CREmedical
Real Physiology You Can Trust

No-Prep Electrodes and Cap for Portable EEG System

URI ELE480 Capstone Design Project, 2015-2016

Company

At CREmedical, we invent new technologies that help us understand the brain and diagnose and treat brain disorders. CREmedical was co-founded by Dr. Walt Besio, a URI biomedical engineering professor and the inventor of tripolar concentric ring electrodes (TCRE), TCRE based electroencephalography (tEEG), and transcranial focal electrical stimulation (TFS). CREmedical turns inventions into products that help relieve disease, disability, pain and suffering.

Introduction

Electroencephalography (EEG) is currently the most important noninvasive method for investigating neural activity of the brain. EEGs are extensively used in both the clinic and the lab, from recording diagnostic data on patients with epilepsy, to neuroscience research on detecting and treating brain disorders. Conventional EEG recordings require time-intensive preparation and setup by a trained technician. Skills required for use include preparation of both electrodes and the scalp, knowledge of electrode placement on the scalp that corresponds to the brain region of interest, and knowledge of the connectivity and operation of the system. A no-prep EEG system would make EEG a more convenient and accessible tool for both research and clinical applications. Further, making this system portable and easy to use would allow for applications such as at-home self-recordings, consistent recordings, and use in clinics in third world countries.

Design

Students who choose this project will have the opportunity to work on the development of a novel electrode design and cap for use in no-prep tEEG recordings. Using the system should be simple enough so that users with no previous EEG knowledge or training can produce clean recordings. This project consists of 4 main design elements:

1. **Electrode design.** Design & build electrodes based on the tripolar concentric ring electrode model that 'comb' through the hair in order to achieve good contact at the electrode-skin interface without the use of electrode paste or gel.
2. **Electrode cap with custom fittings.** Design & build custom fittings for an electrode cap that will allow for easy and accurate electrode placement for at-home EEG recordings.
3. **Printed circuit board, instrumentation amplifier, and signal processing.** Design & build an amplifier and PCB on the electrode cap that connects to the electrodes and apply signal processing techniques to ensure clean signals.
4. **Wireless data transmission.** Wirelessly transmit EEG data to a data collection computer.

Team & Gained Experience

We are looking for a team of 2 ELEs and 1 CPE. These students will gain experience in the novel design of a medical device, learn about patient-safety and wireless communication standards, as well as learn

about acquiring biological signals. They will learn about different areas of the brain and what electrical activity is typical in certain areas. Additionally, they will gain experience with tools such as Solid Works, a 3D printer, and data acquisition equipment for acquiring biological signals.

Tasks/Requirements

1. Research the best method for making consistently clean contact between the scalp and sensor.
    a. Starting point: research various types of pins that attach to the electrode surface (gas-powered, spring loaded, etc.)
    a. Mouser electronics, Digi-key

2. Design and make TCREs with chosen contact elements

3. Design custom fittings for electrode cap in Solid Works
    a. The design should maintain accurate placement of each electrode on the scalp, as well as secure each electrode to ensure minimal movement and good contact with the scalp

4. Make electrode cap with 3D printed electrode fittings

5. Take impedance measurements to assure good scalp-electrode connection

6. Design instrumentation amplifier and filters to be small enough to fit on small PCB

7. Research wireless communication and determine which type is best suited for this application
    a. Bluetooth vs Wifi standards

8. Calculate data transfer rates

Division of Labor

ELE tasks: 1, 2, 3, 4, 5, 6

CPE tasks: 1, 2, 3, 7, 8

Technical Contacts

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