An Implementation of Firmware for Non-Invasive Charge-Coupled Brain Stimulation

Elizabeth Staley, Harsha Ganegoda, Dr. Emil Jovanov, Computer Engineering

Introduction

Transcranial direct current stimulation (tDCS) systems have shown success in applications ranging from stroke rehabilitation to cognitive enhancement [1, 2]. However, tDCS does not provide localized stimulation of brain regions necessary for many applications. We propose a Spatio-Temporal Switched Capacitor (STSC) brain stimulator to selectively stimulate or inhibit specific brain regions.

System Architecture

Use Case:
1) User selects electrodes and voltages
2) User enables system on Teensy 3.6
3) TinyFPGA sends start signal to Teensy 3.6
4) Teensy 3.6 uses SPI to program DAC and send switch and MUX configurations to TinyFPGA
5) TinyFPGA generates state machine control signals
6) Repeat steps 3 through 5 until user disables system on Teensy 3.6

Firmware

Experimental Setup

-0.5 V DC Test
- Voltage: 1 V
- +V: Electrode 1 (E1)
- -V: Electrode 2 (E2)

+/− 0.5 V AC Test
- For 12 ms:
  - Voltage: 1 V
  - +V: E1
  - -V: E2
- For 13 ms:
  - Voltage: -1 V
  - +V: E1
  - -V: E2

Results

Brain Model

Resistance/Capacitor (RC) network models user’s head

Future Work

The preliminary tests demonstrate that the design can successfully generate DC and AC spatial patterns. Future work will utilize more complex patterns on an anatomically correct head phantom with the aim of eventually integrating the system into a compact, portable headband for brain stimulation applications.

References