MINDFULNESS IN VIRTUAL REALITY

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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

o Oculus Rift

o Unity Game Engine

o Muse 2016 headband

o Mind Monitor

o Microsoft Visual Studio

o 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.
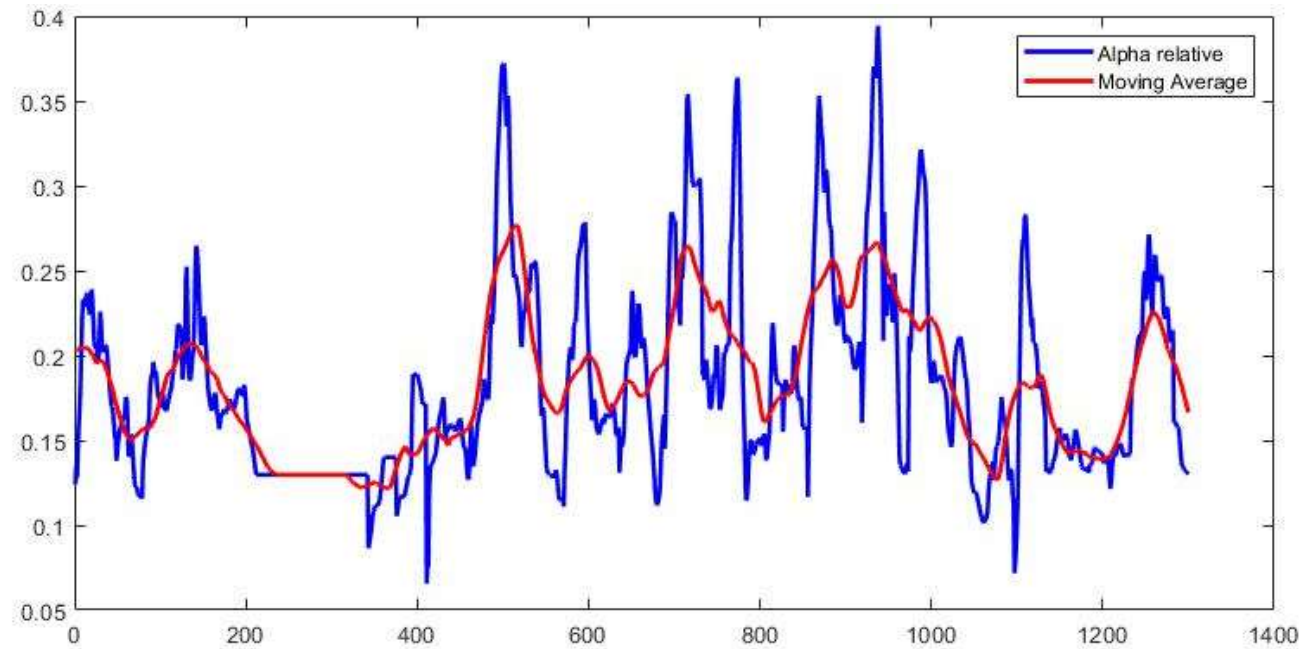
SYSTEM STATE MACHINE
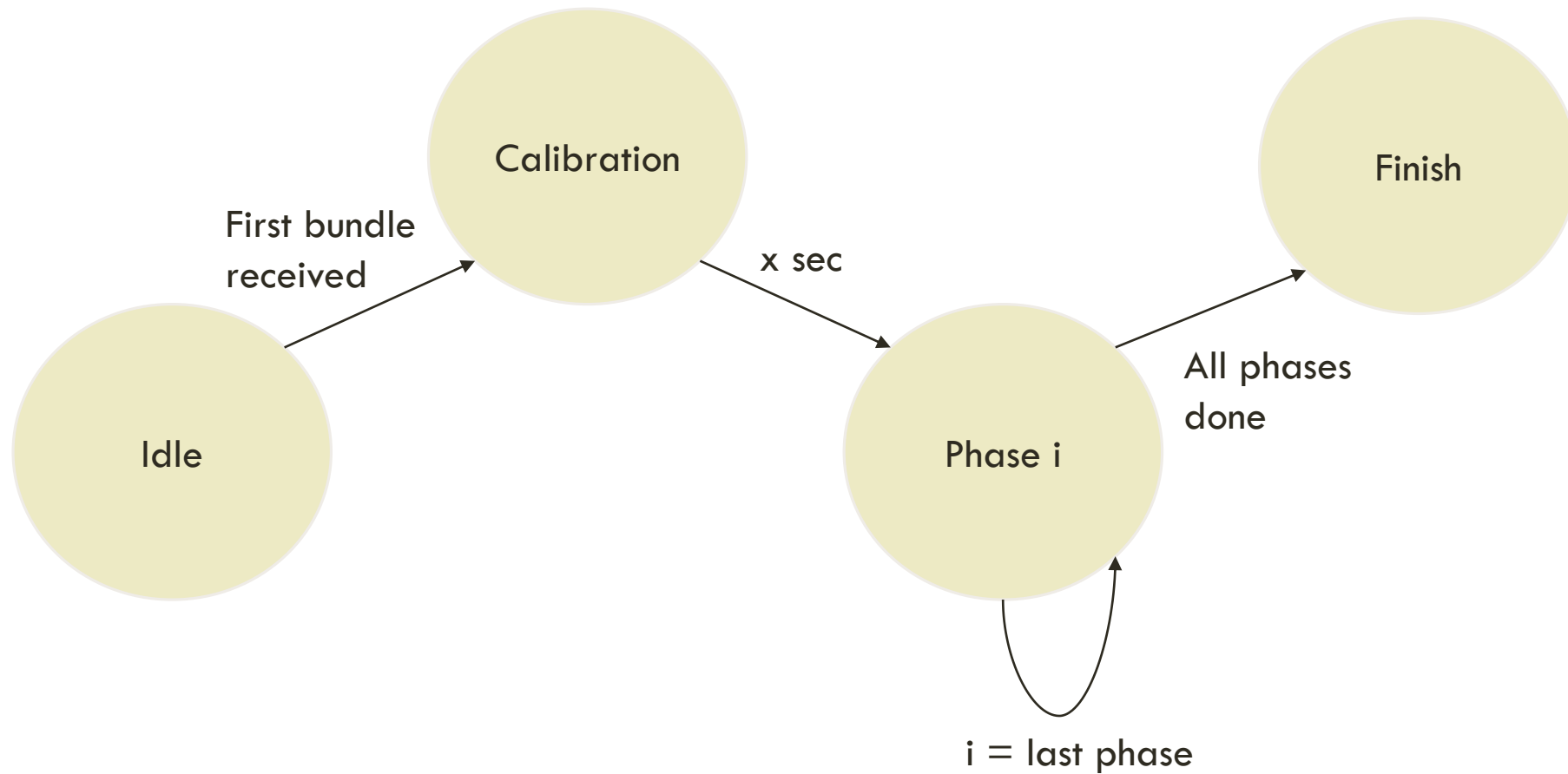
CLASSIFYING MENTAL STATES

- 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

$$Th_i = factor_i \cdot Alpha\ Relative\ Average$$

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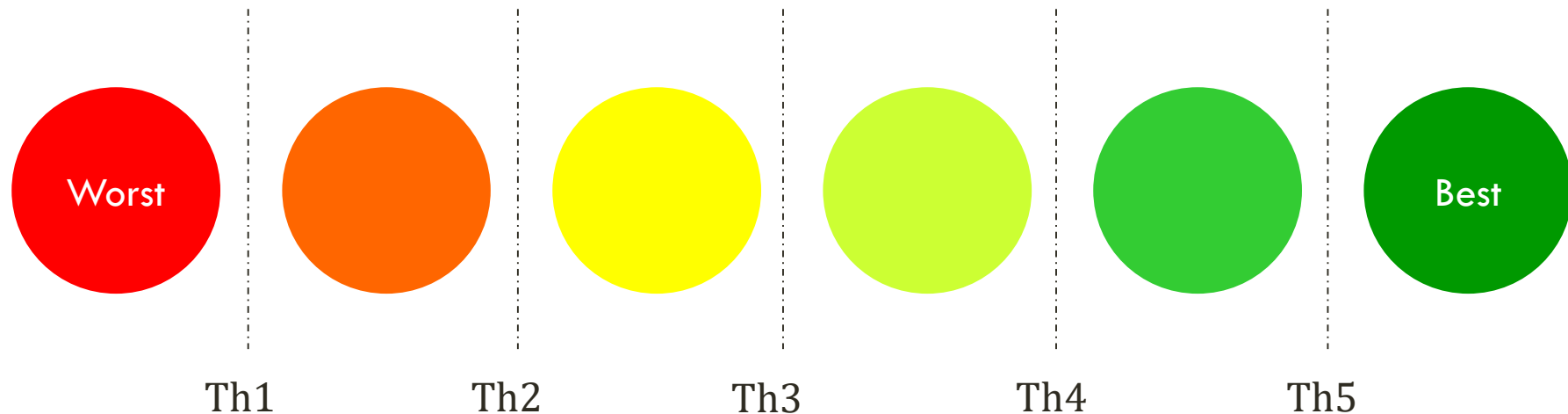
THE SCENE

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
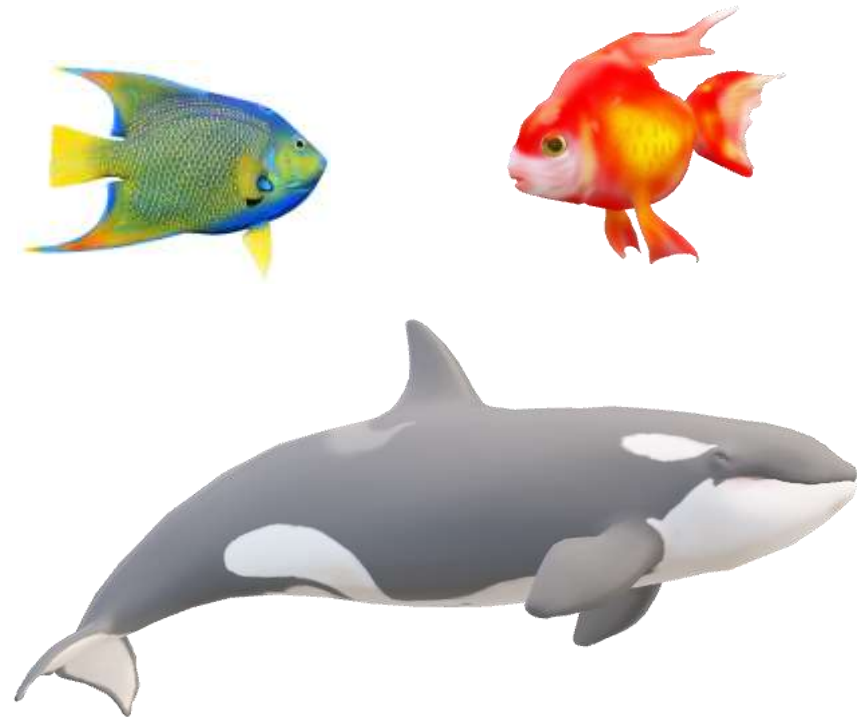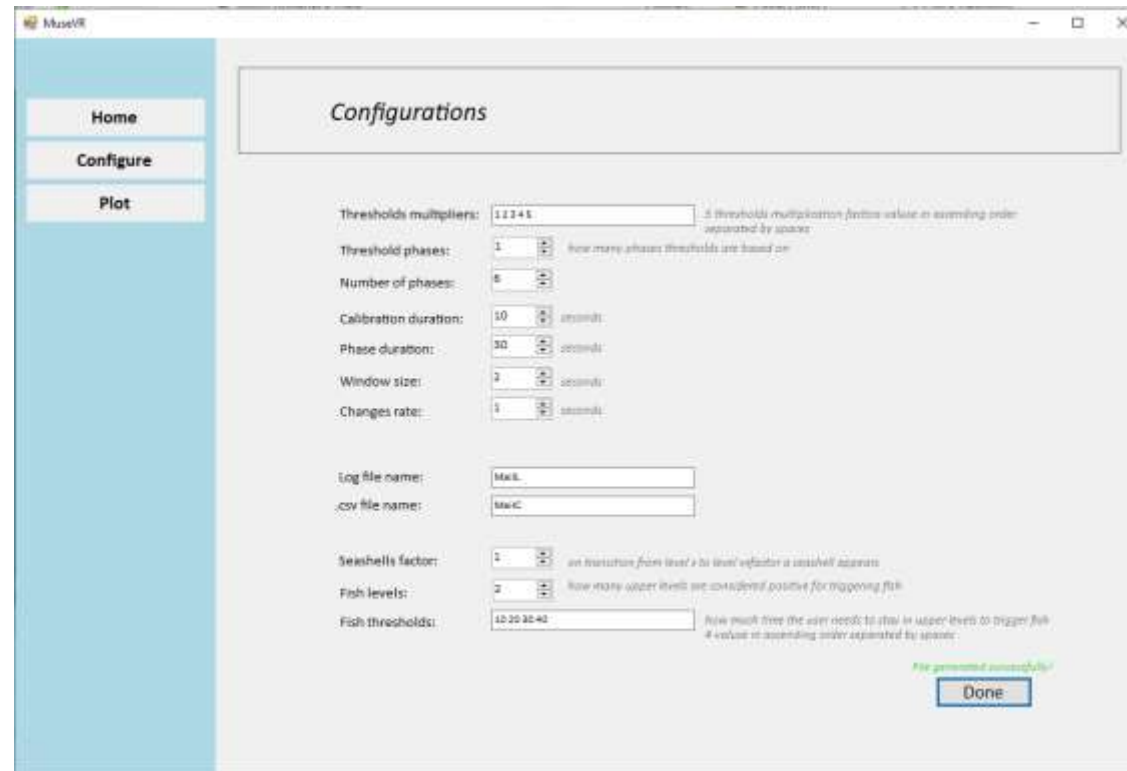
INPUT AND OUTPUT

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

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
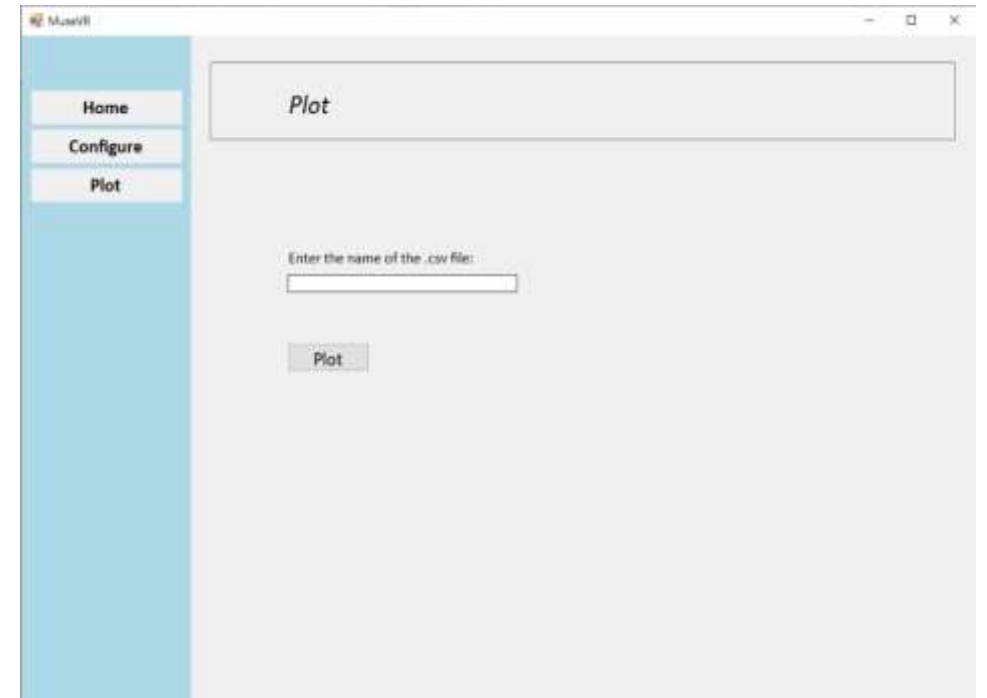
.CSV FILE

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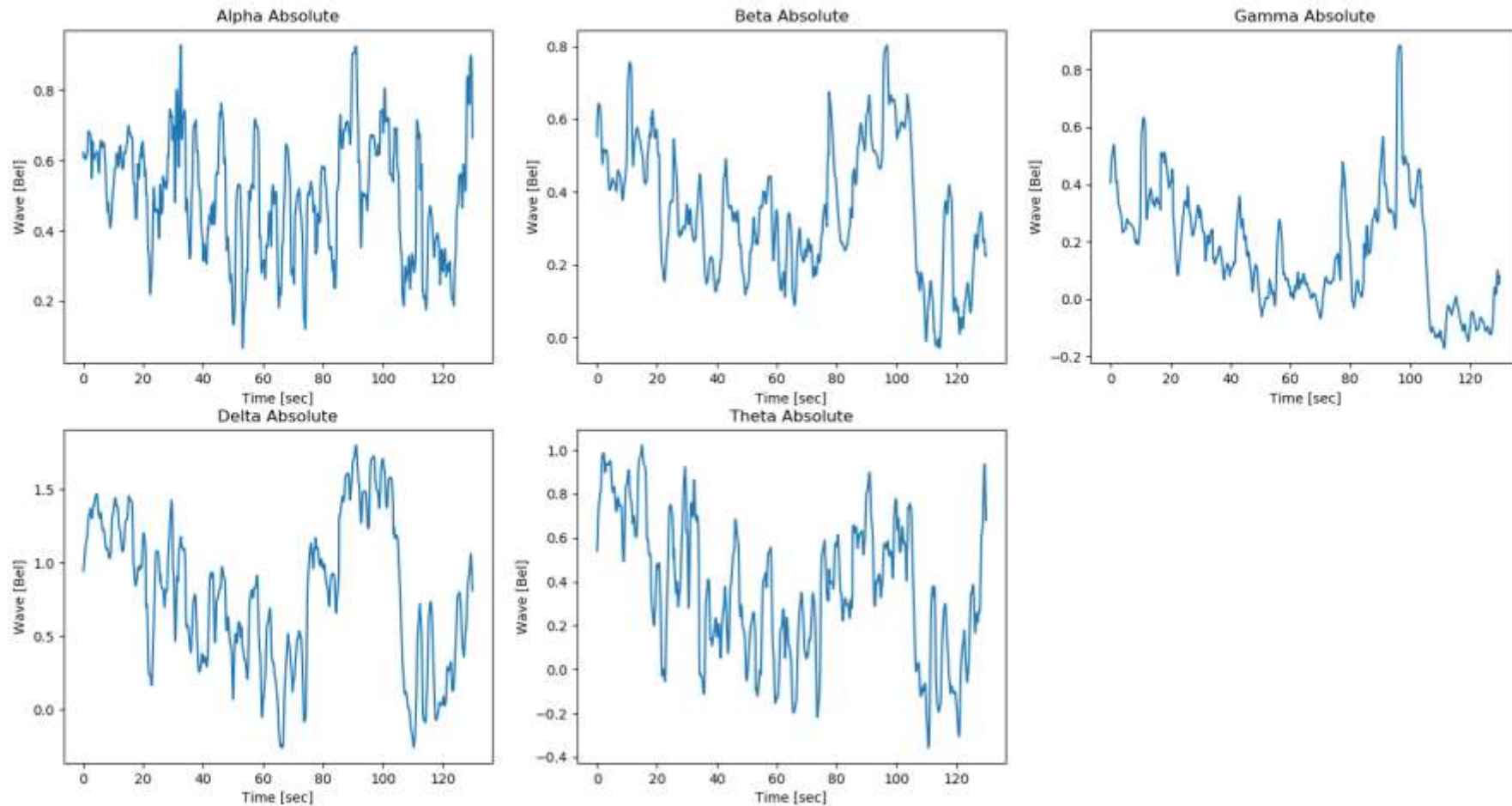
Can be found at <current working directory>\Logs\<file>.csv

GRAPHS

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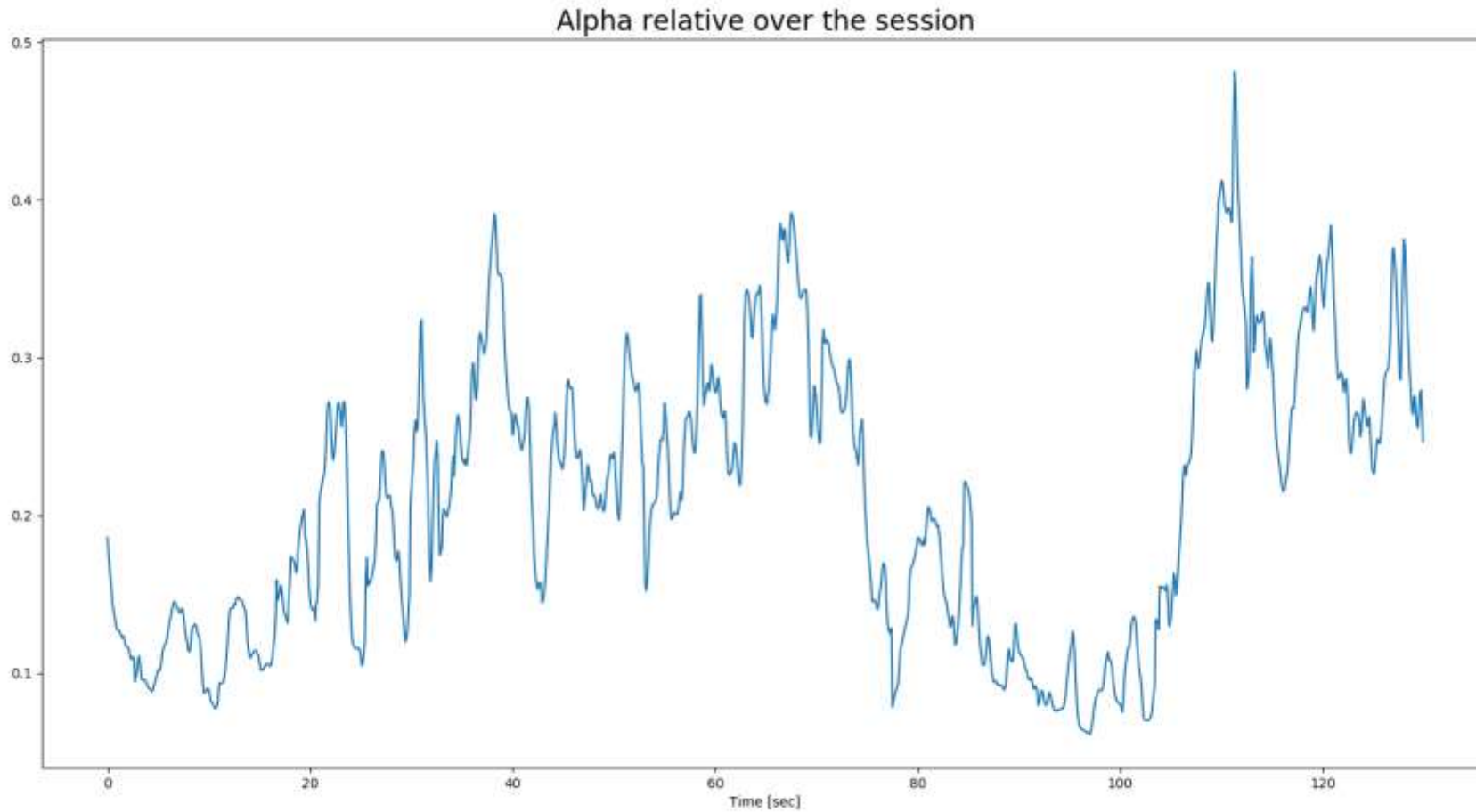
➤ Implemented in python – matplotlib.

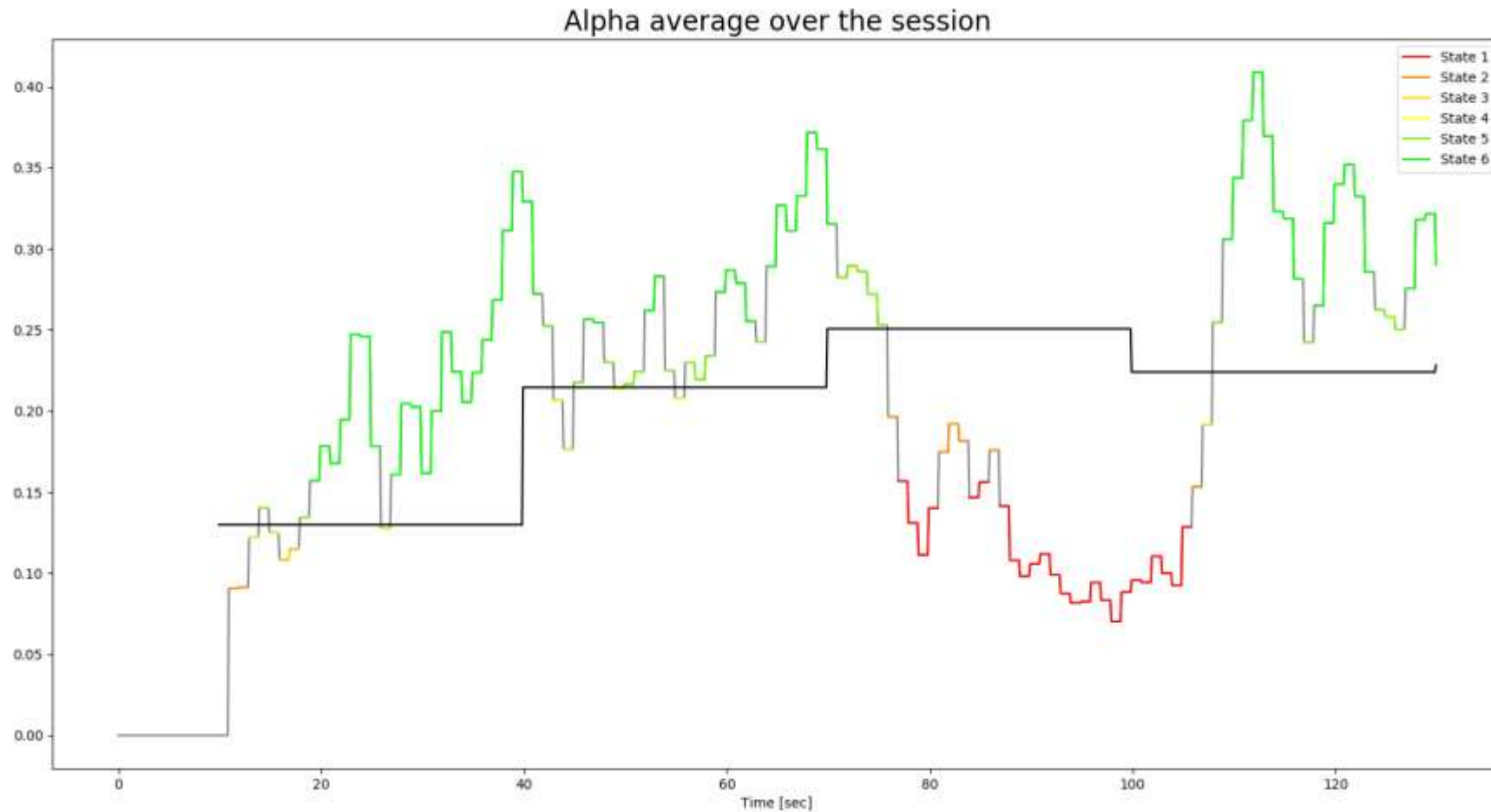# 5 Graphs of the EEG waves during the session:

Absolute Waves Values

Alpha relative values during the session:

Alpha relative over the session

Alpha relative average during the session:

Alpha average over 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!