CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

33786

Project Title

EEG Cortical Signal Acquisition System for Automatic Artifact Removal, Evaluation, and Monitoring of Cochlear Implants

Abstract

Objectives/Goals

The electrical stimulation from a cochlear implant (CI) must be fine-tuned (fitted) regularly by an audiologist for each individual user. Recent research has shown that it is possible to objectively assess CI performance by measuring neural responses of the cortex to a sound stimulus using an electroencephalogram (EEG) system. However, this EEG system has not been optimized for CI applications. The purpose of this project is to determine the minimum system requirements for a CI-specialized EEG system to accurately measure the cortical evoked potentials from the brain and filter out the large electrical artifact from the CI.

Methods/Materials

For the hardware component, I designed and implemented a single-stage differential amplifier circuit and a low-pass filter and combined these with a sound card found in computers to create a simple, low-cost EEG system. On the software side, I wrote computer software in the MATLAB programming language to control the experiments and to collect, display, and analyze the data. An expensive, professional-grade system (~$5000, 4 stage differential amplifier and 3 stage band-pass filter) was used as the baseline. For each experiment, I sampled the average of two hundred N100 neural response signals to a 300ms tone at 1000Hz.

Results

The results showed that the simple, low-cost EEG system (<$50, 1 stage differential amplifier and 1 stage low-pass filter) is able to measure cortical evoked potentials in CI users. It can remove the large CI-induced electrical artifact obscuring the neural response and yield comparable data to the expensive, professional-grade EEG system.

Conclusions/Discussion

This EEG system has two significant advantages over the professional-grade system. First, its low cost allows it to be accessible to CI users and small audiology clinics. This system can be used at home by CI users to monitor the functionality of the implant and to objectively track the user#s hearing development. The system will also allow parents of infant CI users to ensure that the CI is functioning properly and that the child#s auditory system is developing normally. Secondly, its simplicity in design allows the system to be much more compact than existing models, paving the way for future developments to integrate the EEG data acquisition system into the CI itself to create a closed-loop, self-monitoring, and self-fitting system.

Summary Statement

This project determines the minimum requirements for an EEG system specialized for cochlear implant (CI) applications to remove CI-induced electrical artifact and measure neural responses of CI users to objectively assess CI performance.

Help Received

Dr. Myles McLaughlin assisted in writing the computer software in the MATLAB programming language; Used lab equipment in the Hearing and Speech Lab at the University of California, Irvine under the supervision of Dr. Fan-Gang Zeng and Dr. Myles McLaughlin.