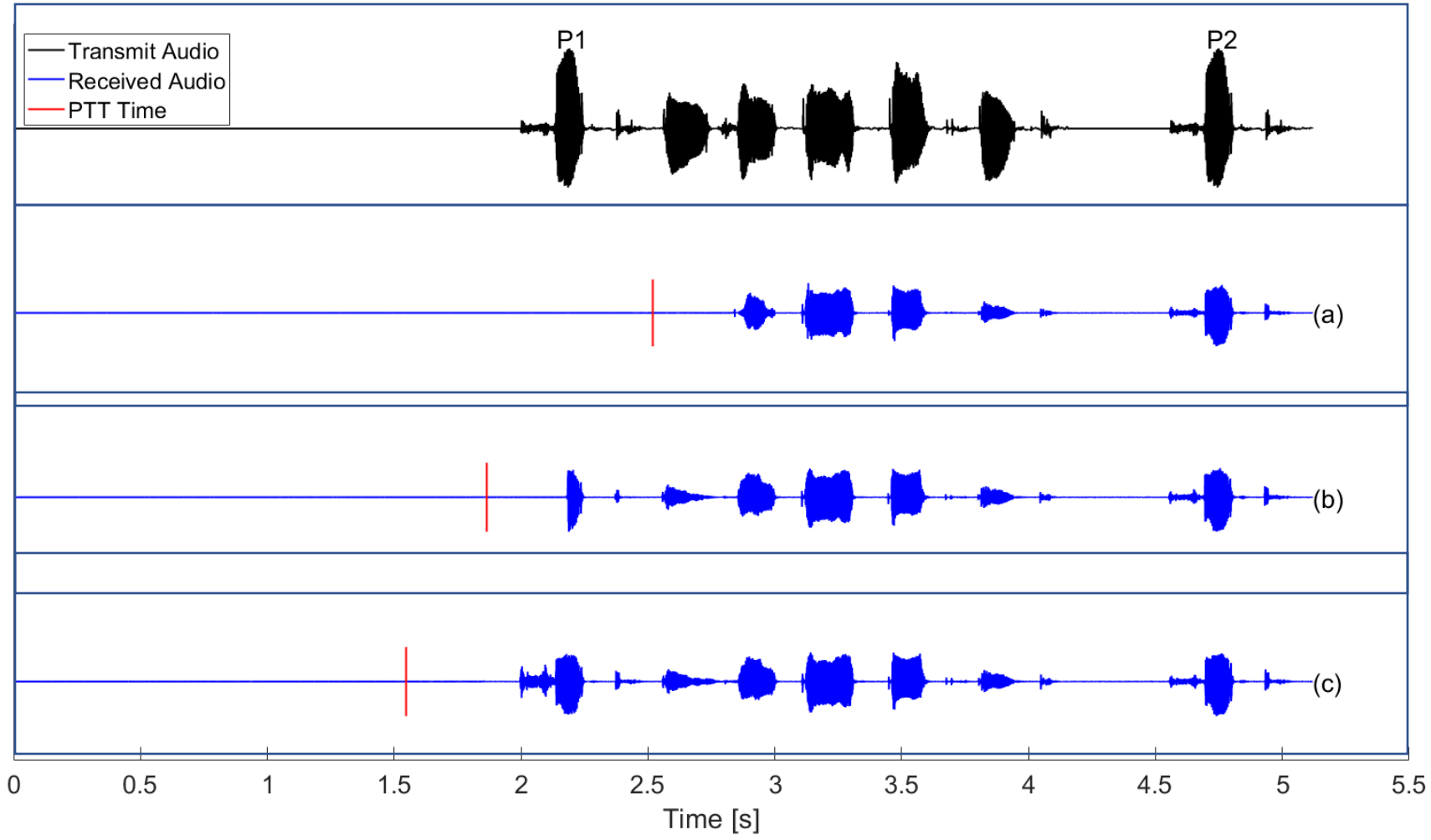
- Select single word from ABC-MRT16 database[1]
  - Use only words from batches where leading consonant varies
    - E.g. *went, sent, bent, dent, tent, rent*
    - Places majority of intelligibility emphasis on beginning of word
- Vary when PTT pressed in relation to start of this keyword
  - P1 – first play
  - P2 – second play
- P2 baselines word intelligibility
- P1 relates PTT time with intelligibility



1: Voran SD (2017) A multiple bandwidth objective speech intelligibility estimator based on articulation index band correlations and attention. 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp 5100–5104.doi: 10.1109/ICASSP.2017.7953128

ACCESS TIME MEASUREMENT CONCEPT

Intelligibility Examples: *hook*



MOTIVATION

- Partially muted words
  - An impairment ABC-MRT was not designed around
  - No human truth data to reference
- Existing audio
  - Hard to identify when MRT keyword is spoken within full MRT phrase
    - “Please select the word west”
    - “d-west”
  - Co-articulation in our audio
- Start over with new speech
  - Record carrier phrase and keywords separately

GOAL

- Design studies centered on partially muted word impairment
- Use audio with no co-articulation
  - Know exactly when a keyword starts

EXAMPLE RESULT

Batch: *thaw, law, raw, paw, jaw, saw*

Distortion: Partially muting of beginning of keyword

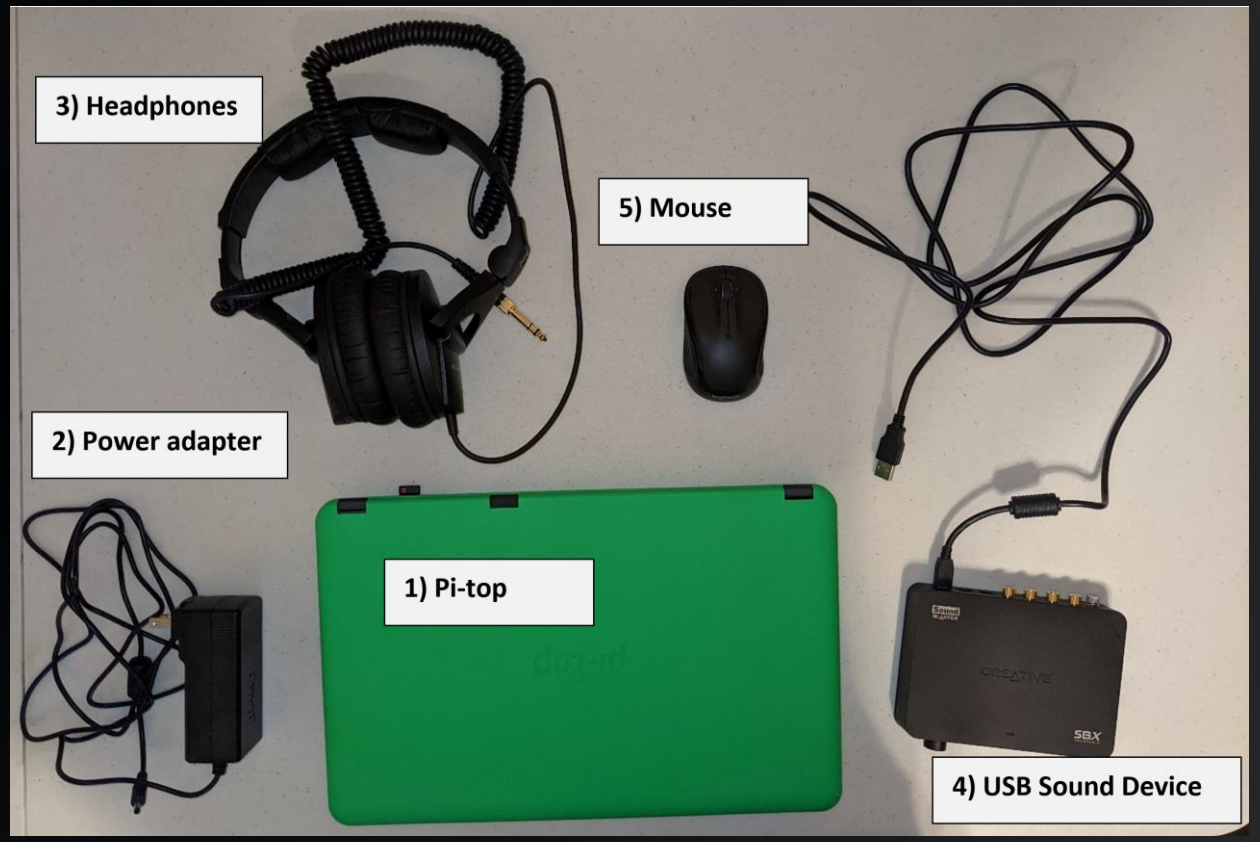
- Extreme
- Moderate
- Mild
- None

LISTENING EXPERIMENTS

- Normal controls
  - Environment ✗
  - Equipment ✓
- How to do that remotely?
  - Balance data quality vs time cost
  - Online Tool
    - Pro – Easier to run
    - Con – Variability in data quality
  - Dispersed Hardware Setup
    - Pro – Control data quality
    - Con – Time to run

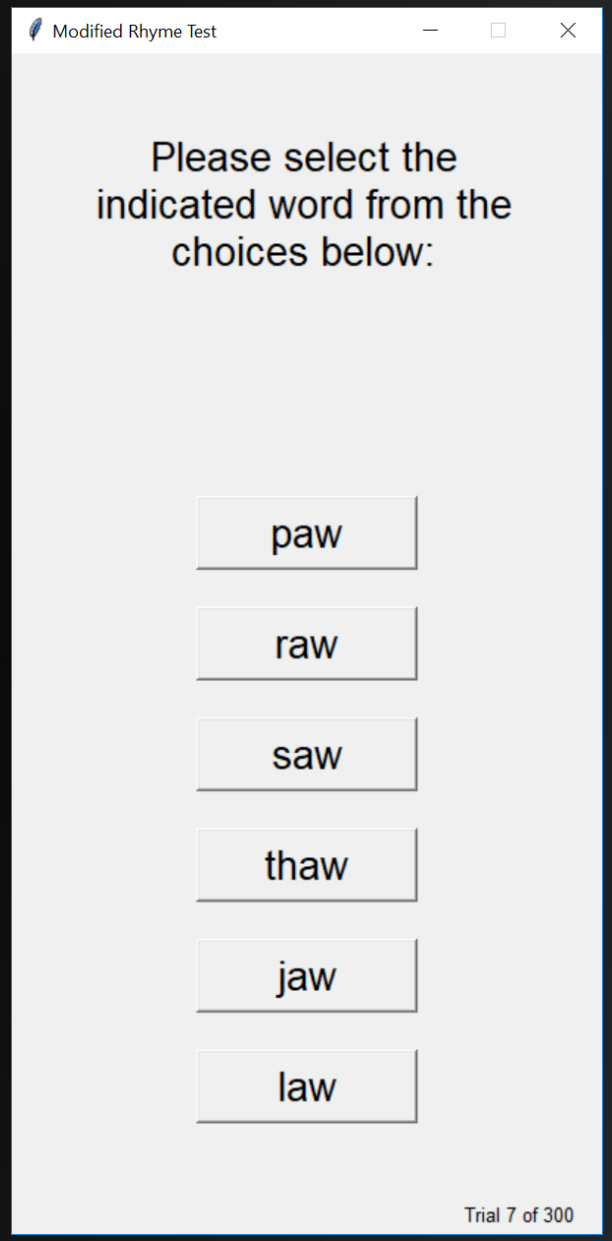
DISPERSED SETUP

- Hardware
  1) Pi-top – simple laptop enclosure for Raspberry Pi
  2) Power Adapter
  3) Headphones
  4) USB Sound Device
  5) Mouse
- Software
  - MRT GUI
  - Kiosk Design



MRT SOFTWARE

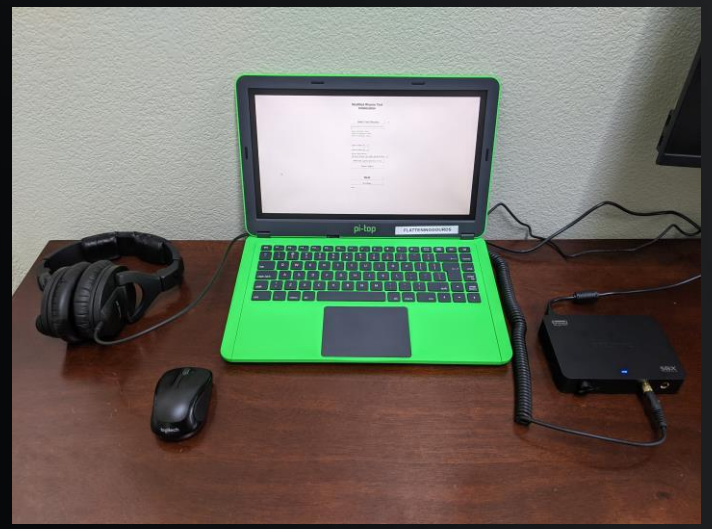
- Python MRT GUI
- In development
- Publicly available
  - https://github.com/usnistgov/mrt
  - Still in development
  - Has setup information for kiosk design



KIOSK DESIGN

- Want it to work, no matter the participant's background
- Does one thing: MRTs
  - Nothing more, nothing less
- Built on Arch Linux
  - Stripped down, easy configuration
- Uses openbox for desktop environment
  - Simple and configurable
- Locked down configuration
  - Auto start MRT GUI
    - Restart on close (test complete)
  - Force GUI on top
  - Disable keyboard shortcuts
    - Alt+F4 (window close)
    - Alt+tab (window switch)
    - Etc…
  - Disable desktop menu

SETUPS IN THE WILD



FUTURE WORK

- Three Stages of MRTs
- PTT Gate Critical Region Boundaries
- Cross-technology Critical Region Boundaries
- Critical Region Study

CONCLUSION

- Created dispersed MRT setup design
  - MRT setups useful in person as well
- Running dispersed MRTs
  - Capture data on access time specific impairments

RELATED PSCR 2021 SESSIONS

- Mission Critical Voice Quality of Experience Measurement Methods Overview
- Introducing a Start of Word Correction for Access Delay Measurements
- Measuring the Probability of Successful Delivery: a QoE Based Approach
- Optimal Transmit Volume Conditions for MCV QoE Measurement Systems
- QoE Software and Hardware Packaging
- QUARC: Quality Under Adjustable Realistic Conditions for Communication Systems
- Lab from Home: Distributed QoE Testing for Mission Critical Voice

QUESTIONS

- Looking forward to questions at our live Q&A session!

THANK YOU

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