

MINDFULNESS IN VIRTUAL REALITY

Students:

Hala Awisat
Ola Awisat

Supervisors:

Yaron Honen
Boaz Sternfeld
Michal Zivan

AGENDA

- Abstract
- Demo
- Scientific Background
- Platforms and Technologies
- System Overview
- Insights and Future Ideas

ABSTRACT

This project is an application that allows the user to practice mindfulness in a virtual reality environment. It uses muse headband to measure real time EEG data of the user, and triggers changes in the environment based on this data, creating a neurofeedback loop. The main purpose of the application is to help the user become more mindful on the long term.

DEMO



NEUROFEEDBACK

- Neurofeedback is a type of biofeedback that uses real time EEG in an attempt to teach self-regulation of brain function.
- Neurofeedback involves rewarding the user for increasing certain brain waves, through audio or visual stimulus.



ALPHA WAVES

- Our neurofeedback system targets the alpha waves.
- Alpha waves are neural oscillations in the frequency range of 7.5–13 Hz.
- Research links alpha to relaxation, it dominates during moments of quiet thought and similar meditative states.
- Alpha waves aid overall mental coordination, calmness and alertness.

PLATFORMS AND TECHNOLOGIES

- Oculus Rift
- Unity Game Engine
- Muse 2016 headband
- Mind Monitor
- Microsoft Visual Studio
- Python matplotlib library



SYSTEM OVERVIEW

- Muse Headband
- Data Transfer Protocols
- System State Machine
- Classification Algorithm
- Neurofeedback in Virtual Reality
- Input and Output

MUSE HEADBAND

- Uses brain sensors to detect and measure brain activity.
- Uses FFT to calculate power spectral density of each frequency on each channel.
- Absolute band power is the logarithm of the sum of the Power Spectral Density of the EEG data over that frequency range.
- Transmits data over Bluetooth.

Wave	Frequency Range
Delta	1-4Hz
Theta	4-8Hz
Alpha	7.5-13Hz
Beta	13-30Hz
Gamma	30-44Hz

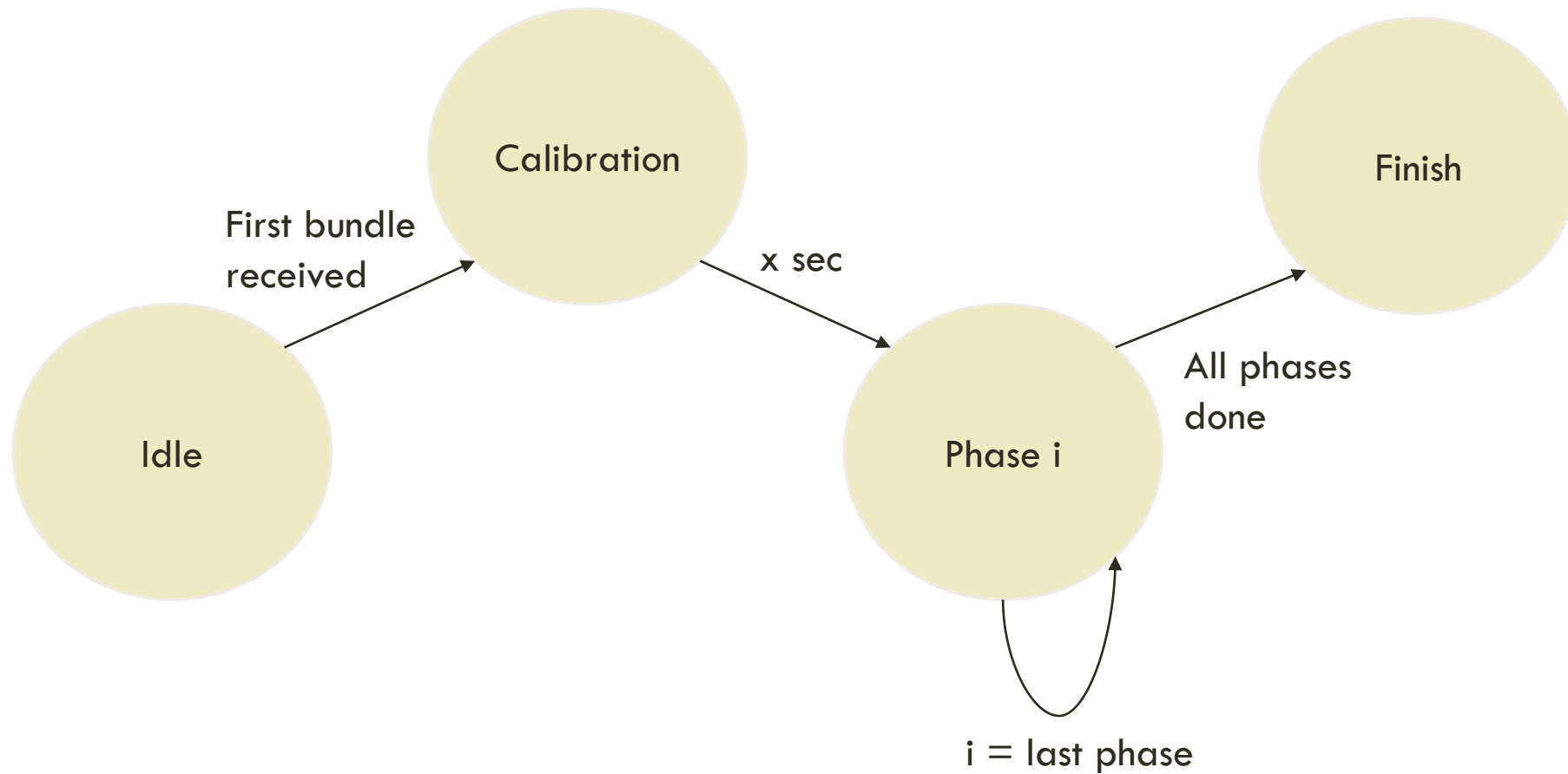


DATA TRANSFER

- Data is transmitted by Muse over Bluetooth.
- Mind Monitor mobile application receives data over Bluetooth.
- Mind Monitor transmits data over Wi-Fi using OSC protocol.
- PC receives data using SharpOSC library.



SYSTEM STATE MACHINE

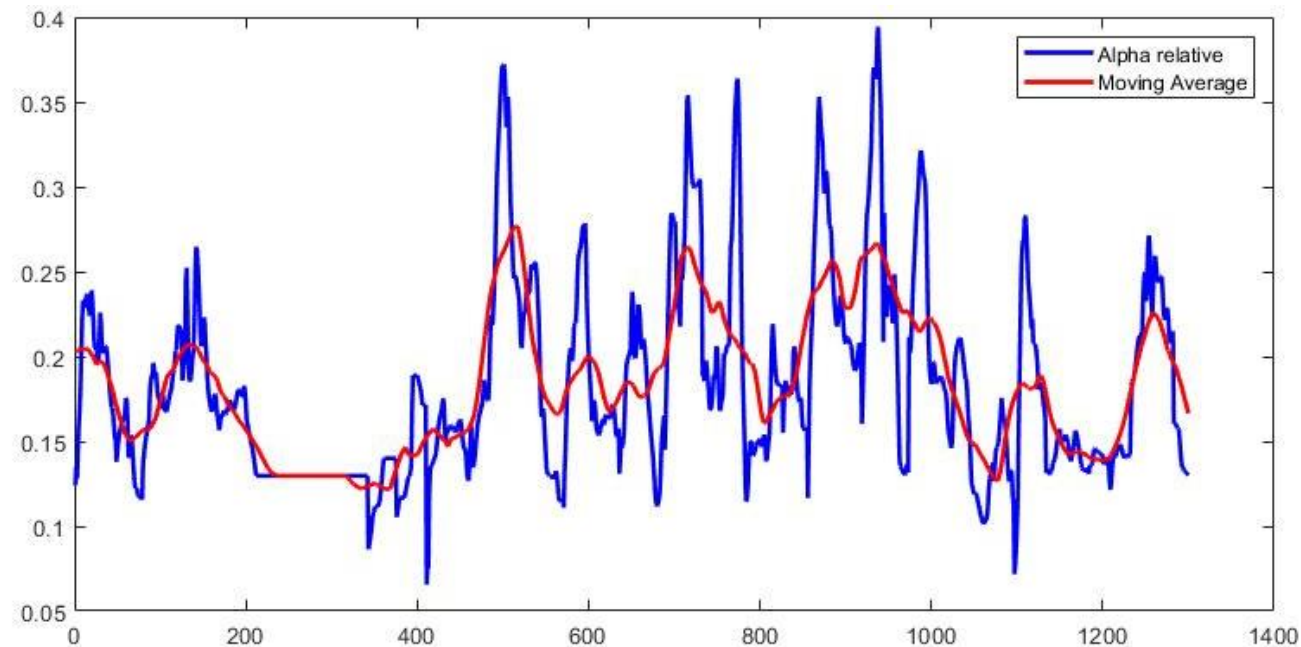


CLASSIFYING MENTAL STATES

- Relative alpha value:

$$\text{Alpha Relative} = \frac{10^{\text{Alpha absolute}}}{10^{\text{Alpha absolute}} + 10^{\text{Beta absolute}} + 10^{\text{Gamma absolute}} + 10^{\text{Delta absolute}} + 10^{\text{Theta absolute}}}$$

- Moving average as noise reduction filter.

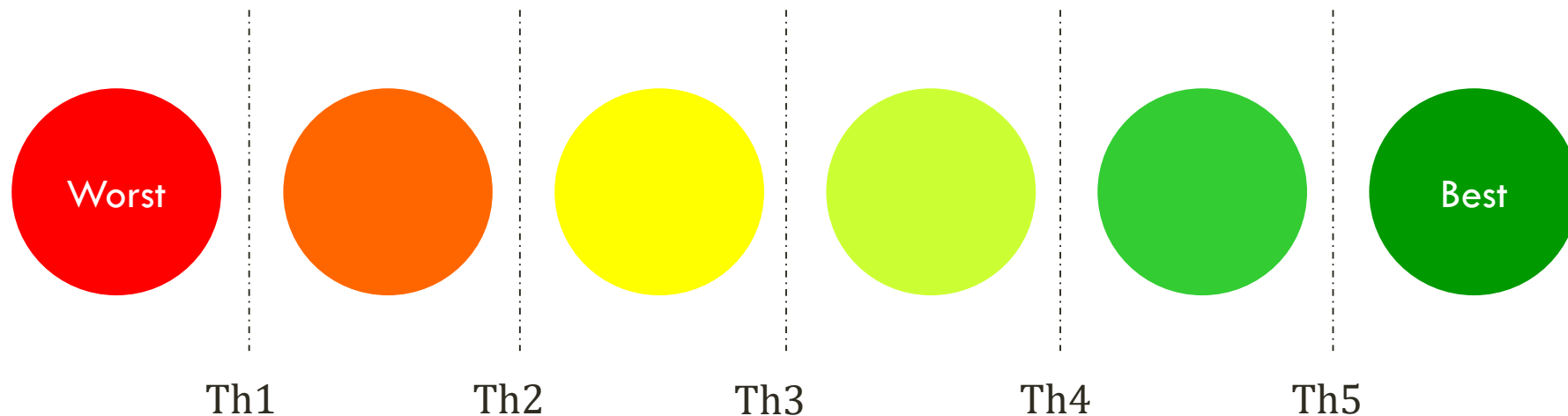


CLASSIFYING MENTAL STATES

- Thresholds based classification.
- 5 thresholds are calculated at the beginning of each phase based on previous data.
- Calibration period used to determine initial thresholds

$$Th_i = factor_i \cdot \text{Alpha Relative Average}$$

- Factors are received as inputs. E.g. factors = [0.3,0.7,1.1,1.3,1.5]



THE SCENE



FEEDBACK

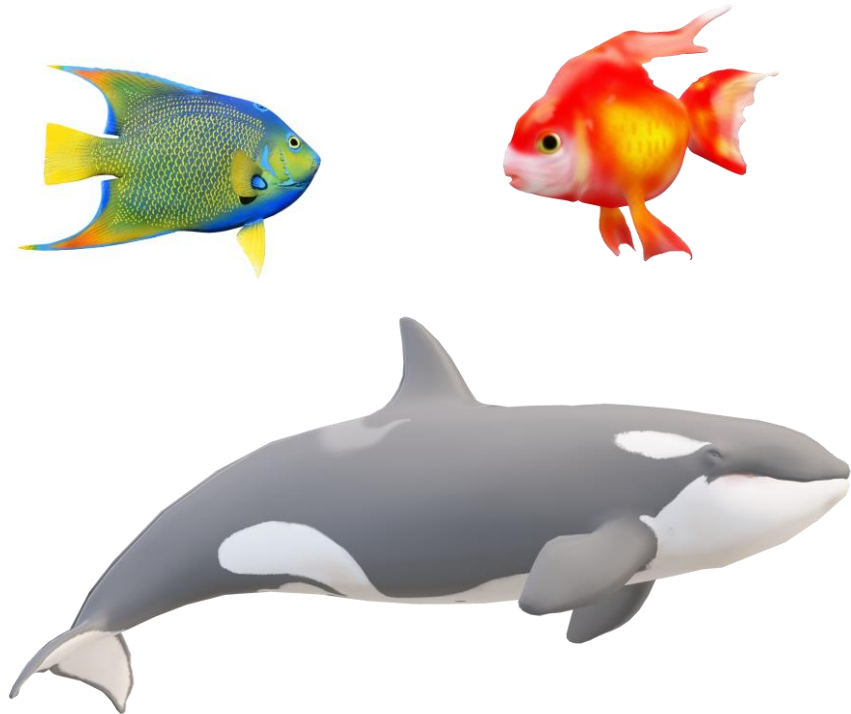
- Feedback is triggered based on mental state.
- Feedback is used to reinforce relaxed mental states and self-regulation of brain function.

Types of Positive feedback:

- Calm sea
- Sunny weather
- Seashells
- Jumping fish
- Music and calm waves sound

Types of Negative feedback:

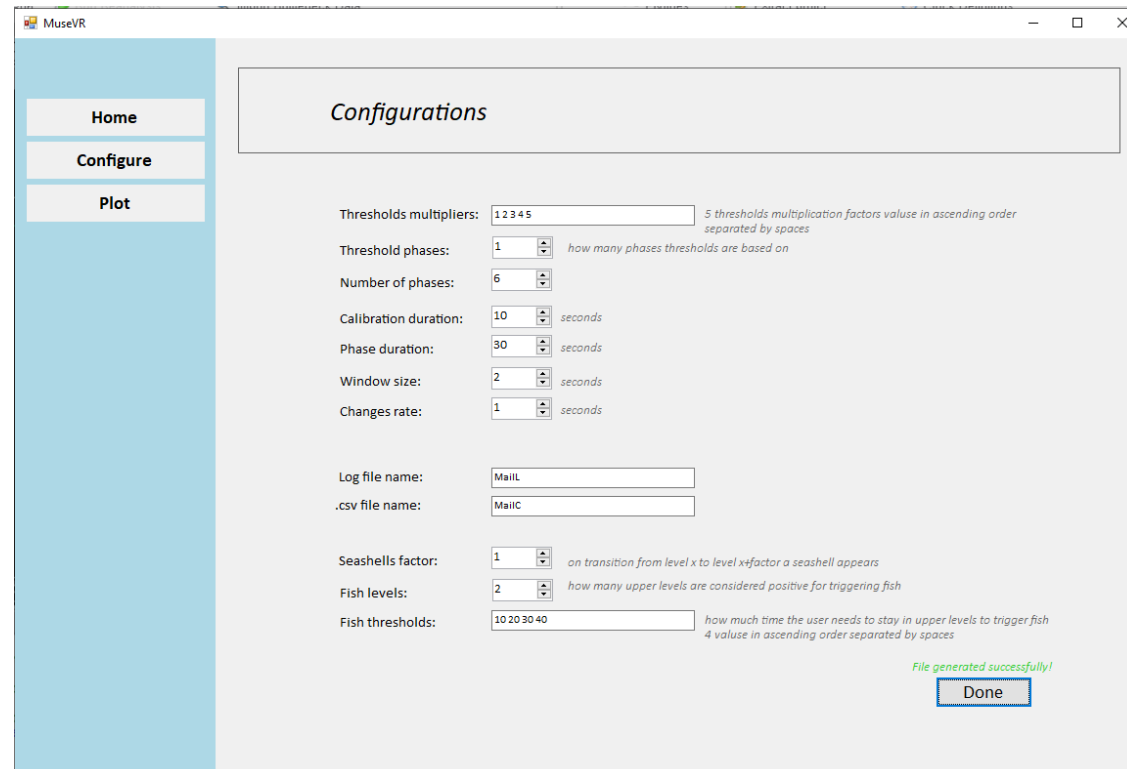
- Stormy sea
- Strong waves sound, weaker music



INPUT AND OUTPUT

Configurations file:

- Thresholds
- Thresholds phases
- Number of phases
- Calibration duration
- Phase duration
- Window size
- Changes rate
- Log file name
- .csv file name
- Seashells factor
- Fish levels
- Fish Thresholds



The screenshot shows the 'MuseVR' application window with a 'Configure' tab selected. The main area is titled 'Configurations' and contains the following settings:

- Thresholds multipliers: 5 thresholds multiplication factors valuse in ascending order separated by spaces
- Threshold phases: how many phases thresholds are based on
- Number of phases:
- Calibration duration: seconds
- Phase duration: seconds
- Window size: seconds
- Changes rate: seconds
- Log file name:
- .csv file name:
- Seashells factor: on transition from level x to level x*factor a seashell appears
- Fish levels: how many upper levels are considered positive for triggering fish
- Fish thresholds: how much time the user needs to stay in upper levels to trigger fish 4 valuse in ascending order separated by spaces

A green message 'File generated successfully!' is displayed above a blue 'Done' button.

Generated at: <current working directory>\UnityApp\MyApp_Data\app_config.txt

LOG FILE

The log file contains all the session's information in chronological order:

- Summary of the configurations
- Packages that were received from muse headband
- Classification of the mind state
- Positive feedback that was invoked during the session
- Summary of the session

Can be found at `<current working directory>\Logs\<file>.txt`

.CSV FILE

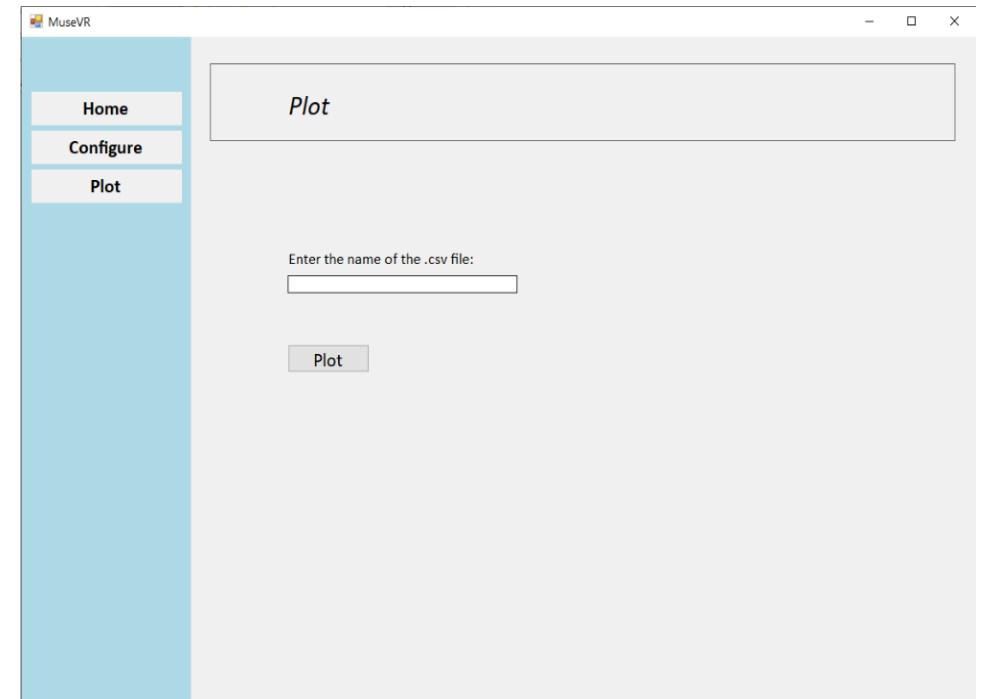
Contains all the values that were received or calculated during the session:

- Waves values (alpha, beta, gamma, delta, theta)
- Alpha relative
- Alpha average
- Thresholds
- Classification
- Feedback

Can be found at <current working directory>\Logs\<<file>.csv

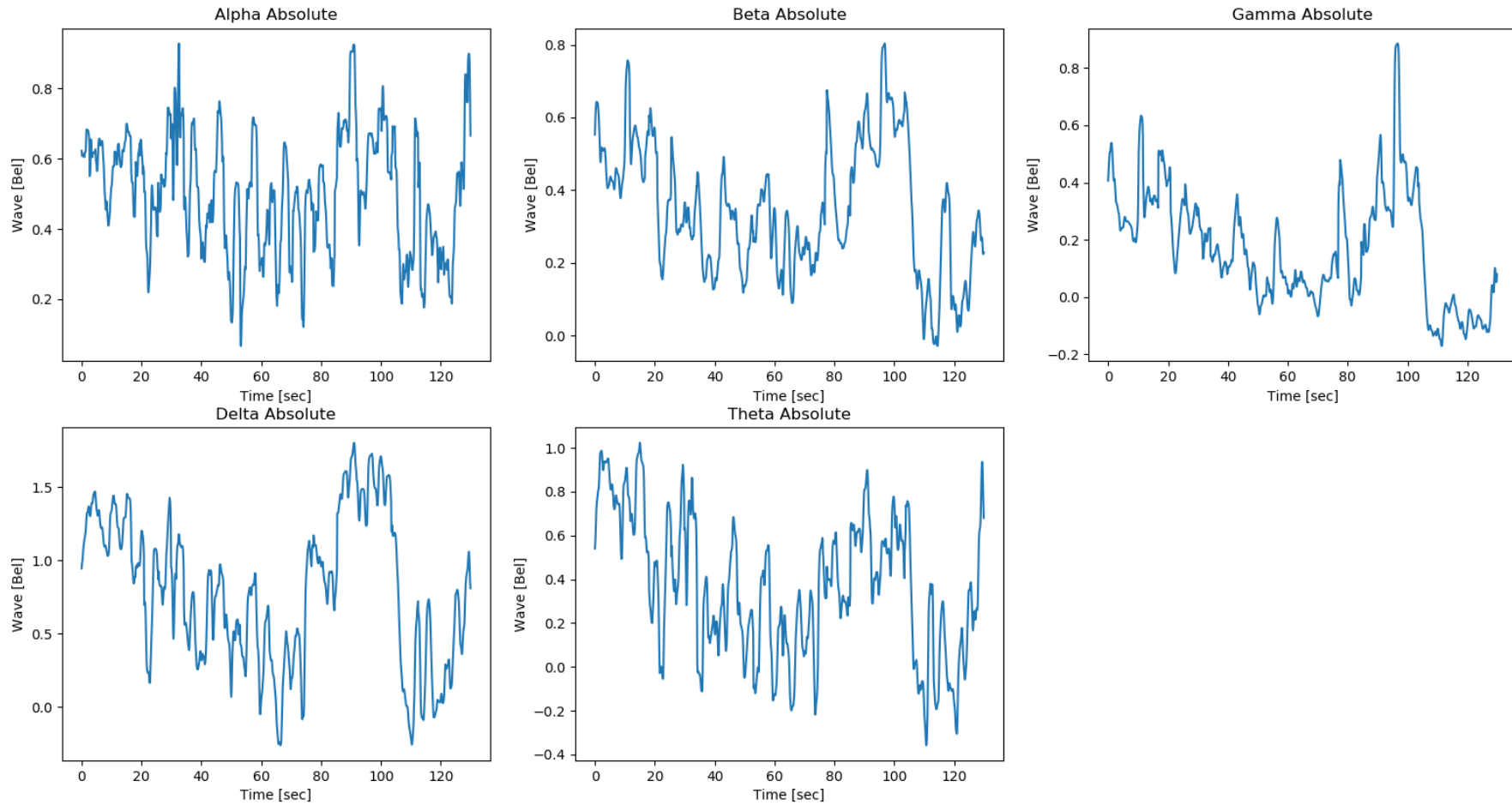
GRAPHS

- The results of the session can be plotted using the Plot tab in the application.
- Implemented in python – matplotlib.

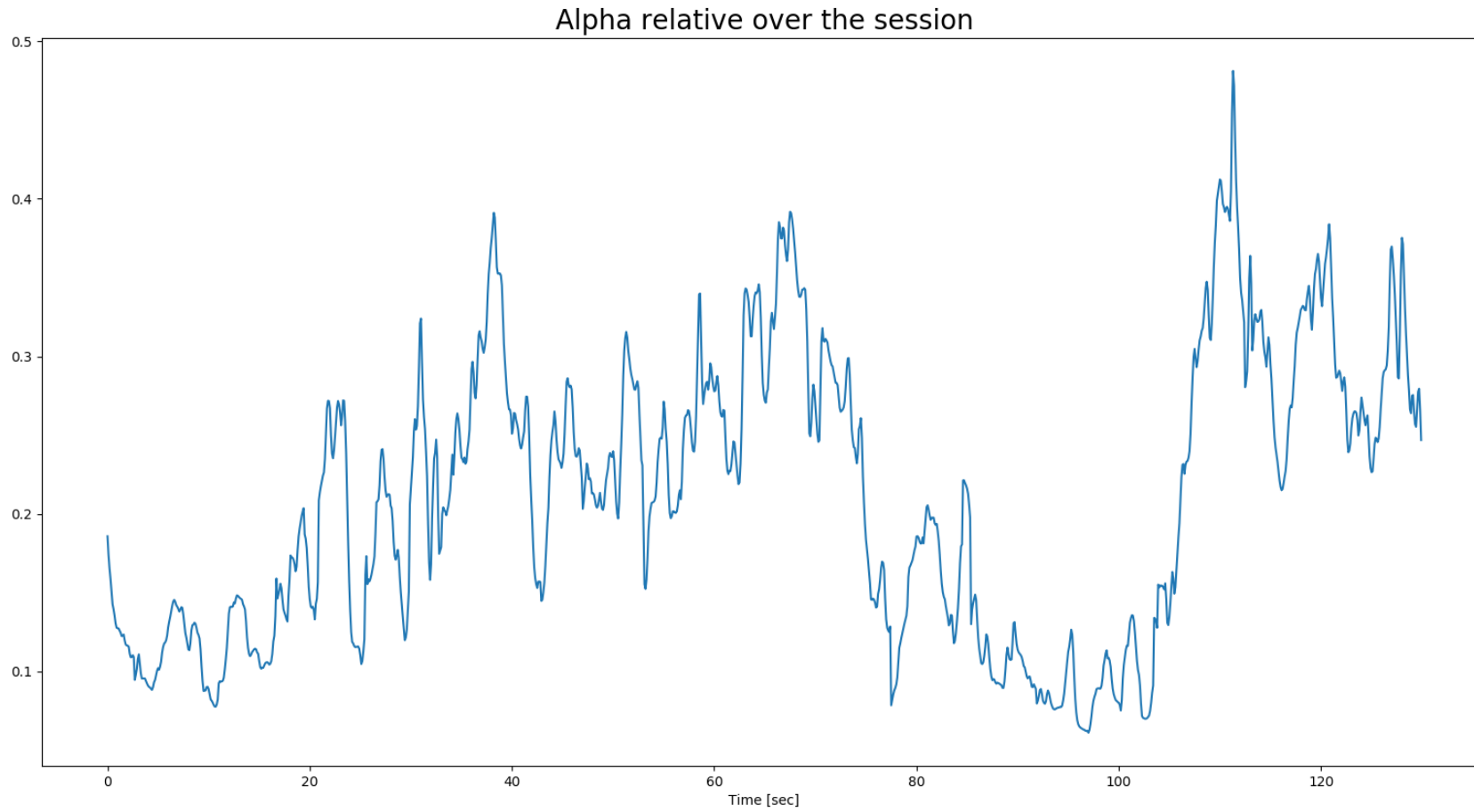


5 Graphs of the EEG waves during the session:

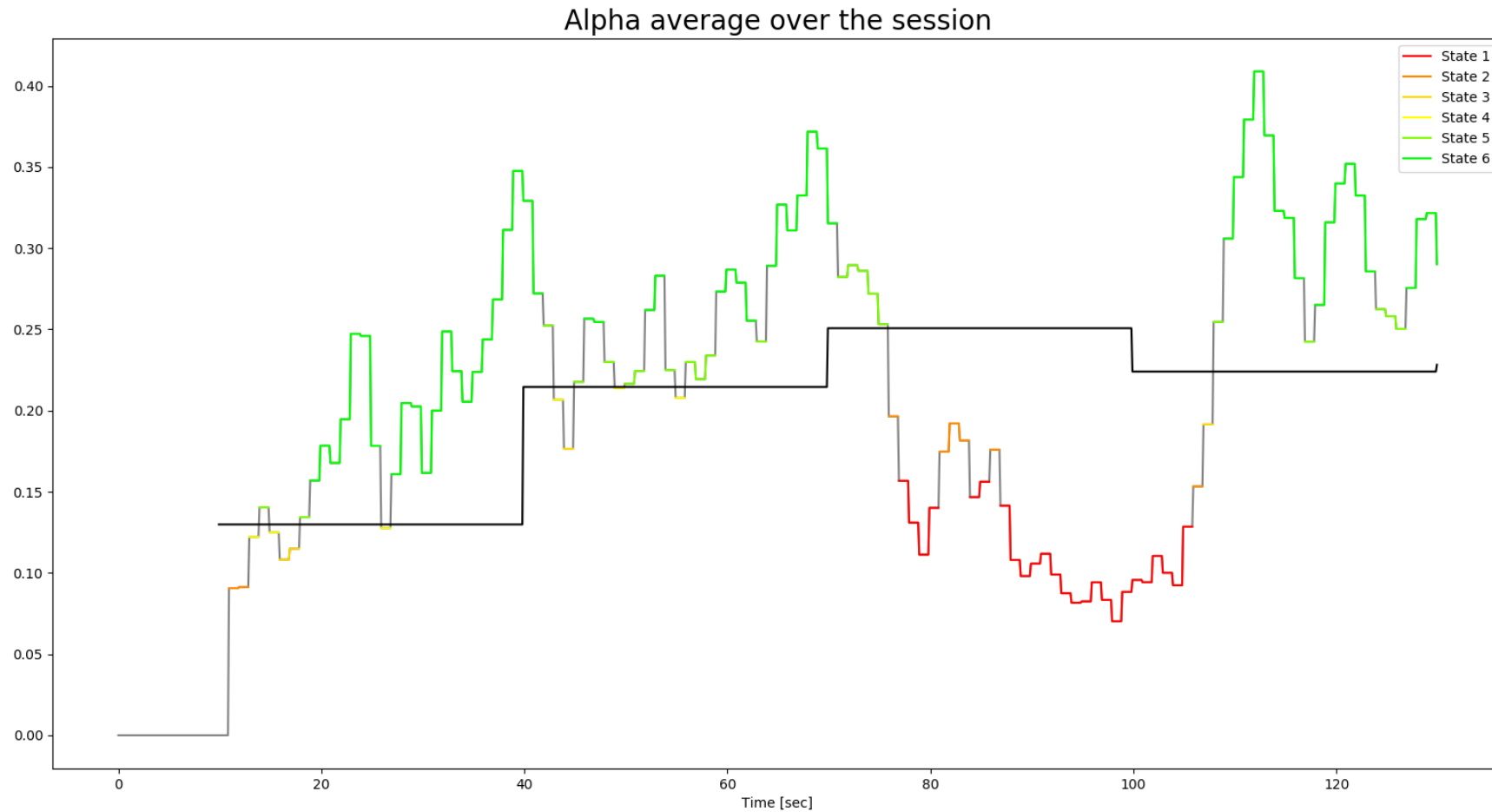
Absolute Waves Values



Alpha relative values during the session:



Alpha relative average during the session:



INSIGHTS AND FUTURE IDEAS

We learnt:

- ❑ Unity design, VR world
- ❑ Product design and working with customers
- ❑ C#, python

We suggest:

- ❑ Graphics improvement
- ❑ Adding more scenes
- ❑ Testing the algorithm and improving based on the results

THANK YOU!