Mobile Research Platform for Hearing Research

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***Abstract* — The societal need for assistive hearing devices for users with hearing loss has increased exponentially over the past two decades; however, actual human speech recognition performance with such devices has only seen modest gains relative to the pace of actual digital signal processing (DSP) technology. A major challenge with clinical hearing technologies is the limited ability to run complex signal processing algorithms which would require powerful DSPs at the source. The CCi-MOBILE platform, developed by our center at UT-Dallas, provides the research community with an open-source, software-flexible, and powerful computing research interface to conduct listening studies with either/both hearing-aids and cochlear implants. The platform uses commercially available smartphone/tablet devices as portable sound processors, and is able to provide bilateral electric and acoustic stimulation.**

I. Introduction

According to the World Health Organization, 5% of the world's population have disabling hearing loss (HL) [1]. HL is the most common birth defect in developed countries, and 3.5 per 1000 children have permanent significant hearing loss [2]. In the United Sates alone, the percentage of individuals impacted by HL ranges from 15% in school-age children (ages 6-19) to about 33% at 65 years of age [3]. Assistive hearing devices, such as hearing-aids (HAs), bone-conduction devices, and cochlear implants (CIs), are some examples of the pervalent technology that can help provide/improve hearing sensation. Success of this technlogy, to a vast extend, depends on effectiveness of sound processing and presentation of stimuli to the human auditory system. In this regard, improvements in sound processing technology have played a critical role in the advancement of assistive technology. Hearing scientists generally rely on research tools/interfaces to conduct perceptual studies with assistive devices. However, research interfaces commonly provided by the manufacturers either have limited functionalities or are not suitable for conducting a broad range of experiments. Computing limitations, portability, and ease of programmability limits the use of existing research interfaces. Our center (CRSS-CILab) over past ten years has been involved in the development of portable research platforms/tools for speech and hearing research [4]. Our latest advancements have been to leverage the computing capabilities of emerging smartphones and tablets for sound processing needs. The platform in its current form is an open-source, software-flexible, and a highly re-configurable system that enables research community to conduct acute and chronic studies with assistive hearing devices to assess true potential of novel sound processing strategies in real-world acoustic situations.

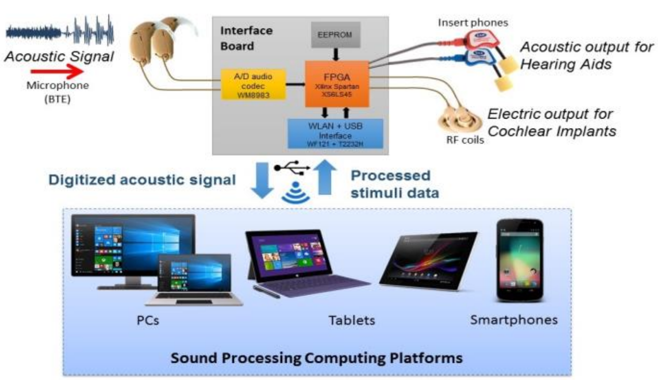

Fig. 1. High-level description of the CCi-MOBILE research platform.

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II. Research Platform

The research platform comprises of a custom-built interface board that interfaces with Behind-the-Ear (BTE) microphone units, HA transducers, and radio-frequency coils (to provide electric stimulation to CIs). Sound processing is carried out on commercially available computing devices, such as personal computers, smartphones, or tablets which connect with the interface board via a USB cable or wirelessly over Wi-Fi. The functional diagram of the platform is shown in Fig. 1. The digital acoustic signal is sampled from BTE units and transmitted to the computing platform where it is processed via a sound processing strategy. The resulting stimuli data is then transmitted back to the board to drive HAs and CIs. Such a system enables the implementation and assessment of custom sound processing algorithms with human subjects with great ease. The platform provides unilateral and time-synchronized bilateral electric and acoustic stimulation, providing the opportunity for both laboratory-based as well as take-home field evaluations. This flexibility opens new possibilities to conduct a diverse range of studies with assistive hearing devices, including long-term evaluation of speech processing algorithms, noise-reduction strategies, psychophysics, and user-specified 'on-the-go' customization, etc., making it a powerful tool to realize scientific ideas that were not traditionally possible under traditional laboratory development and testing paradigms.

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