

# Utilizing EEG Signals for Wireless BCI Applications

David Andres Pacheco, Timothy Joo, Advisor: Laleh Najafizadeh

Department of Electrical & Computer Engineering

## Abstract

The aim of this project is to develop a user-friendly, mind-controlled device that utilizes EEG signals to wirelessly control the operation of different systems. This device, also known as Brain-Computer Interface (BCI), is an interface that creates a direct communication between the mind and an external device.

Towards this goal, we used a non-invasive brain imaging method, called electroencephalography (EEG), to obtain the required signals and developed a working system which is capable of turning on and off LEDs with number of eye-blinks given as the control measure.

## Vision

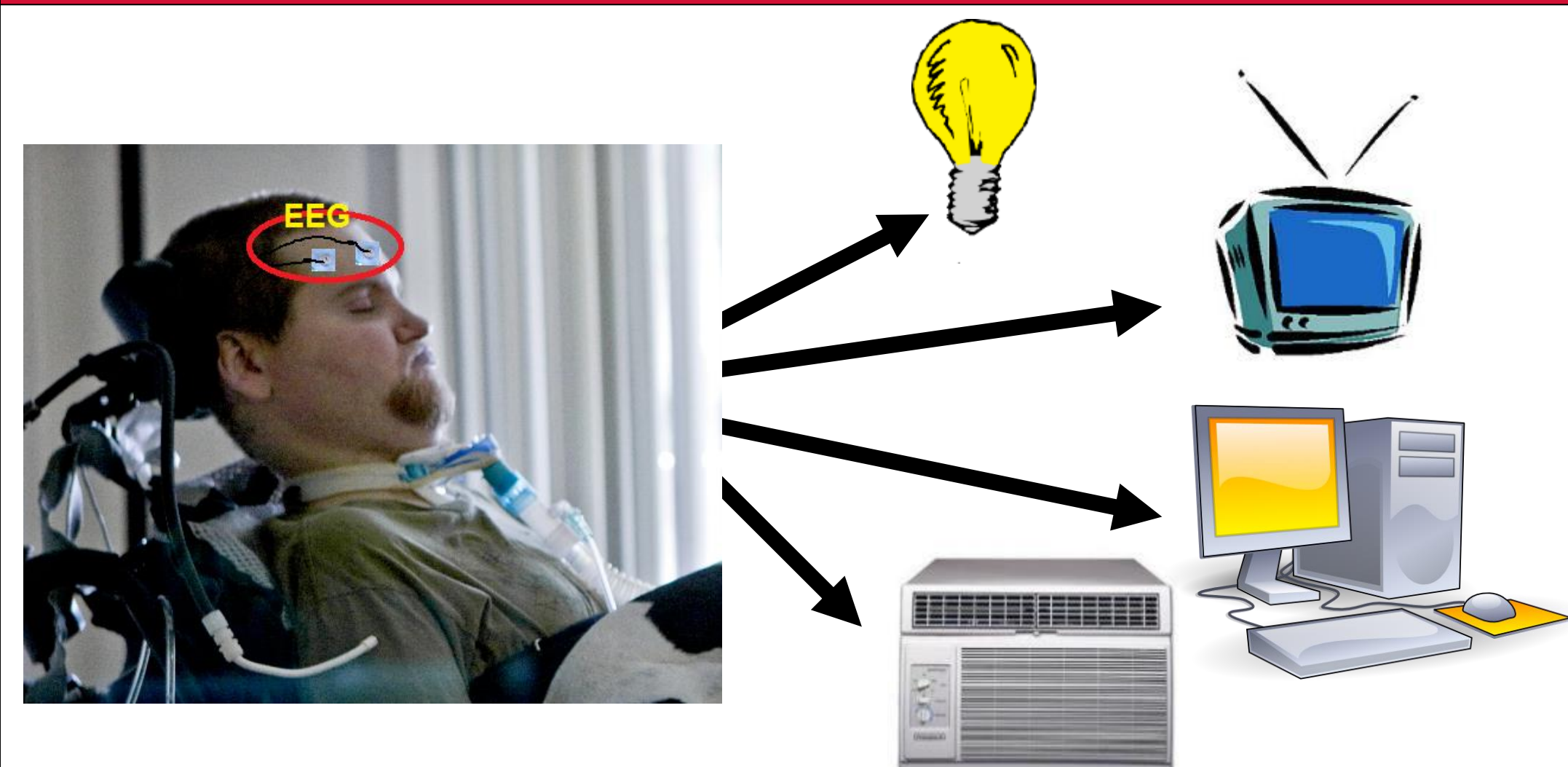


Figure 1: Physically disabled man with our envisioned system capable of controlling his appliances at home with his eye-blinks.

Our vision in this project stems from an interest in aiding people with motor disabilities and freeing them from the inability to perform simple tasks in their homes on their own.

## Design

As a representative of practical applications, we used LEDs, and implemented a system to control their turn on and off with eye-blinks.

The design included both hardware and software aspects:

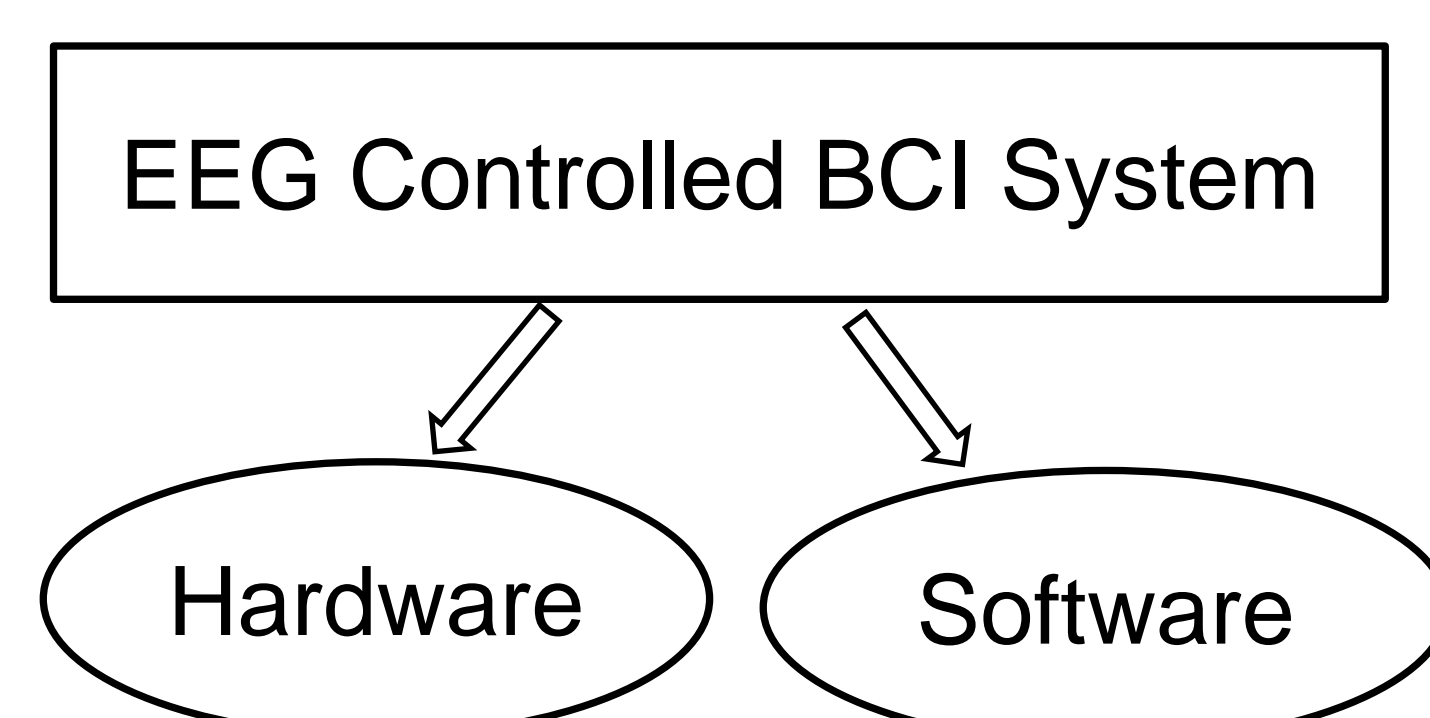


Figure 2: General block diagram of our system.

## Hardware

The hardware part consists of:

I. EEG sensors: EEG sensors from Brain Products were used. Strong eye-blink signals can be recorded from EEG sensors located over the prefrontal cortex.

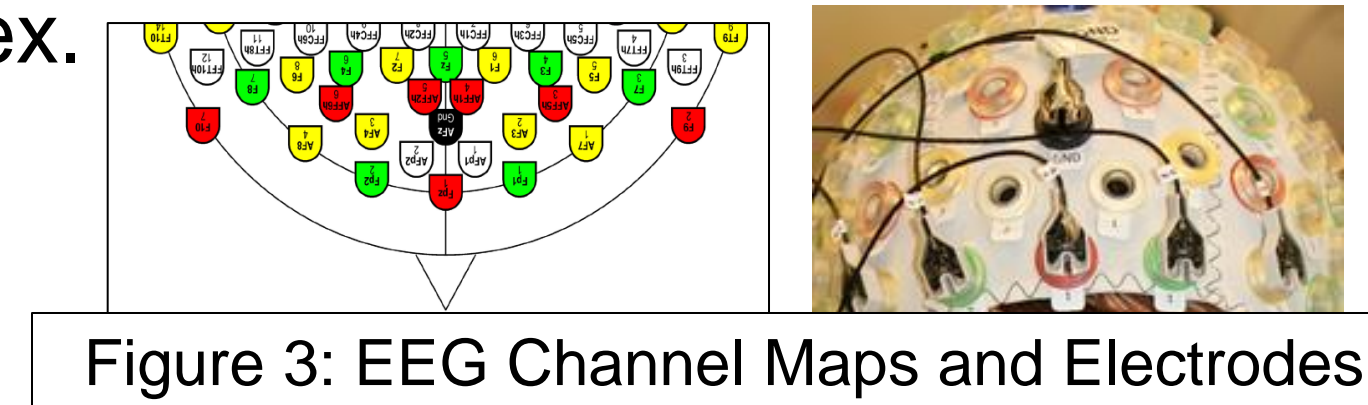
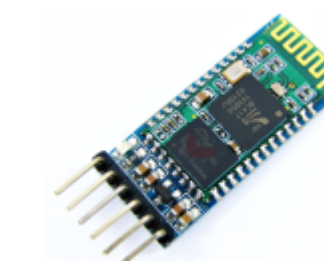


Figure 3: EEG Channel Maps and Electrodes

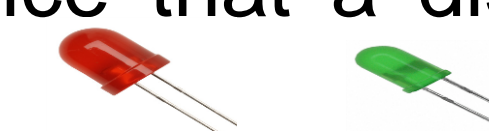
II. Arduino Board: An Arduino Uno was used to be our integrated drive electronic (IDE) because of its compatibility with many different open source software and because it is very user-friendly.



III. Bluetooth Module: A Bluetooth module utilizing HC-06 firmware was used to create a wireless connection between the Arduino and the PC.



IV. LEDs: LEDs were used to simulate the applications. Two red LEDs signify the number of blinks that have been currently counted. The green LED symbolizes any external device that a disabled person may have trouble turning on and off.



## Software

MATLAB and Arduino software were used to code and simultaneously run our program. The connection between MATLAB and Arduino was fairly easy using a given ArduinoIO sketch. The figure below illustrates the loops used in our coding. A threshold value was observed and if a signal exceeded it, a blink would be counted and the timer for 1 second, or 100 data points, would be started. Each blink toggled a given LED. Every blink will toggle on a red LED. Every three blinks made within a *one second* interval will toggle on/off the green LED.

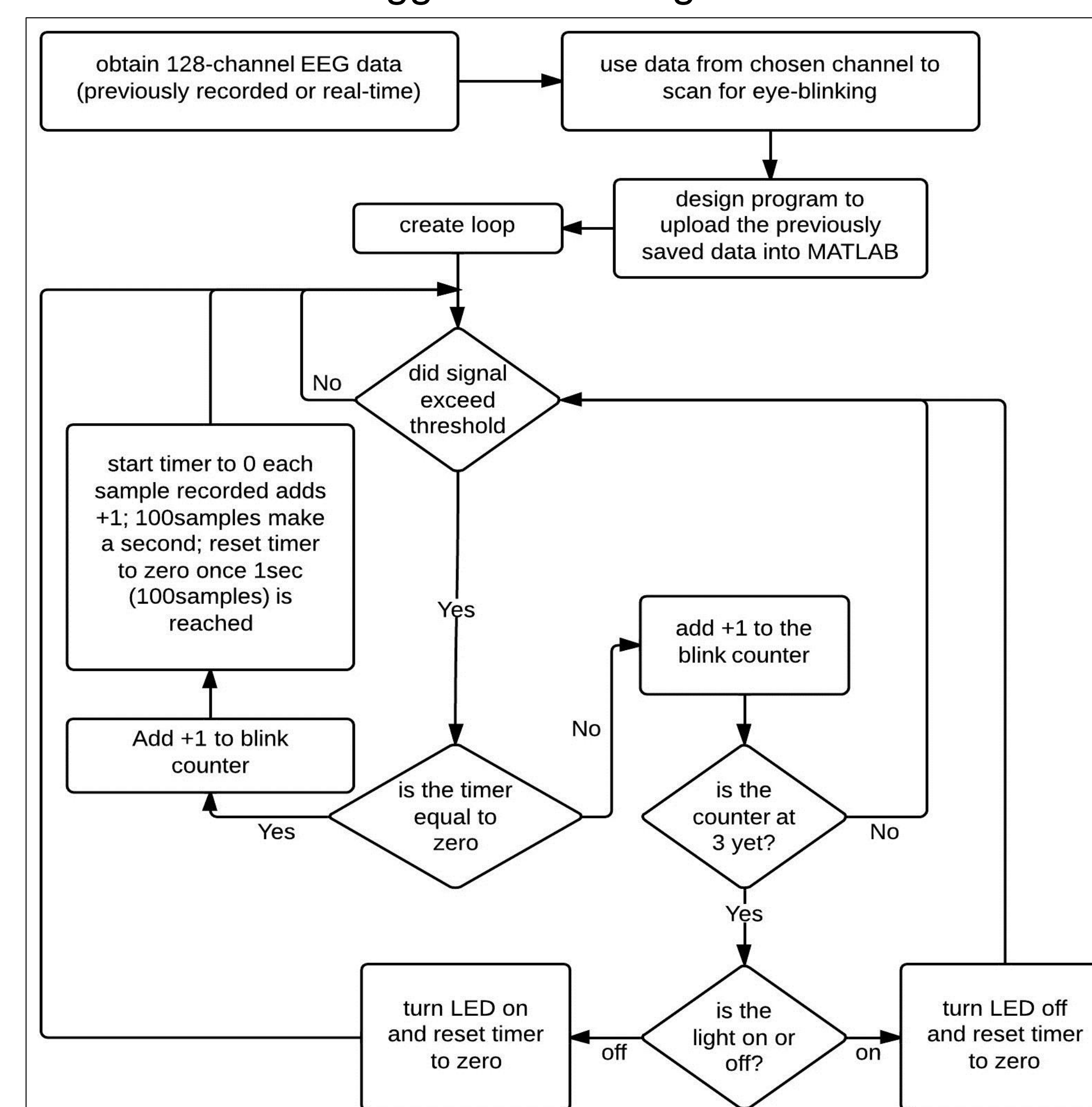


Figure 4: Flow chart of MATLAB coding algorithm.

## Final Product



Figure 5: Subject of recording.

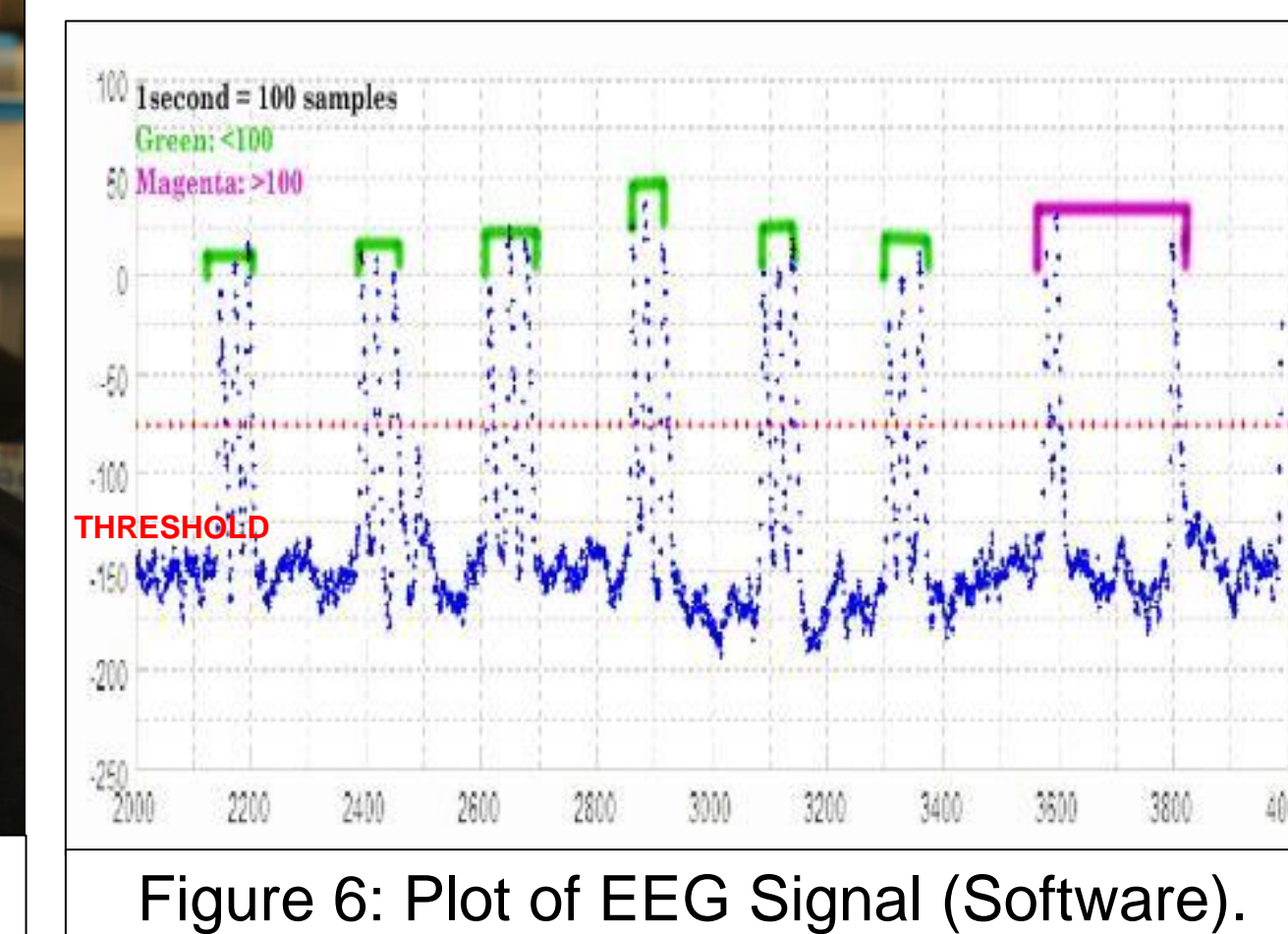


Figure 6: Plot of EEG Signal (Software).

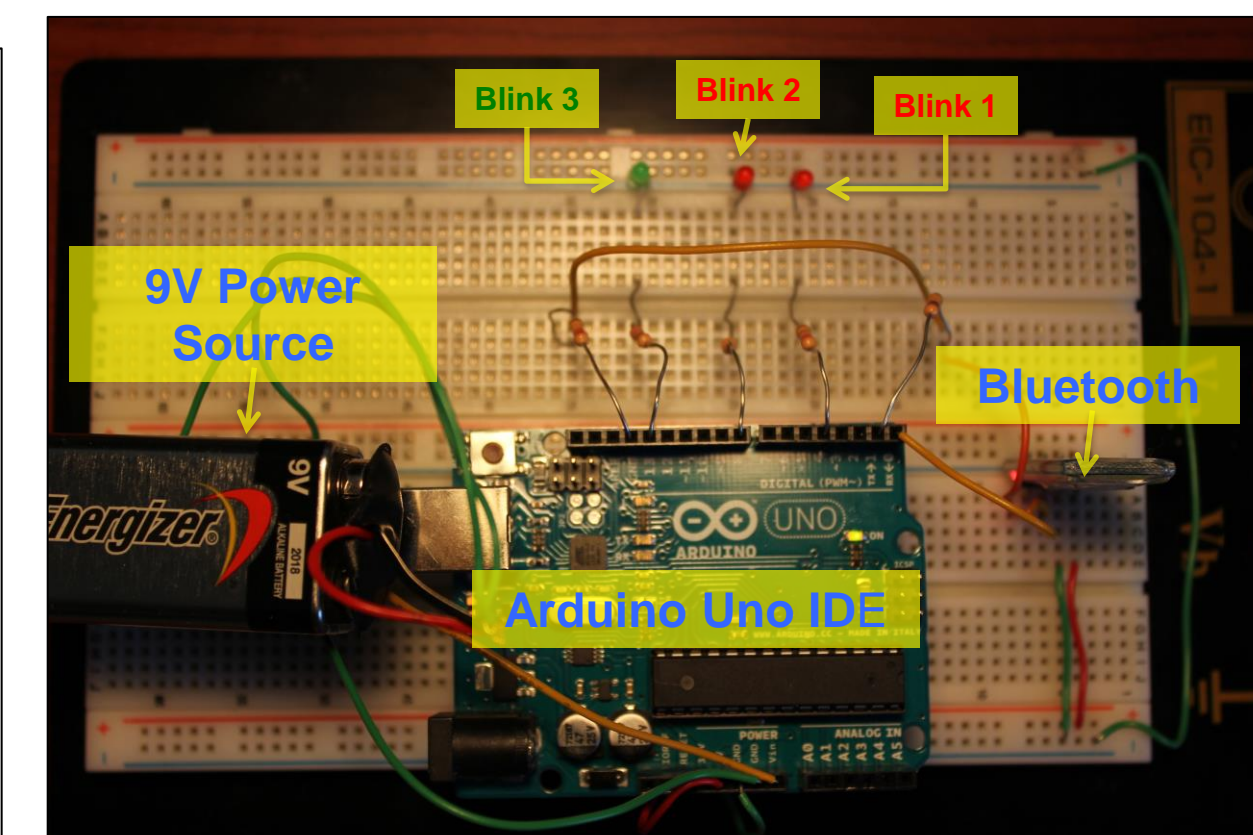


Figure 7: Image of Wireless Arduino Setup (Hardware).

## Challenges

- Learning the new language of Arduino software
- Learning how to link Arduino software with MATLAB simultaneously
- Learning how to record EEG data
- Differentiating separate LEDs and isolating eye blinks
- Timing of program
- Using our project for real-time applications

## Future Work

In regards to the future of our project, we ultimately hope that interest was generated in this field of study to further develop this idea and help people who have difficulty with motor functions. One possible future development that would be necessary is the ability to program our device for real-time applications. Another good development that could be made is the ability to toggle numerous devices, not just one as we demonstrated in our design with a single green LED. As noted earlier, we simply hope that more people see the potential in this field to innovate much more advanced BCIs to enable disabled people way beyond turning on and off machines.

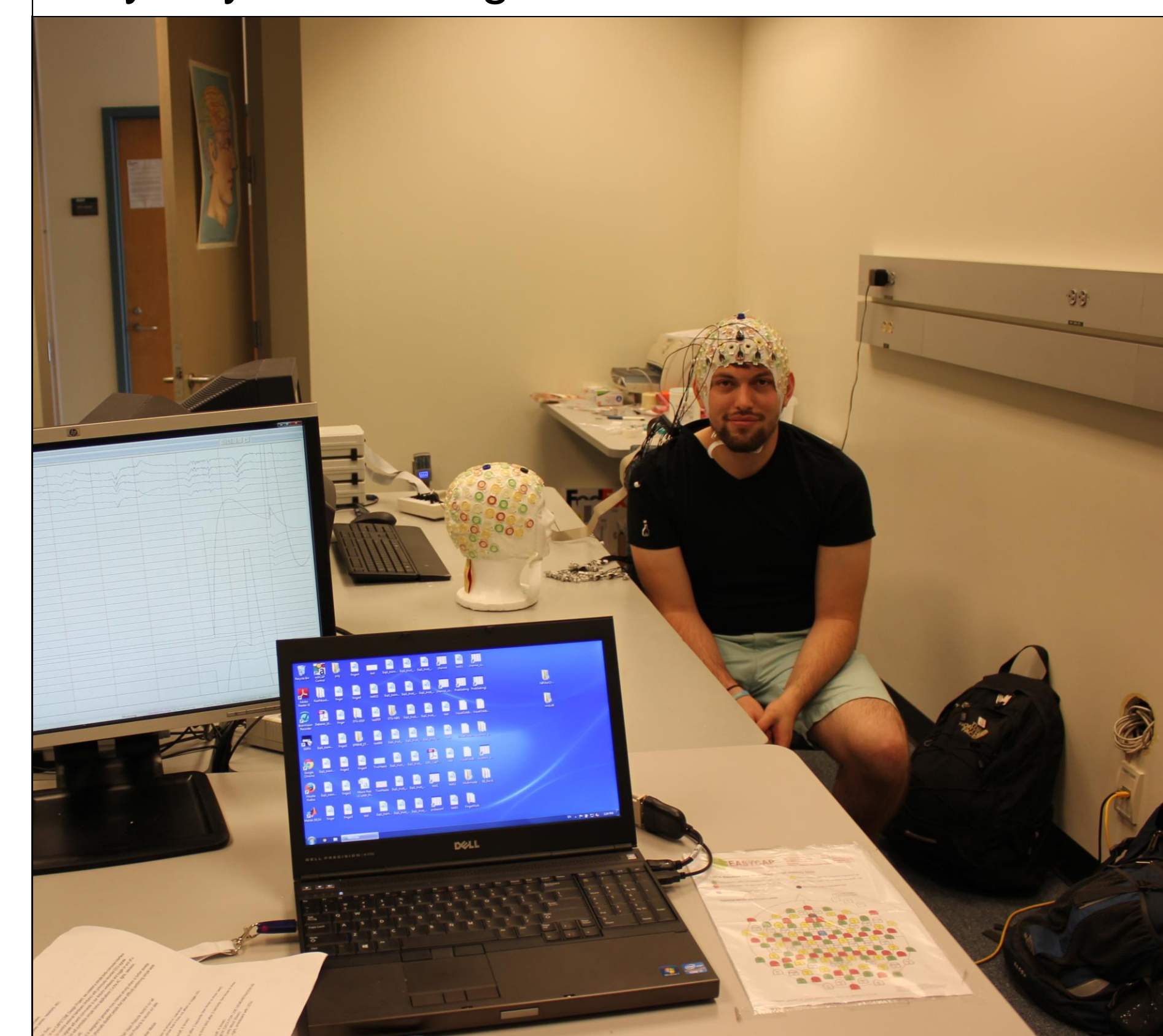


Figure 8: Experimental Setup (ECE Neuroimaging Lab).



Figure 9: BCI on Wheelchair.  
(<http://neurogadget.com/tag/wheelchair>)