# **CBREN**

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**Contents**

[**CBREN** 1](#_Toc468183379)

[**University of Texas at Arlington** 1](#_Toc468183380)

[**Introduction** 3](#_Toc468183381)

[**Purpose of the project** 3](#_Toc468183382)

[**Accomplished** 3](#_Toc468183383)

[**The Stakeholders** 4](#_Toc468183384)

[**Personas** 4](#_Toc468183385)

[**Project Constraint** 4](#_Toc468183386)

[**Mental modal** 4](#_Toc468183387)

[**Related Work and Assumption** 4](#_Toc468183388)

[**Functional Requirements** 5](#_Toc468183389)

[**Functional Requirements** 5](#_Toc468183390)

[**Data Requirements** 5](#_Toc468183391)

[**Non-Functional Requirements** 5](#_Toc468183392)

[**Usability Requirements** 5](#_Toc468183393)

[**Environmental Requirements** 6](#_Toc468183394)

[**Operational Requirements** 6](#_Toc468183395)

[**Phases** 6](#_Toc468183396)

[**Phase-1** 6](#_Toc468183397)

[**Phase-2** 6](#_Toc468183398)

[**Phase-3** 6](#_Toc468183399)

[**Phase-4** 7](#_Toc468183400)

[Conclusion 7](#_Toc468183401)

[Results 7](#_Toc468183402)

[Reference: 7](#_Toc468183403)

# **Introduction**

Human cognition can be improved by Brain entertainment & neural feedback systems. With the current advancement in technology, now we have off the shelf EEG bands like Emotiv Epoc that can record and log the brain wave patterns. Integrated computer applications can be developed which can aid cognitive improvement. These computer applications not only help in the aid of the cognitive improvement but also can be used for analysis, relaxation and entertainment of the brain. One such type of application in this field is “Muse meditation “ app which reads the brainwave patterns of the user in real time and measures how much the user is relaxed.

# **Purpose of the project**

Even though there are products available for neural feedback (NF) & brain entertainment (BE) in isolation. As far as our knowledge extends we could not find a product which combines both BE & NF, additionally, in BE focusing on using the visual cortex a large window to the brain. We wanted to create a solution that might potentially help people to improve cognition in general and also with mood disorders like depression, whose brains could not be accessed via biological channels using drugs.

# **Accomplished**

We created CBREN (Computer- Brain Entertainment & Neural Feedback System). The system is a combination of Emotiv Epoc EEG headband, Computer, an ASP.Net web application. The user is given EEG based brain feedback with Asynchronous neural feedback protocol. We used cloud computing technologies Azure, Amazon IOT, Amazon MySQL service, Dynamo DB and AWS Lambda.

We used Unity Game Development Engine to develop a game which takes neural feedback from the user and performs the given task.

# **The Stakeholders**

Current stakeholders include the team behind the CBREN- Karthikeya Rajamani, Adhavann Ramalingam and Srinivas Bavisetti as well as our mentor Filia Makedon and her HCI research Lab. Future stakeholders include the companies / financial donors that wish to make CBREN as a product for the people or usability testing using the CBREN.

# **Personas**

The CBREN can be used by the people for two purposes, first is to develop the cognitive abilities of the people and other is for the people who are depressed. CBREN will assist the people in depressed state to improve the emotion state of the person helping them to get out of the mood by engaging in other activities. It also improves the person’s cognitive abilities by the neurofeedback game by improving the brainwaves of the person.

# **Project Constraint**

# **Mental modal**

The CBREN System aims to collect data that is produced from the human brain waves after a set of events , targets the users vison and sense of sound in a systematic manner and then tries to increase the alpha brainwave by neurofeedback gaming. Then we record the data of the user form a set of tests and observe the improvement in the brainwaves of the user.

# **Related Work and Assumption**

Electroencephalogram(EEG) is being used to analyze the user’s mood and to improve the capabilities of the human for instance to improve the cognitive ability and improve the emotional state of the person (Ramirez, Lefler, Giraldo & Vamvakousis, 2015). The emotional state of the person can be differentiated between the depressed and casual or normal state using the alpha-beta activity in the left and right mid frontal cortex. Increased activity of alpha/beta ratio of the right mid-frontal cortex relative to the left mid-frontal cortex will improve the emotional state of the person.

Due to the use of Emotiv Epoc EEG band, the activity of the brain on the particular electrode location can be measured, moreover the alpha-beta ratio of the electrode location F4 and F3 is of high concern because alpha-beta ratio on F3 and F4 provides the necessary information of the emotional state of the brain (Ramirez, Lefler, Giraldo & Vamvakousis, 2015). Since each person’s alpha-beta ratio will vary from person to person, we are carrying out the test in prior to find out the average value of the alpha-beta ratio of the person for electrode location F3 and F4 separately. The positive value in the alpha-beta ratio difference. It is hypothesized that the increasing difference in the alpha-beta ratio of the electrode location F4 and F3 will improve the emotional state of the person and improve the alpha activity.

# **Functional Requirements**

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The Emotiv Epoc EEG band is used to collect the EEG data from the users which has 14 channel wireless sensors and connects to the computer through Bluetooth USB. CBREN can be used in any Operating System having support for Python v2.7

## **Data Requirements**

The Emotiv Epoc EEG band is used to collect the EEG data from the users which has 14 channel wireless sensors and connects to the computer through Bluetooth USB. CBREN can be used in any Operating System having support for Python v2.7

# **Non-Functional Requirements**

## **Usability Requirements**

Simple user Design and easy to implement single web application with user friendly interface is one of the major usability requirement.

## **Environmental Requirements**

Users should be present in a welllit room and a computer with good internet . The room should be present in such a way that the user could be able to relax completely and be comfortable in the room to take the test.

## **Operational Requirements**

User should have minimum knowledge of how Emotiv Epoc Head Band works and setting it up.

# **Phases**

## **Phase-1**

We initially evaluated Muse head band & Emotiv Epoc for the EEG data, Muse band delivered aggregated results & had frequent disconnections so we tried using the Emotiv Epoc headband, it had 14 sensors that delivered individual sensor readings, but it had only the visual output & we could not access the raw EEG data.

We initially designed a set of games that can help us profile the user brain. We evaluated various games like reflex, matchstick puzzle etc.,

## **Phase-2**

When presenting the related work on the project we came across implementation on Asyncrononous protocol for neural feedback, but could not get the left Alpha & right Alpha separately. But, getting the raw values was not supported by the Emotive SDK.

We tested Muse band to possibly implement the Asyncrononous protocol. We developed a Minecraft game which could be potentially used for neural feedback. The prototype was using the mouse clicks instead the data from the Emotiv.

## **Phase-3**

We communicated extensively with Emotiv Technical Support Team & finally found that we could use the average power through an API & deduce the required brain patterns. We created centralized access for the processed EEG data through Amazon IoT services which will be useful to get the input for neurofeedback.

We developed a simple space shooter game where we have to use the hands to control the movement of a space craft and the shooting part is done based on the output received from a file.

## **Phase-4**

Data collection from EEG, ASP.Net Web application & Unity game were completely integrated & the pre-test & post test scores were reported to measure cognitive change.

# Conclusion

Through our CBREN, we can able to improve the cognitive ability and emotional state (Depression) of an adult person by continuous session of CBREN.

# Results

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