Boston University

Electrical & Computer Engineering

EC464 Capstone Senior Design Project

Second Prototype Test Report

EEG-based Brain-Computer Interface

Submitted to:

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by

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For the prototype test, our equipment was composed of an EEG electrode headset, a PIC32 microcontroller and bootloader, a bio-sampling chip, as well as a multimeter with probes. The software required for testing included the OpenBCI GUI, Arduino IDE, and Python code for the 3D virtual environment and machine learning library.

During the testing, our team had three goals. The first was to display a set of current challenges faced with the development of our project. For example, the firmware communication channel did not accurately interface between the computer and the microcontroller, since input from the bio-sampling chip was not being received. We displayed the hardware connections in and out of the chip and debugged the firmware to explore potential root causes of the issue.

The second goal was to demonstrate the software responsible for receiving data streams for the printed circuit board. The software needed to allow an easy start and stop of data streams as well as readability for debugging purposes. We demonstrated the software during prototype testing and displayed its core functionalities.

Lastly, we demonstrated a sample (tentative) LSTM-based neural network that will be used to classify our EEG brainwaves into predefined motor imagery tasks. We also displayed a virtual environment simulation that the user will eventually be able control using their mind. This simulation involved a sphere that could be moved in any direction.

We were able to measure the hardware through a variety of circuit-based characteristics. To ensure continuity between the necessary pins, voltage power was measured. Furthermore, communication between the sampling chip and microcontroller was evaluated to determine its functionality. Data streams in the software were also measured with Python functions, those being start_stream( ) and end_stream() to demonstrate the speed at which Python can process a set amount of example data. For the virtual environment, virtual coordinates were displayed in the simulation to display to the user how far they have moved across the screen compared to the origin (which is 0,0).

Conclusively, our 2nd semester prototype test displayed a variety of operations that can be performed by the hardware and software that we developed. Being able to showcase our methodology behind investigating root causes for hardware and software issues will be integral for the success of the project. Furthermore, our demonstration of the sample neural network and Python environment simulation showed the importance of the EEG electrode headset to the end-user. The ability to control a virtual system using predefined motor imagery tasks will prove to be a significant feat for a senior design project.