A Platform for Evaluating the Benefits of Virtual Travel for Clinical Conditions

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Overview

While virtual reality (VR) is revolutionizing the gaming community, little work has been done to exploit it as a therapeutic tool in the medical domain. Salisbury et. al [1] demonstrated potential for using VR and Brain Computer Interface (BCI) devices as a means for rehabilitation. Tangentially, travel is an experience known to stimulate a wide range of cognition and emotion. This leads us to our question:

Can a system be designed to research effects of virtual travel on patients with Alzheimer's or other chronic conditions?

The work presented here is a system designed to assist researchers in exploring viability of using virtual travel as a means of Alzheimer's prevention/coping. However, the platform can easily be targeted toward researching VR's effectiveness toward treating other conditions, such as persistent pain.

Experimental Design

The platform setup consists of the following components **(Figure 1):**

- Windows Mixed Reality (WMR) headset - Hardware delivering the virtual travel experience
- Muse BCI - Records electroencephalographic (EEG) signals
- Microsoft Surface Book with an NVIDIA GTX 1060 graphics card, equipped with Unity 3D

Figure 1: Setup during data collection phase

Setup | Run | Results

Setup

- User is equipped with Muse
- The WMR headset is then placed on the user. The Muse is adjusted to make optimal contact for all four electrodes

Run

- User interacts with VR environment(s) using controllers
- BCI collects data about user's electrical pulses from brain in response to stimuli

Results

- User removes WMR headset and Muse
- Data is converted from *.muse* to a CSV file; Python script reformats data and outputs array of plots

The platform for researchers uses a three-step process: setting up hardware, running data collection software, and generating plots for analysis.

Virtual Travel Environments

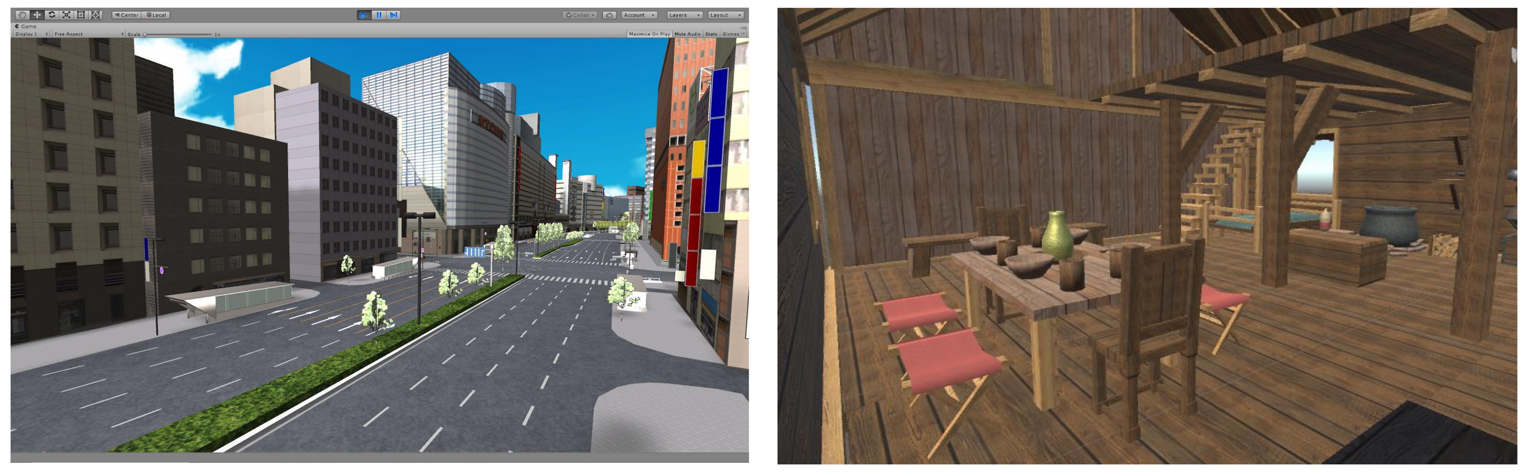

Figure 2: Synthetic environments developed in Unity 3D for virtual travel experience: "City Scene" (L) and "National Park" (R)

The environments were developed with the following constraints:

- Simulate real environments so tests may be run on control groups
- Incorporate tasks targeted for Alzheimer's research (e.g. "Landmark Mapping" used in "City Scene" (**Figure 2, left**)

Experiment: Exercising Data Collection and Filtering Methods

To exercise our platform, data from three subjects were collected under three conditions:

- Calm scene overlooking Mt. Rainier in the WMR Cliff House
- Watching a 360 degree video in Virtual Reality
- Navigating one of our virtual scenes using teleportation

Data was reformatted and filtered:

- High-pass filter to remove DC offset
- Band-pass filter to isolate alpha and beta bands
- Smoothing function

5 plots per electrode per person per test:

- Power/frequency vs. time
- Alpha/beta µV vs. time
- Power spectral density (PSD) vs. frequency

Experiment Results

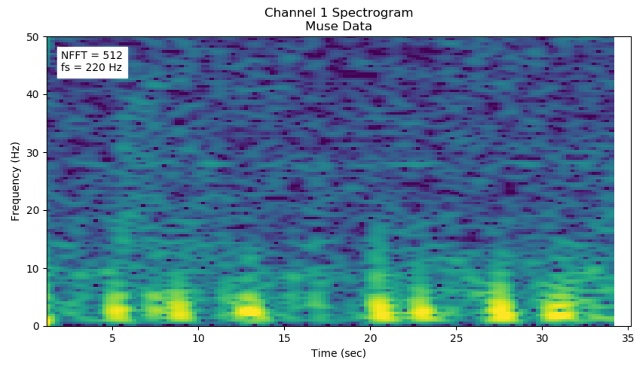

Figure 3: Channel 1 Spectrogram

- Calm activity: lower frequency and high amplitude
- Interactive activity: higher frequency and high amplitude

- Alpha waves: 8-12 Hz [2]
- State: Physically and mentally relaxed **(Figure 4)**
- Beta waves: 12-38 Hz [2]
- State: Alert **(Figure 5)**

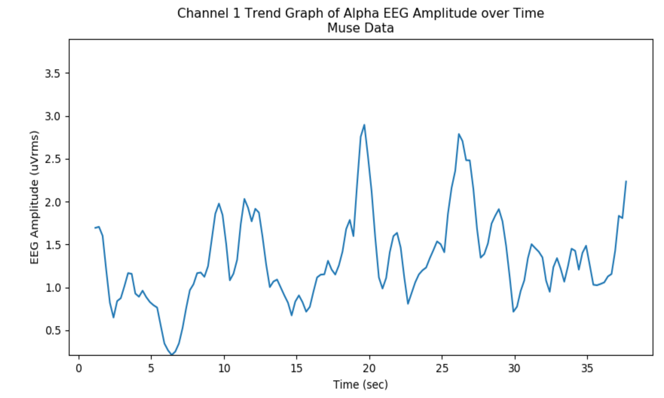

Figure 4: Amplitude vs. Time - Alpha waves

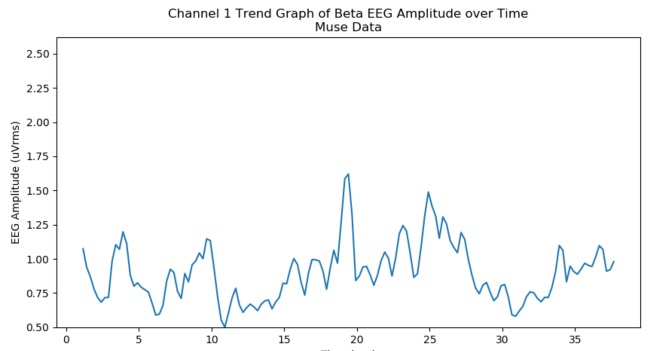

Figure 5: Amplitude vs. Time - Beta waves

- Platform generates plot to differentiate calm activity from interactive activity, and active versus passive VR engagement

Discussion and Conclusion

The results of the experiment demonstrate that the platform can generate a wealth of data in a short amount of time. The platform is highly customizable; the virtual travel environments can be exchanged for other environments or 360 degree videos, and the Python script can be modified to filter for alternate frequency bands or additional electrodes. Combined with the ease of use and low cost of the system, this platform may serve as a convenient tool for future researchers to explore the possibility of VR on Alzheimer's or other conditions.

References

[1] Salisbury, D., Dahdah, M., Driver, S., Parsons, T. and Richter, K. (2016). Virtual Reality and Brain Computer Interface in Neurorehabilitation. *Baylor University Medical Center Proceedings*, 29(2), pp.124-127.

[2]"What is the function of the various brainwaves?", *Scientific American*, 2018. [Online]. Available: https://www.scientificamerican.com/article/what-is-the-function-of-t-1997-12-22/. [Accessed: 29- May- 2018].

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