Software Requirements Specification

for

Software for Balance and Memory Improvement Brain-Computer-Interface Prototype

Version 0.1

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# Revision History

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| --- | --- | --- | --- |
| **Name** | **Date** | **Reason For Changes** | **Version** |
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# Introduction

## 1.1 Purpose

This document specifies the requirements for the development of Brain-computer Interface training prototype. The scope of the prototype is to describe the features, interface of the software, underlying system and constraints under which it must operate. This document is applicable for the developers and stakeholders of the interface system using as an outline.

## 1.2 Document Conventions

This Document was created based on the IEEE template for System Requirement Specification Documents.

## 1.3 Intended Audience and Reading Suggestions

This document is meant to be a reference document for the BCI system developers in the study group as well as the stakeholders of the cognitive training schemes both in academic and healthcare area. It is also for the Ethics committees of the University of Liverpool, National Tsing-Hua University and the UK NHS Health Research Authorities.

## 1.4 Product Scope

Non-invasive BCI intervention requires slighter and less-expensive implementation compare to conventional fall-prevention programmes such as physical therapy and reconstruction of living environment. A widely used BCI therapy for improving cognitive function is electroencephalogram (EEG) based neurofeedback (NF) training. To date, emerging studies on the use of Brain-Computer-Interface(BCI) for cognitive training supported that BCI could strengthen neural plasticity by neurofeedback (NF) training. In particular, neurofeedback training applies BCI to change cognitive process and provide real-time feedbacks in either visual form. Considering fall risk reduction, the scope of the project is to create a hardware-software solution to bridge the gap between fall risk and genitive function deficits using brain-computer-interface technology.

The application is responsible for interfacing with the EED headset, extracting information from EEG signals headset collected, and allow user to modulate the signals to complete tasks by mental commands. The timed-up-and-go task is performed before the gaming session to collect user’s EEG features. After this, the application will require the user to modulate alpha band amplitude and theta band coherence to complete the games. This product is an interface connecting with the headset that develops a therapeutic tool to improve older people’s performance on balance and memory. By Using this tool, older people’s cognitive functions could be trained and their fall risk could be reduced.

## 1.5 Reference

# 2 Overall Description

## 2.1 Product Perspective

The product is a software-hardware system that create an offline user interface for neurofeedback training. The product establishes communication between an EEG headset device and gaming software for the user to complete cognitive tasks. The major components of the system to be developed is shown in figure 1.

Graphical user interface

Description automatically generated

Figure 1. Major system components of the brain-computer-interface system

In the action and interaction subsystem, a set of interactive training programs will be developed. The content of training task may vary, but all programs should read real-time brain signals from the EEG hardware and provide visual and audio feedback.

The application should support the following use cases:

1. User triggers the movement of an avatar to complete timed up and go (TUG) test mentally. chosen because of the easy realization in an indoor laboratory.
2. User navigates an avatar in the virtual environment of to complete cognitive task.
3. User interact with the virtual environment through EEG hardware.
4. User records real-time data passively for signal analysis.

## 2.2 Product Functions

1. Communicate with the user’s brain
2. Monitor user’s brain activities
3. Conduct signal processing for user’s EEG signals in real-time
4. Game application receives control signals from signal processing program
5. Store individual’s processed brain data

## 2.3 User Classes and Characteristics

There will be two kinds of user classes:

1. Aging users who would like to improve their balance and memory functions. The user should be able to see objects on a screen and think independently during the training.
2. Administrators who are part of the study group. They should be able to access the stored user EEG data in the system.

## 2.4 Operating Environment

## 2.5 Design and Implementation Constraints

## 2.6 User Documentation

## 2.7 Assumptions and Dependencies

# 3 External Interface Requirements

## 3.1 User Interface

## 3.2 Hardware Interface

## 3.3 Software Interface

## 3.4 Communication Interfaces

# 4 External Interface Requirements

## 4.1 System Feature 1

## 4.2 System Feature 2

# 5 Other Nonfunctional Requirements

## 5.1 Performance Requirements

## 5.2 Safety Requirements

## 5.3 Safety Requirements

## 5.4 Software Quality Attributes

# 6 Other Requirements

# Appendix A: Glossary

# Appendix B: Analysis Models

# Appendix C: To Be Determined List