1493: CCI-MOBILE: BILATERAL AND BIMODAL SYNCHRONIZATION WITH THE CI/HA RESEARCH PLATFORM

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1. INTRODUCTION

CCi-MOBILE Research Platform

- Supports synchronized bilateral electric and acoustic (EAS) stimulation for in-lab and in-field experiments for research with cochlear implants (CI) and hearing-aids (HA)

- Supports unilateral and bilateral CIs as well as bimodal configurations (EAS)
  - On-the-go signal processing adjustments
  - Plug-and-play system;
  - portable;
  - wearable

Fig 1. Hardware design and overview of CCi-MOBILE Research Platform.

- USB/Wi-Fi research interface configured to evaluate sound processing strategies (real-time or offline) and/or data collection for CI/HA
- Currently, only compatible with CIs manufactured by Cochlear Corporation (CIC4 implants)

Fig 2. In-field configuration with CCi-MOBILE and Android phone.

2. EXPERIMENT

- CI24RE Implant Emulator and audio LINE_OUT was used to analyze synchronization of channels on the oscilloscope based on two case scenarios
- **Case-1:** Acoustic delay; **Case-2:** Synchronized (no delay)

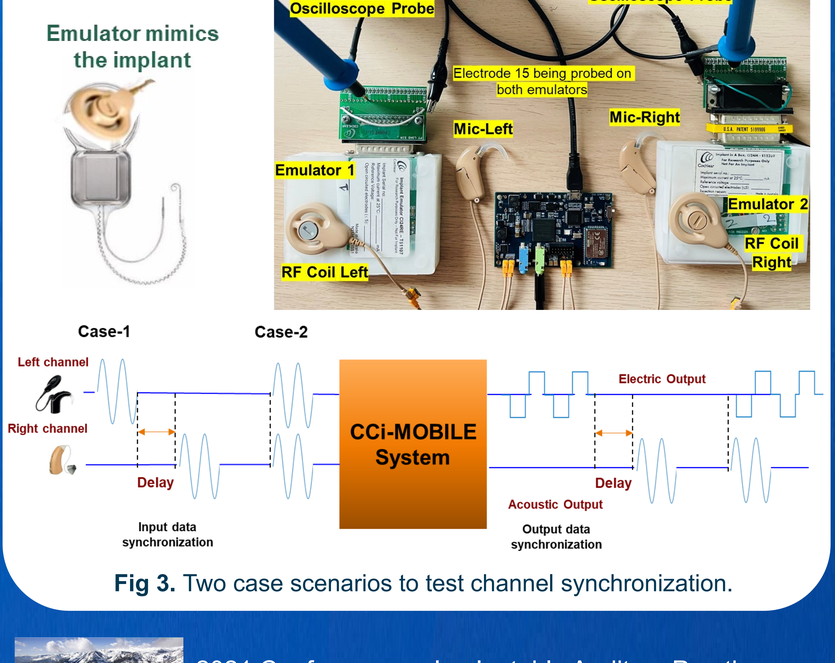


Fig 3. Two case scenarios to test channel synchronization.

3. STIMULATION MODES

- CCi-MOBILE Stimulation modes supported are:
  1. **Unilateral:** CI in one ear and normal hearing for contralateral ear; requires 1 output channel
  2. **Bilateral:** CI in both ears; requires 2 output channels (**time synchronized**)
  3. **Bimodal:** CI in one & HA for contralateral ear; requires 2 output channels (**time synchronized**)

Unilateral/Bilateral Stimulation

- Unilateral stimulation mode requires one stream of output: left or right
- Bilateral stimulation mode requires both output channels to be synchronized (across left and right) to maintain localization of incoming sound

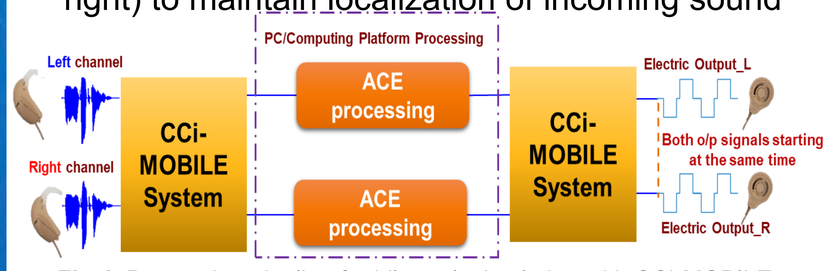


Fig 4. Processing pipeline for bilateral stimulation with CCi-MOBILE.

Bimodal Stimulation

- Bimodal stimulation has 2 synchronized output channels generating an electric out (for CI) and acoustic stimulation (for HA) simultaneously

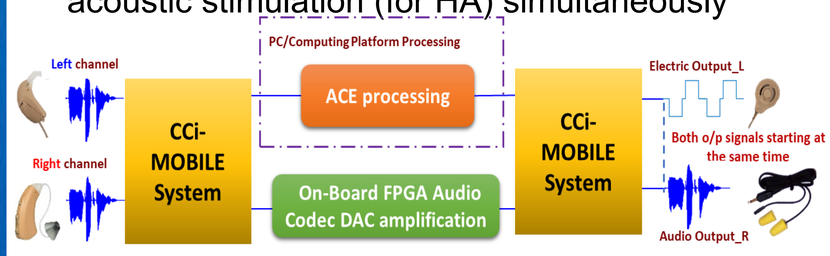
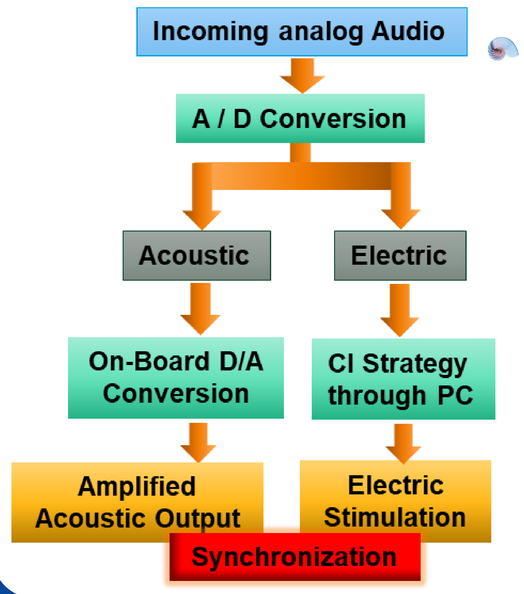


Fig 5. Processing pipeline for bimodal stimulation with CCi-MOBILE.

Stimulation Processing

- Acoustic channels need an extra D/A conversion and amplification through the on-board CODEC, whereas the electric outputs are generated through the PC which and delivered to RF output



- FPGA must ensure proper time delays to maintain relative time synchronize in L&R channels for different processing times

Fig 6 (left). Different channel processing pipelines for synchronization in bimodal stimulation mode.

4. RESULTS (VALIDATION)

- Stimulation rate for each experiment was maintained at 1Khz, with a pulse width of 25μs and probing on electrode 17 of the emulator
- Both cases verified and validated (results below)

Case 1: Externally induced Acoustic delay

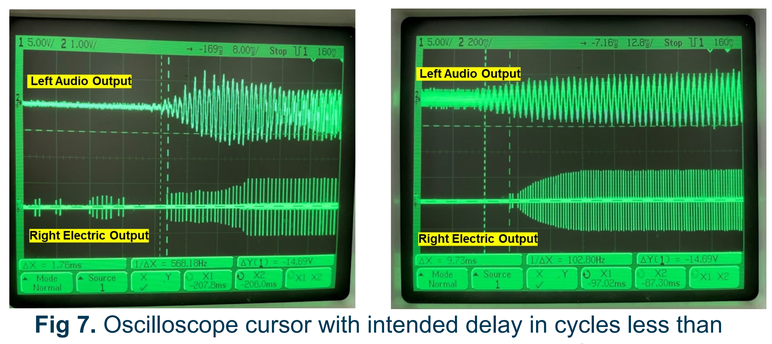


Fig 7. Oscilloscope cursor with intended delay in cycles less than 10ms in the right output channel in bimodal configuration.

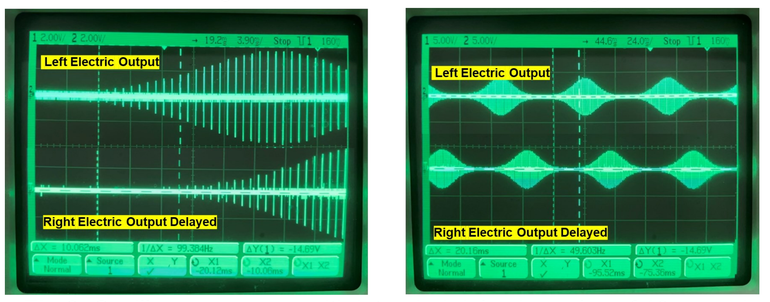


Fig 8. Oscilloscope cursor with intended delay in cycles of 10ms and 20ms respectively to demonstrate both the left and right output channels in bilateral configuration (CIs-only).

Case 2: Synchronized (no delay)

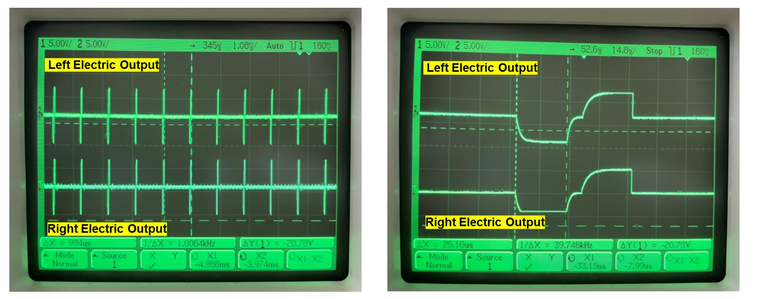


Fig 9. Oscilloscope cursor aligned for both left and right RF output channels in bilateral configuration (CIs-only).

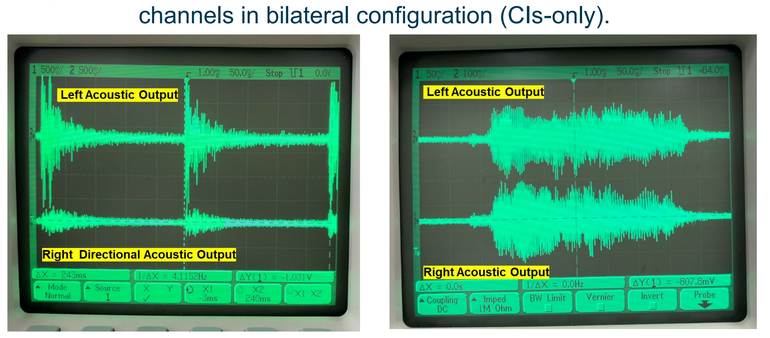


Fig 10. Oscilloscope cursor aligned for both left and right acoustic (LINE_OUT) output channels in bilateral configuration (HAs-only)

5. CONCLUSIONS

- CCi-MOBILE as a research platform performs as effective as industry manufactured CIs and HAs; provides researchers flexibility towards algorithm development (e.g., ensures time synchronization for L&R processing in bilateral, bi-modal research)
- **Website:** https://crss.utdallas.edu/CILab/

2021 Conference on Implantable Auditory Prostheses
Lake Tahoe, CA (Virtual), July 12 – 16, 2021

This work was supported by the grant R01DC016839 from the National Institutes of Health, National Institute on Deafness, and Other Communication Disorders