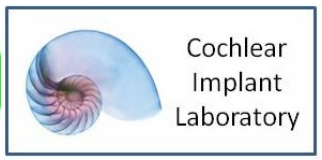
Mobile Research Interface for Cochlear Implants

Hussnain Ali, Feng Hong, Jun Wang, John H.L. Hansen

Cochlear Implant Laboratory, Center for Robust Speech Systems (CRSS-CILab)

Department of Electrical Engineering

The University of Texas at Dallas - USA



Overview

2012 (yesterday)

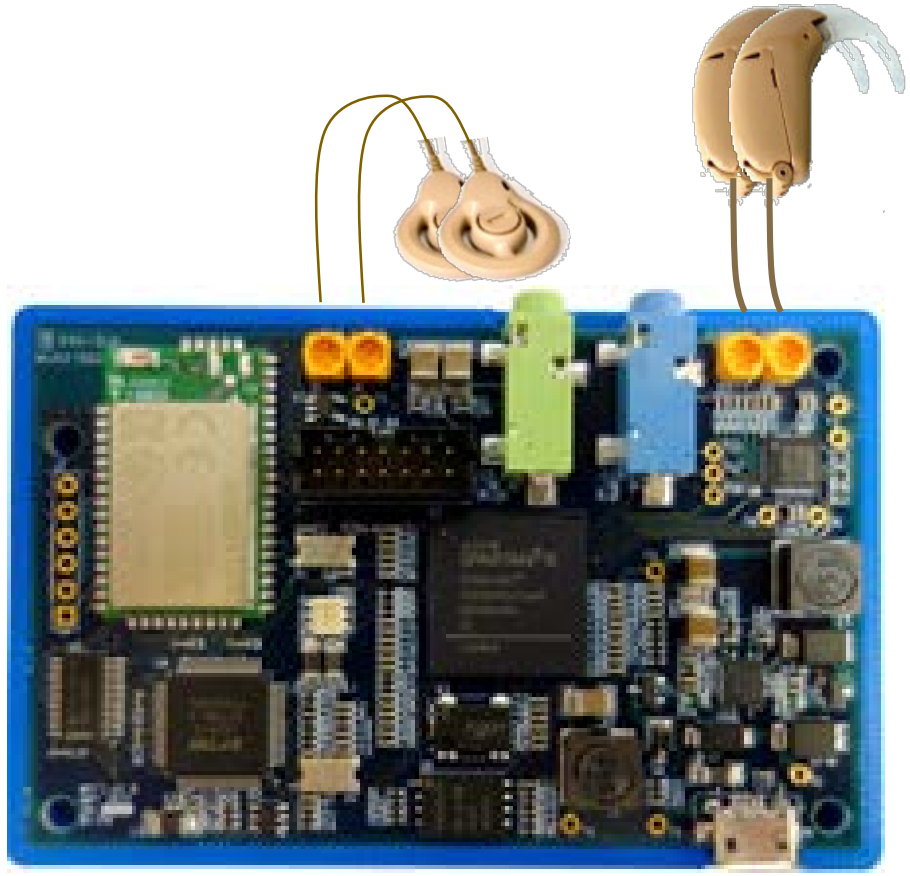
PDA-based
SDIO interface

2016 (today)

Smart Phone/Tablet-based
USB/Wi-Fi interface

CI2016 TORONTO

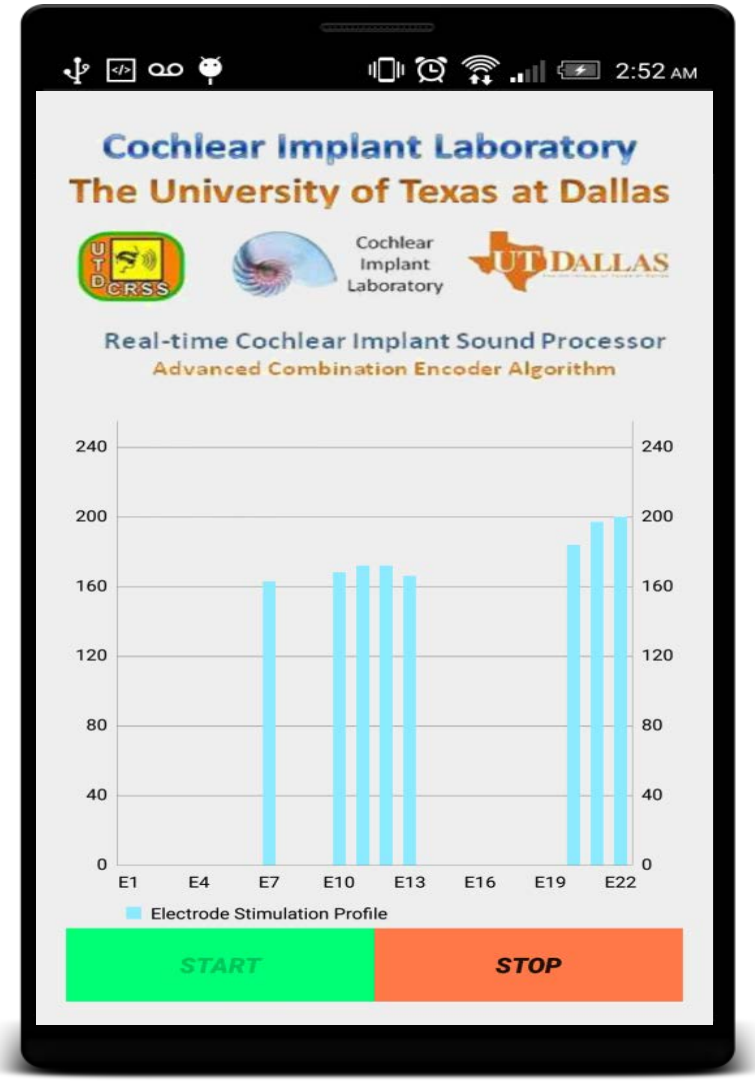
Overview



UTDallas CRSS-CILab
Interface Board

Wi-Fi

USB



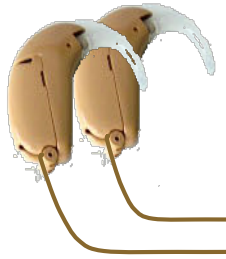
Processing Unit

CI2016 TORONTO

High-level Diagram

Acoustic Signal

Microphone
(BTE)



Interface Board

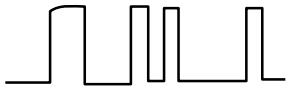
EEPROM

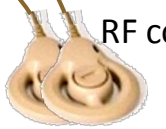
A/D audio codec WM8983

FPGA
Xilinx Spartan XS6LS45

WLAN + USB Interface
WF121 + T2232H

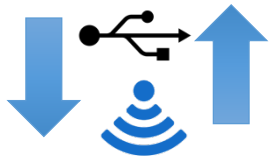
RF Bursts





RF coils

Digitized acoustic signal

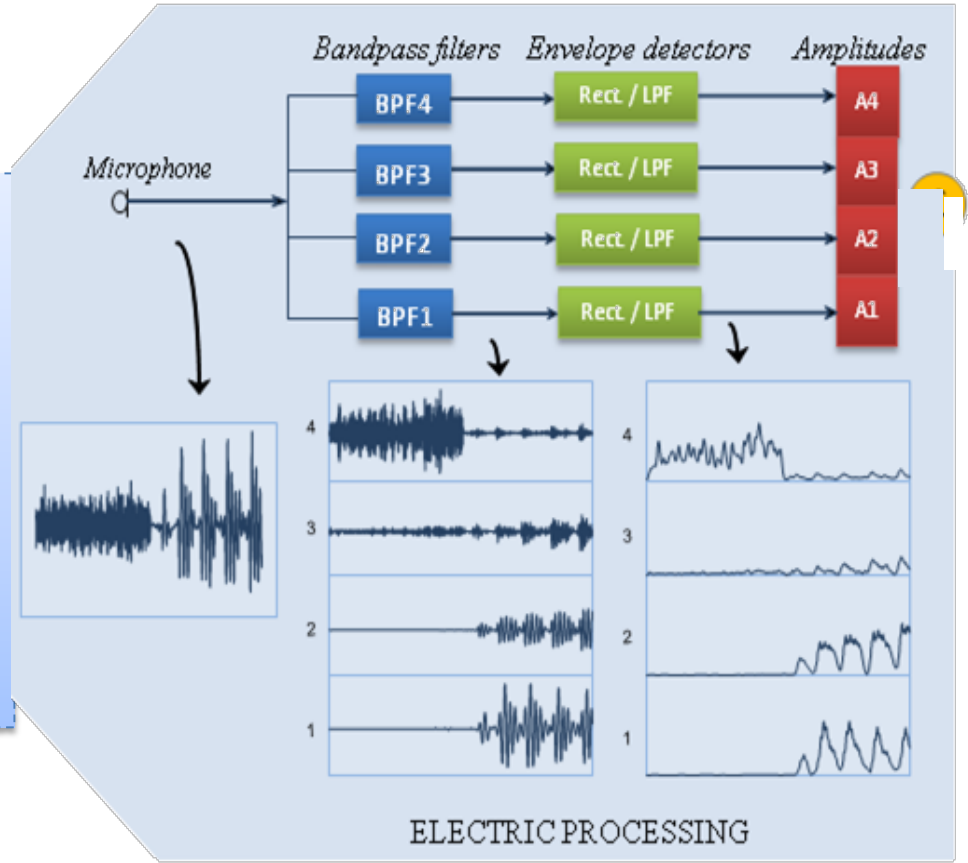


Processed stimuli data

Smart-phone

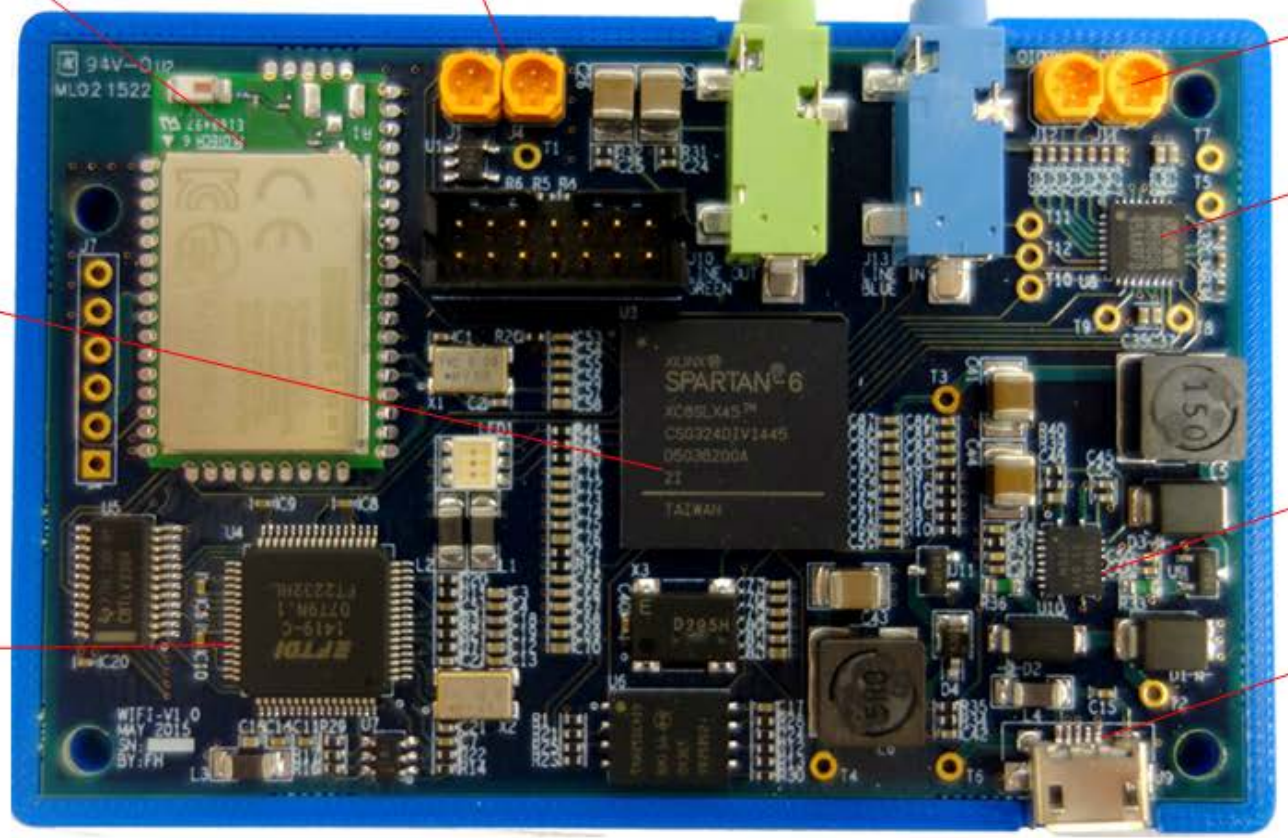
Computing Platforms/Signal Processor

Processing



CI2016 TORONTO

Hardware – Interface Board



Bilateral RF output

Audio I/O ports (3.5mm)

Wi-Fi Transceiver

Custom Audio connectors (L/R)

Audio CODEC

FPGA

Power Management Circuitry (PMC)

Serial USB-UART

USB port

Features

- Supports **unilateral**, time-synchronized **bilateral** stimulation
- Electric alone and electric + acoustic stimulation (EAS).
- Supports two operational modes:
  - **Real-time:** Similar to a clinical body-worn processor to conduct experiments in free field. Smartphone/tablet acts as a processor. Suitable for take-home field trials.
  - **Bench-top:** allows platform to be used in bench-top (offline) mode to conduct experiments in laboratory (e.g., using MATLAB) for acute studies.
- Flexibility in implementing sound coding algorithms as Apps
- Programming flexibility – MATLAB, C, C++, JAVA, C#, LabView
- Wireless (Wi-Fi) link + USB interface.
- Idea can be extended to iphones, windows-based phones/tablets

CI2016 TORONTO

Available Software Suite (UTDallas, CRSS-CILab)

MATLAB – based processing in real-time

Android-based apps for field trials

CI2016 TORONTO

Evaluation

- Six post-lingually deafened adult CI users
- Assessment of speech recognition accomplished with adult minimum speech test battery (MSTB) for adult CI recipients.
- Clinical Processor(s) – Free field evaluation
- CCI – RT Processor (PC) – Free filed evaluation

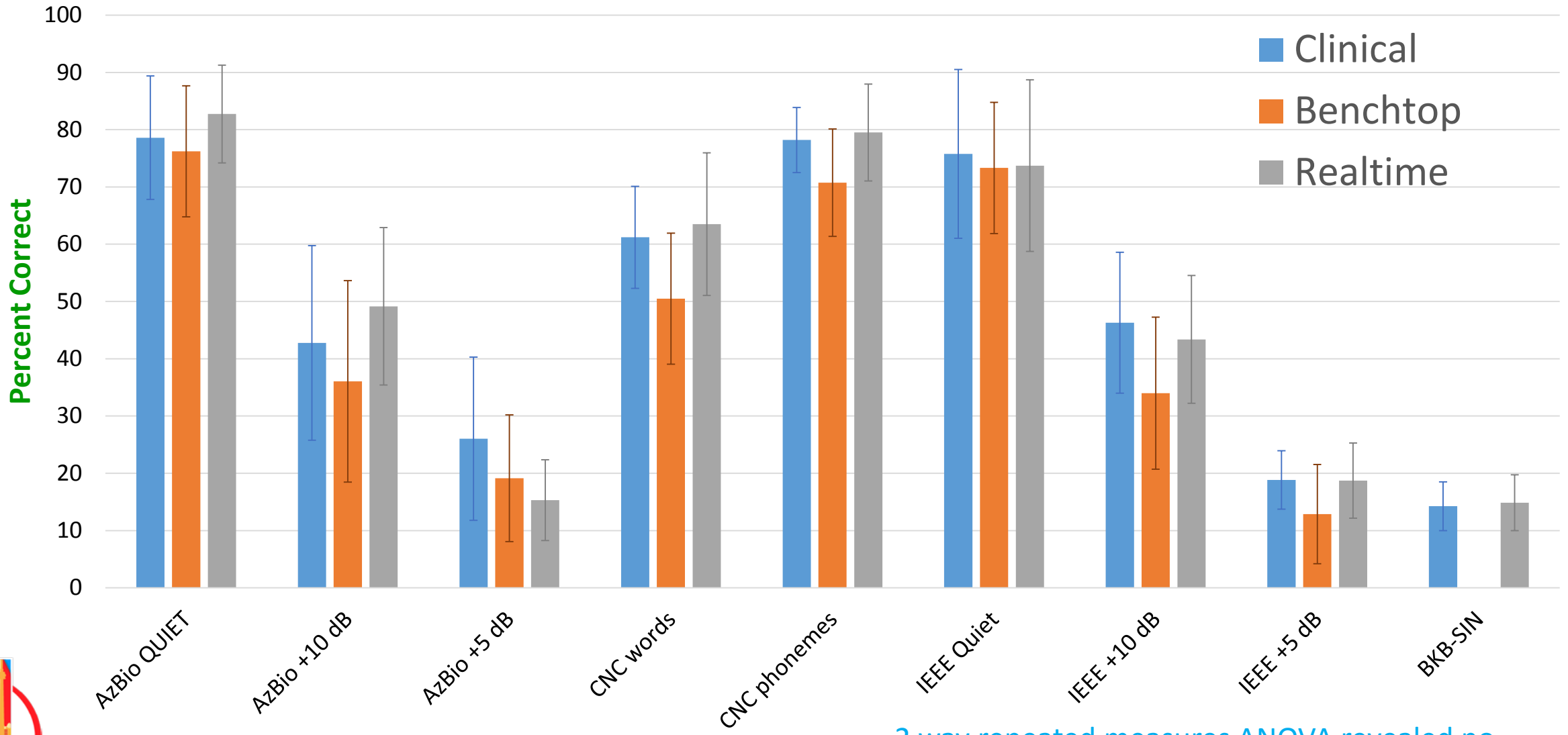
} 60 dB SPL in a double-walled sound-booth

- CCI – Benchtop Processor (PC) – Direct Connect mode
- All devices were programmed with ACE sound coding strategy

Subject ID	Gender	Age (yrs)	Implant + Processor	Configuration	# of electrodes	Implant experience
S1	F	62	CI512 + N5	Unilateral	20	7 yrs
S2	F	63	L: CI512 + N5 R: Freedom CI24RE CA + N5	Bilateral	L: 22 R: 20	L: 5 yrs R: 4 yrs
S3	M	52	Freedom CI24RE + N5	Unilateral	21	5 yrs
S4	M	75	L: CI512 + N5 R: CI512 + N5	Bilateral	L:21 R: 22	L:2 yrs R:3 yrs
S5	F	60	L: Freedom CI24RE CA + N6 R: Freedom CI24RE CA + N6	Bilateral	L: 22 R: 22	L: 6 yrs R: 5 yrs
S6	M	72	L: Freedom CI24RE CA + N5 R: Freedom CI24RE CA + N5	Bilateral	L: 22 R: 22	L: 6 yrs R: 2 yrs

CI2016 TORONTO

Results



2 way repeated measures ANOVA revealed no significant difference between processor types

CI2016 TORONTO

Conclusions and Future Directions

- Flexible research interface developed to carry out a wide variety of acute and chronic experiments.
- Supports easy development and quick evaluation of new research ideas without learning advanced programming skills.
- Results from preliminary study indicate equivalent performance to the clinical processor; ensures reduced/limited platform impact.
- CRSS-CILab will distribute the platform to research laboratories.
- CRSS-CILab will extend idea to iphones, & mobile widows-based systems.

CI2016 TORONTO

This work was supported by NIH/NIDCD grant number: R01 DC010494