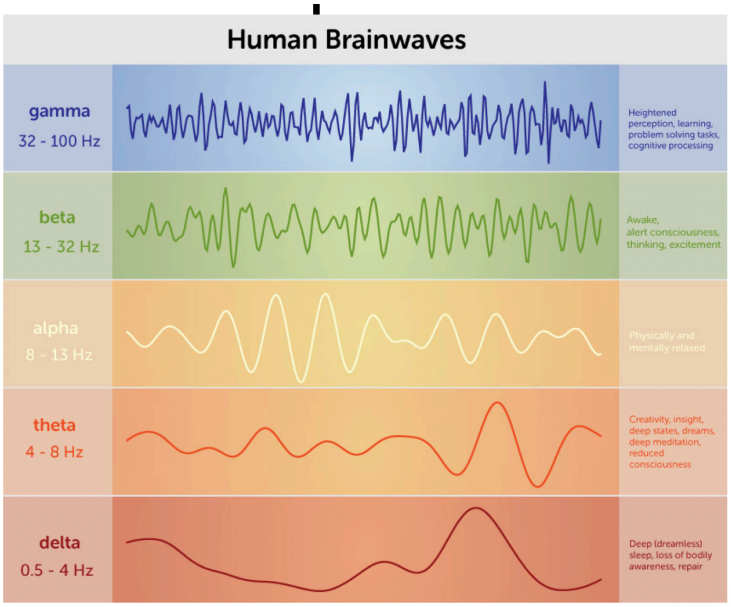
Brain Computer Interfaces:
Drone Racing

Myles Lewis
Morgan State University
1700 E Cold Spring Ln, Baltimore, MD
Myleslew422@gmail.com

Ben Clinkscale
Morgan State University
1700 E Cold Spring Ln, Baltimore, MD
clinkscale.ben@gmail.com

ABSTRACT

Recently brain-robot interaction applications have started to become more popular. However, there is a lack of working, investigative ways to integrate electroencephalography (EEG) technology with modern web and drone technologies. To address this gap, we designed and implemented a desktop application with electron that is able to read data from the Muse Interaxon EEG device enabling commands to be sent to a tello drone. Alongside the web application, we used React, a very comprehensive javascript library for creating user interfaces. From the data received from the EEG, the application utilizes this information to control the actions or direction of flight of the drone. For example, for the drone to be able to move, the engagement, a number that is returned from an algorithm that takes data from all the electrodes on the EEG device, must be above the threshold of (.2). Once the engagement is above the threshold, the drone is able to take off. Next, whenever the engagement passes the threshold, it will be compared to the last engagement that had passed the threshold. This will determine the direction of flight for the drone. An example of this is if the engagement was greater than the engagement before then you can pass a move forward command, and if the engagement was less than the previous engagement then you can pass a move backward command. What makes this application an advancement from any previous works, is the implementation of Brain-Computer Interfacing controls for tello drone within a React application.



1. React

React is a JavaScript library that provides a more friendly User-Interface for the User. When programming with react, it allows the programmer to access more color, icons, animations, and much more. This framework is being utilized by major companies such as Fackbook, Instagram, and Twitter. React has become one of the 'Go-To' libraries in today's programming world.

We used React to develop a comprehensive and interactive User Interface, as well. This is essential to our project as it will draw in the attention of the user to inform them on how to properly participate in the web application and provide tips on how to engage the software.

2. EEG

EEG is an acronym for Electroencephalography. EEG data can be simply defined as the electrical activity that occurs in your brain. This activity in the brain can be broken down into bands, which include Alpha, Beta, Gamma, Delta, Theta, and Gamma waves. In our research, we used a relatively inexpensive way to read in electrical current in the brain, called a Muse. Because of this device, we can analyze and interpret brain data. With this information, we can construct new applications to how this data can be implicated.

A Band is a type of wave that your brain gives off and these bands are named Alpha, Beta, Gamma, Delta, Theta, and Gamma. Alpha band means you are mentally relaxed, Beta band means you are alert, Gamma means your perception levels are heightened, Theta means you are dreaming, and Delta means that you are sleepy.

3. Electron

Electron is an open source, cross platform, web technology framework for creating native applications. Since Electron involves creating desktop applications with javascript, its as smooth as building a website. It includes all the functionality that comes with Javascript, but with a couple more lines of code. The benefits of having a cross-platform framework when developing desktop applications is essential, since there are several operating systems like Linux, Windows 10, and others out on the market. In turn, the compiling of Electron on different operating systems, allows developers to be more flexible with their user experience.

4. Combining Everything

The integration of these elements is what makes this application very unique. Using EEG technology that can analyze brain activity, combined with a dynamic User Interface, and a cross platform, web technology for creating desktop application. We can, in turn, create software that is available for people to use in their own homes.

Since Electron and React are relatively new, having the ability to use electron to create a cross platform

with React played out pretty well. It is now very easy to load up this application and utilize it.

5. Challenges

5.1) A challenge that was occuring often was the flow of data. Sockets were used to communicate the data from the BCI device, to the back end, then to the drone. These problems were solved with different trial and error troubleshooting methods.
5.2) Another challenge that occured was how many commands the drone could receive before it would start sending constant errors. At first, videos on the tello drone and the documentation for the Tello drone stated that every command had command delay that occurred after a command was sent. After creating functions that are able to manipulate these commands, we were able to find a stable program that would send commands to the drone every 3.5 seconds with an amplitude of 30cm.
5.3) Having the correct Node Modules was also a challenge that was frequently occurring. Making sure that the correct modules are in the "node_modules" is the first step, then the user must do a "*npm install"* or *"yarn* install" on that module that they want to use.

6. Future Work

The Application that was created is the first of its kind. No one to our knowledge has created an application that allows the Muse BCI device to control a drone purely powered by brain activity. Though this is the first prototype, this application is put into the Electron. Electron allows this application to be utilized on the desktop without wifi opposed to a web application where you will always need to be connected to wifi. Going forward, to further this work, we plan to analyze brain activity to get a better understanding how the brain reacts to certain thoughts or movements. From there, we can look at those brainwave patterns and implement different drone commands based off of the new findings.