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Brain\_Computer Interface

[Company name] | [Company address]

COMP3782 IT project

finn0066

[Year]

# 1.0 exexutive summary

In 2003, as a part of the Centre for Neuroscience and Medical Device Research Institute, a variety of specialists in the Neuroscience, Medicine, Computer Science, Engineering and Psychology fields came together to form the Brain Signal Lab (BSL). The primary objective for the BSL team is to investigate the behaviour of neurological diseases by using technology and machinery to analyse various signals generated from the brain. This process however involves an excessive amount of MATLAB coding and complex algorithms which, in most cases, can be very hard to explain to audiences with little knowledge in Computer Science.

The BSL team aims to create a simple yet interactive Brain Computer Interface (BCI) that utilizes electroencephalography technology to create an interesting model that will appeal to young children. In developing this program, the BSL team hopes to apply to a broader audience, mostly focussed on school aged children, to both engage students in neurological research and show the importance of this innovative technology.

In this project specification document, the selection and overview of an interactive, user friendly model will be explained in detail using a variety of project management techniques. These techniques are used to justify why the preferred option is chosen as well as the team management process and costs it would take to complete the project. Such techniques include conducting cost estimates, doing a stakeholder analysis and writing milestone lists which present information to be analysed about the proposed project in factual and numerical data.

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# 2.0 introduction

This report is the final report for the team working on the Brain computer interface project in COMP3782. This project’s main stakeholder is Trent Lewis, Trent wishes to have a solution that allows him to simulate brain signals using a RGB LED strip. This is to allow a way for Trent to offer a visual demonstration to children with the purpose of creating a fun and engaging demonstration.

This document will go into specifics on how the project went throughout the phases of development and how the project team achieved its goals. Project management tools and schedules shall be included to show any problems that team members may have encountered and solutions that were developed.

## 2.1 Project Overview

2.1.1 Title

Brain Computer Interface (BCI)

## 2.1.2 Vision

After speaking with the main stakeholder Trent Lewis, the project aims were to develop a software solution to allow an EEG headset (Epoch+) to communicate with an addressable RGB LED strip to simulate brain activity, This LED strip will be placed in a hollowed out 3D printed brain and made available to show primary school age children. This is to provide a more engaging and visual representation to increase interest in Brain computer interface technology and the field of STEM amongst younger school aged students.

### 2.1.3 Objectives

As the topic of Brain EEG signals can be a complex subject the objective of this project is to provide a visual representation of signals being passed in a visual way that can be easily understood and presented to younger school age children. Through this it is hoped that the research currently being conducted by Trent Lewis will be more widely available to a larger audience thereby increasing the interest in the field of Brain computer interfaces.

### 2.1.4 Scope and Acceptance Criteria

Project scope was identified early on and with the approval of the primary stakeholder Trent Lewis. It was agreed upon by the development team and primary stakeholder that the project would not exceed the original need of Trent to have a way to show younger ages school children a fun and interactive visualization of brain activity.

Acceptance criteria would be the creation of appropriate user documentation of code (using Javadoc’s) and a user manual that would describe on how to use the software. Also, that a working prototype would be developed simulating brain activity on addressable LED lights that can be placed in a hollowed-out 3D printed brain model.

This is to be delivered no later than the deadline of 6/11/2018.

# 3.0 Problem statement

It was discussed with Trent Lewis that he had found problems in trying to offer a visual way in describing how brain signals work and what areas of the brain are active in different moments of time. Work had been made by Trent to turn off a LED light using a modified We-Mo although was unsuccessful.

# 4.0 Project purpose

The purpose of the *BCI* project is to make the research of the Brain Signals Lab more accessible to a wider community, with a focus on school aged children. Thereby making the STEM more engaging and fun to a younger audience.

Currently projects have been developed that allow a LED to be turned on and off through changes in the brain’s Alpha rhythm (Lewis, 2018). Due to the simple nature of turning a LED on and off, more engaging outputs are required to fully engage school students in the STEM area. This project will address this issue by looking at creative way of display brain activity.

With the sponsorship of Trent Lewis, we are going to attempt to develop a more engaging way to interact with BCI technology in the hopes of garnering more interest in STEM among school-aged children. The majority of our work will be done at the Flinders University Tonsley campus with the end product being deployed into schools to reach our target audience.

# 5.0 assumptions

This section shall highlight assumed items that the project team may have thought of during or after completed development;

## Assumptions

* All team members in the project have programming experience in multiple languages and are willing to learn new skills.
* Drivers and libraries are available to the team to use and are open source increasing development time.
* All communication from the team to the stakeholder will be answered in reasonable fashion.
* The Solution can be achieved either with open source platforms or programs.
* LED lights are all functional and drivers can be used to control the LED lights.
* Any costs will be incurred by the University in procurement of additional technology and this will be supplied in a timely manner.

## Constraints

* All software developed must be able to interface with the EPOCH+ provided
* Instructions on how to use the hardware must be presented in an easy to use format.
* Communication with primary stakeholder Trent Lewis may be hard as the stakeholder may have time constraints.
* If using open source software, it must be chosen that supported release will last the next five years at a minimum
* Code will be must be following programming language guidelines and have comments to explain complex blocks.

# 6.0 work plan

This section is focused on how the system will be interpreted by the Work Breakdown structure and highlight the amount of work that may be involved with building the system. Information presented in this structure will be used to split assigned tasks to team members and help with the creation of the Gantt chart for team members to use.

## 6.1 Work Breakdown Structure (WBS)

## 6.2 Gantt Chart

# 7.0 - Stakeholders Analysis

The Stakeholder Analysis, shown below details the relevant stakeholders that are associated with the project. Internal stakeholders are limited to Trent Lewis as the brain signals laboratory is not collaborating with the project. External stakeholders are future stakeholders that may have interest in a completed project submitted by the project team.

## 7.1 – Internal Stakeholders

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Stakeholder Name | Role on project | Impact | Organisation | Level of Influence | Suggestions |
| Trent Lewis | Project Supervisor | Very High | Flinders University, Tonsley 3.26, (08) 8201 3867 | Very High | Inform Supervisor through weekly meetings about project status |

Figure 9. Internal Stakeholders

## 7.2 – External Stakeholders

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Stakeholder Name | Organisation(s) | Impact | Level of Interest | Level of Influence | Suggestions |
| Suppliers | Flinders University, Emotiv | Provide materials, resources for project | Low | High | Spend time researching education department guidelines and Emotiv developer guidelines. |
| Government | Department of Education |  | High | High | Communicate with variety of Government Departments to discuss any legal concerns. |
| End Users | Children, Students. |  |  | High | Discover ease of use options for children of all ages. |

Figure 10. External Stakeholders

## 7.3 Communication Management plan

Managing communication between internal and external stakeholders is a vital part to ensuring the projects success. Team members had decided to create a communication plan for the project’s lifecycle. External stakeholders are needed to be contacted one the project is near completion.

### 7.3.1 Communication Summary

|  |  |  |  |
| --- | --- | --- | --- |
| Stakeholder | Type of Communication | Producer | Frequency |
| Project Team Members | Physical Meetings, Discord | Project Team Manager | Weekly |
| Trent Lewis | Physical Meetings, Email | Project Team Manager, Individual Team members | Weekly |
| Suppliers | Email | Suppliers | Quarterly |
| End Users | Email | End Users | Before Event. |

### 7.3.2 Communications Responsibilities

As communication with stakeholders is vital to the project, agreed terms have been established by team members.

* Issues that arise during project development must first be discussed with the group members. If no suitable option can be chosen primary stakeholder Trent Lewis will only then be contacted by the Project team leader.
* All Communication shall be discussed with team members at the weekly meeting and any emails sent between team members and stakeholders will be made available for viewing.
* Communication that may be needed with external stakeholders should first be discussed with Trent Lewis.
* Communication between team members will be civil and discord will be the primary tool used. All team members will be available and have accounts created on discords application to ensure timely communication.

# 8.0 Change requests

Change requests were needed to be agreed upon all team members, As the project specification became more complete documented changes were needed. Project changes also needed to be discussed and agreed to with the internal stakeholder Trent Lewis. Once agreed team members could then implement the changes.

**BCI Project Change Request 1**

**Project Name:** Brain Computer Interface

**Date Request Submitted:** 11th September 2018

**Title of Change Request:** Remove LSL broadcasting to improve efficiency of heatmap program

**Submitted by:** Josh Francis

Change Category:  Scope  Schedule  Cost  Technology  Other

**Description of change requested:**

Removal of LSL broadcasting component within the software to improve efficiency and responsiveness of heatmap LED driver.

**Events that made this change necessary or desirable:**

It was discovered that the Raspberry Pi struggled to run the heatmap calculations. This resulted in a system that did not satisfy the desired level of responsiveness.

**Justification for the change/why it is needed/desired to continue/complete the project:**

In order to improve system responsiveness, it was deemed necessary to remove the LSL broadcasting component.

**Impact of the proposed change on:**

**Scope:** Reduces development time by reducing overall complexity of the software.

**Schedule:** No negative effect on overall project schedule.

**Cost:** No effect on the cost of the project.

**Risk:** No risk involved.

**Suggested implementation if the change request is approved:**

Simple deletion of the code responsible for LSL broadcasting.

**Required approvals:**

|  |  |  |
| --- | --- | --- |
| **Name/Title** | **Date** | **Approve/Reject** |
| All project members | September 2018 | **Approved** |

**BCI Project Change Request 2**

**Project Name:** Brain Computer Interface

**Date Request Submitted:** 25th September 2018

**Title of Change Request:** Multithread heatmap calculations

**Submitted by:** Josh Francis

Change Category:  Scope  Schedule  Cost  Technology  Other

**Description of change requested:**

Make changes to the existing code responsible for heatmap calculations by modifying the logic such that multiple threads could work simultaneously on the task, in the hopes of improving system efficiency and responsiveness.

**Events that made this change necessary or desirable:**

Having removed the LSL broadcasting component, it was evident that the system still did not meet the desired level of efficiency.

**Justification for the change/why it is needed/desired to continue/complete the project:**

As responsiveness is a key component of the final system, it was deemed necessary to make whatever changes necessary to achieve this.

**Impact of the proposed change on:**

**Scope:** increases development time by increasing complexity of the software.

**Schedule:** Minor effect on overall project schedule.

**Cost:** No effect on the cost of the project.

**Risk:** No risk involved.

**Suggested implementation if the change request is approved:**

Modifying the logic within the “updateMatrix” method in order to facilitate concurrent execution via multiple threads.

**Required approvals:**

|  |  |  |
| --- | --- | --- |
| **Name/Title** | **Date** | **Approve/Reject** |
| All project members | September 2018 | **Approved** |

# 9.0 issues list

As the project commenced issues were encountered while trying to implement the project these issues are to be documented in this section and made available for team members to review. Project reflection will use information gathered in this section to avoid mistakes in future projects.

Date: 9/08/2018

Title: Awaiting Project files.

Parties Involved: Stakeholder, Project Team

Description:

As teams had been specified both groups ran into problems progressing further. This was due to awaiting documentation and project files from the stakeholder. While waiting it was decided that team members should research different methods of completing the project without the project files, team members found different methods for implementation and proceeded to investigate further.

Result:

Stakeholder eventually did release project documentation to group and gave advice onto what directions could be achieved from there project resumed scheduled delivery.

Date: 16/08/2018

Title: Awaiting hardware requests

Parties Involved: Stakeholder, Project Team

Description:

Team members ran into problems trying to get access to the EPOCH+, only one unit is available for both team groups to use at a time to collect data. Also team members were waiting for the LED lights that would connect to the raspberry pi to show the different signals

Result:

Both groups agreed to share the EPOCH+ and it was assigned to the software-Team for this week. Josh had organized with Trent to be able to use the LED and take them home for further testing. In the meantime, the project team decided to focus on creating a dummy script and look at how they can implement all the python files for use in the raspberry pi.

Date: 23/08/2018

Title: Implementing .xdf format

Parties Involved: Project Team

Team members have analyzed and tried to implement the code changes, Git hub has proved useful in the team development environment. Project members are having a hard time using. .xdf format and creating dummy scripts to test the implementation on the Raspberry pi. As test data has not been received yet

Result:

Team members brute forced and hacked together a basic implementation which proved useful in testing.

Date: 8/30/18

Title: LED Driver implementation

Parties involved: all team members

Priority: Major

Team had encountered issues implementing LED drivers to control specific colors and configuring power requirements.

Result:

Team worked together to look at drivers and check online user guides on how to fix the issues. Team came to a satisfactory conclusion.

Date: 9/6/2018

Title: Epoch+ Bluetooth connectivity issues RaspberryPI

Parties involved: Michael

Priority: minor

Description:

While implementing Bluetooth capability for transferring data between the raspberry pi and epoch+ headset. Michael ran into problems with the PI unable to form a proper connection to the device.

Result:

Team members consulted Documentation on line and eventually got the PI to receive the signal.

Date: 9/20/2018

Title: LED Driver implementation problems

Parties Involved: all Team members

Criticality: High

Description:

While running program on raspberry pi the team encountered issues with unsigned integers returning a -1 value. Team was expecting a return value of 1-255 which would be used to highlight a colour on the LED strip.

Result:

Josh and Michael have started to debug the issue and going through log statements in the Raspberry Pi.

Date: 10/4/2018

Title: Raspberry Pi implementation problems

Parties involved: Michael Doug

Criticality: Low

Description:

While trying to implement the drivers from Josh’s software program Michael had issues trying to get the program to function correctly. Work began on trying to fix the implementation from Josh’s Drivers.

Result:

WIP.

Date: 10/11/2018

Title: 3D printed Brain Malfunction

Parties involved: George Prios

Criticality: Medium

Description:

While printing the 3D printed model of Trent’s brain for the seminar that will be holding the LED’s issues arose in the structure of the print and problems with hollowing it out.

Result:

A reprint of the model took place and replaced the original version.

# 10.0 outputs

# 11.0 recommendations and conclusion

# 12. final reflections

# refrences

# appendix