PREPROJECT - REPORT

FOR BACHELORTHESIS

TITLE:			
Man/Machine interaction through EEG			

CANDIDATE NU(S):			
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ASSIGNER(S)/SUPERVISOR(S):
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ABSTRACT:

The preproject report describes how the group will work in the main project, it goes through all the boundaries, plans, norms and how the group will work together with the supervisors to ensure the quality of the project. This main project is given by Aalesund University College, and is a research project designed to investigate the possibilites that EEG unravels when it comes to interfacing mind and machine. We applied for this project since it seemed very future oriented while giving us alot of creative freedom. In recent years EEG has proven itself to have a more widespread use than previously recognized, brainwave patterns can be sampled and used as commands controlling a computer. This opens up alot opportunities for disabled people and those with special needs, if this technology is refined and built upon their everyday lives could be drastically simplified.

More specific, this group use will established software like Unity 3D and the development platform Visual Studio with the programming language C#, to tie together the Emotiv Epoc development kit with a game envoirment created with the Unity game engine. This will then in turn enable direct interactivity between the game envoirment and the players mind, throughout this process new ideas will immerge and these will be evaluated in hope of discovering new applications in this field. The character of this project is highly creative, therefore it up to the group to take this project as far as possible, everything will be documented in a scientific manner to lay a possible foundation for future work and research.

This project is handed in for evaluation and accreditation at Aalesund University College.

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1 Introduction

1.1 Abstract

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1.2 Concepts

EEG
Electroencephalography (EEG) is the recording of electrical activity along the scalp. EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain.

Unity 3D
Unity is a game development ecosystem: a powerful rendering engine fully integrated with a complete set of intuitive tools and rapid workflows to create interactive 3D and 2D content.

Visual Studio
Visual Studio is an IDE designed to develop software based on Microsofts .NET platform. Supported languages include C#, C++, Visual Basic and more.

C++
C++ (pronounced as cee plus plus) is a general-purpose programming language.

C#
C#(pronounced as see sharp) is a multi-paradigm programming language encompassing strong typing, imperative, declarative, functional, generic, object-oriented, and component-oriented programming disciplines.

Emotiv Epoc
The headset for the EEG, where Emotiv is the manufacturer and the model is named Epoc.

Dropbox
Dropbox is a free service that lets you bring your photos, docs, and videos anywhere and share them easily.

API
In computer programming, an application programming interface (API) is a set of routines, protocols, and tools for building software applications.

Milestones
Milestones are a tool used in project management to mark specific points along a project timeline. These points may signal anchors such as a project start and end date, a need for external review or input and budget checks.

2 Project organisation

2.1 Projectgroup

Studentnumbers
120405
110184
120138

2.1.1 Tasks for the project group

To ensure maximum advantage of the given resources, it is necessary that the group share different roles and responibilities throghout the course of the project. The group needs one projet manager and one secretary, each member of the group will try out all possible areas of responsibility before the project is over.

With a well organized project, better task monitoring concerning the progression of different elements during the process of completion will be ensured, this will make it much more easy to succeed in realizing the projects ultimate goal.

The project group will do the everyday work, that means, investigation, testing, writing reports and generally pushing the project forward by taking on the challenges that arise throughout the course of the project. Especially with this kind of open project they will have to generate ideas and create new tasks and possibly discover new possibilities.

2.1.2 Responsibilities and tasks for the project menager

The project manager is responsible for the projects completion within timeframe and budget, he/she will also has to monitor the projects objectives and wether or not everyone is realising their full potential. He/she is also responsible for the groups communication, cooperation, he/she will also guide and motivate the group. The project manager oversee the project to ensure that the desired result is achieved, the most efficient resources are used and the different interests involved are satisfied. It is also important to ensure good reporting/logging during the process. Mainly the leader is responsible for keeping the project on track concerning the goals and boundaries that is set before the project started.

2.1.3 Responsibilities and tasks for the secratary

The secratary has in general the responsibility of daily operational tasks within the project, in many ways the secretary functions as the project leaders right hand. The secretary shall have an overview of what happens in the work process, and at the same time award tasks and daily routines to each member in the group. If certain procedures or tasks do not work sufficiently, it is the secretary's responsibility to improve/change this.

It should be noted that these are general roles described from a generic point of view, the clear distinction of roles is more important the bigger a project is. The project described in this report consists only of three group members and therefore as a natural consequense the roles will be more dynamic and fluent than observed in bigger corporate projects.

2.2   Steering group

The groups assigner:

- Aalesund University College

The groups supervisors:

- Robin T. Bye

- Anders Sætersmoen

3 Appointments and agreements

3.1 Agreements with assigner

Aside from the agreed topic, meeting location and time, and reporting are the essential agreements. It should be noted that this project has few boundaries and allow the participants to investigate and explore the topic quite freely. Beside this it will obviously be necessary having a good dialog and communication between the group and the supervisors during the project period.

3.2 Workplace and resources

As mentioned, this project is provided by Aalesund University College, workplace must therefore be at the school. Probably most of the work will be performed in one of the computer labs.

Apart from the actual equipment, which the group already has been handed, there will probably be no need for any additional equipment.

Since this project will be done at Aalesund University College where all the professors and supervisors reside, access to qualified personel will not be a problem.

The group are also sharing folders with supervisors through dropbox. This folders are consiting of various documents, research articles, contracts according to the equipment, documenting and reporting, sourcecode etc. This allows the supervisors access to the work performed and updated to any time.

3.3 Group Norms - Cooperation Policy

All participants of the project should consider themselves as an important part of the project, and thus share the responsibility with the rest of the group when it comes to taking initiatives and coming up with ideas. Open discussion is highly regarded and considered very important in this project. For good morale, it is important that the group allows loose and dynamic roles for each participant, that way everyone gets to put their best on the table. Also to achieve the best learning experience for everyone, there will be meetings that ensure that everyone is updated and knows what is going on in every aspect of the project. All discoveries should be shared with the entire group.

4 Project description

4.1 Approach to the problem

This project aims to establish communication and interaction between the Emotiv Epoc headset and an envoirment created in Unity 3D in such a way that different brain activity is translated into commands that will be used to control aspects of the Unity 3D envoirment. Partial goals in this project; establishing a functioning communication bus between applications, creating a complete Unity 3D envoirment that functions as fun games that test the players ability to focus, getting familiar and trained with the equipment. More partial goals will arise as the project progress, since this is a research project the different elements of this project is somewhat unclear at the starting point. No clear process goals has been set at this point. The study of available litterature on the subject of EEG and it's applications will also be an essential part of the project, as this lays the foundation for the experiments that will be performed with Unity and EEG. These are the main goals, but further than that the group wants to develop an application that ties all aspects of the project into one package.

- **Main goal:** Create an experimental platform for real-time communication and control of Unity 3D virtual environments using the Emotiv EEG headset.

- **Effect goal:** Easy to use GUI application that allows everyone to experience and play with the technology. Key words here is fun and easy.

- **Result goal:** Functioning applications that interface mind and machine that give a good foundation for further research.

4.2 Requirements for solution or project results - spesification

This is a research project with loose boundaries, yet some requirements are set by the project provider. These are listed below.

1. Establish communication and control between the EEG headset and Unity

2. Study literature on EEG experiments involving 1D, 2D, or 3D tasks on screen

3. Create one or several test environments ("games") in Unity for performing experiments

4. Get a number of people to do an experiment, collect the data, and do a simple data analysis

5. Provide documentation and modularity of software for future work

Below are each of the five points more specifically described:

1. **Establish communication and control between the EEG headset and Unity**.

   There exist already an Emotiv EPOC Unity3D^{TM} Developer Support Pack that I will provide for you. It can be used for this task so you do not have to develop this from scratch. You will need to familiarise yourselves with the software and test it. I note that the support pack above says "EPOC" and we have the "EEG" version of the headset, but I think/hope this will work fine anyway. I have attached a screen capture of software add-ons for the Emotiv EEG and SDK.

2. **Study literature on EEG experiments involving 1D, 2D, or 3D tasks on screen**.

   You should read literature and see what experiments have been performed using EEG and tasks on screen. We are especially interested in 3D tasks, since we have a nice 3D game engine to play with. In particular, check out papers such as those on the Emotiv website that actually use the Emotiv equipment, and even better, see if you can find papers from people who are doing the same thing as us: Using Emotiv EEG + Unity.

3. **Create one or several test environments ("games") in Unity for performing experiments**.

   When you have studied the literature, see if you can think of an experiment that you can do that has not been done before. A good idea may be to just extend somebody else's work in one or more directions, e.g., if someone did something in 2D, can you do it 3D? Can you combine two experiments into a new one? Can you combine EEG measurements for control with mouse/joystick/keyboard control? You can also consider just using the EEG for measurements and data analysis during some manual (hand) task.

   The experiment will require you to make "games" or "tests" in a Unity virtual environment. Discussion with me about how to implement and what experiments to implement is imperative.

4. **Get a number of people to do an experiment, collect the data, and do a simple data analysis**.

   This task depends on how far you get in your project. With good progress and time permitting, we could have your entire class do an experiment. The data collected can then be used for analysis.

5. **Provide documentation and modularity of software for future work**.

   This is very important. Your code must be clear, easy to read, and with much documentation. Your report must be at such standards as to make it easy for future people to continue your work.

4.3   Development methods

Documentaion in this project is highly essential, and each discovery will be documented throughout the progression of the project, in this way no loss of key details will occour. Other than that, communication between group members is emphasized and highly regarded. Information gathering through the internet, which is full of relevant information is one of the most important methods of finishing this project on time, and getting through roadblocks. There is as of now no glaring weaknesses that threaten the survival of this project.

4.4   Information retrieval

Alot of small projects and some research has been done with the Emotiv Epoc headset, but any real significant applications for everyday use is still not achieved. This technology is relatively new, and therefore only a fraction of the possibilities has yet been realised. Similair work has been done before, for instance a previous similar bachelor thesis, this will be built upon in this project. EEG has been used for a long time in a completely different setting, it has been used to diagnose and monitor brain activity in research or medical applications. Epilepsy is a typical condition that can be diagnosed with EEG.

When collecting background information intented for this project different sources will be considered, internet forums seems to be a good source of information when it comes to problem solving and getting the different elements of the project to function. Emotiv has its own forum where developers discuss different approaches to different problems, this forum will definately be used. Some scientific papers on EEG will also be used to get a basic understanding on how the technology work and at the same time giving the group some feeling on they are working on.

4.5   Risk analysis

As this project does not have a clearly defined goal, one of the biggest risks is not having clearly defined milestones. As a consequence, the group might lose motivation and work morale. This requires us to work closely with our supervisors, and construct milestones as the project advances. Because this project iterates on a previous groups work, the time frame given is looked upon as decent when it comes to finishing the main goals of the project. There is in other words only a small chance of failing to complete the project on time. Like all software projects, a computer crash in which we loose all data is also a risk. To take measures against this happening, we use Dropbox to store all our project files. This way, if one computer crashes, information is still available on all other computers. In a case where Dropbox does not help, for example if the project files become corrupted, we aim to take regular backups. Backups will be done by compressing the entire project folder into a zip-archive. Further methods of ensuring data storage might be implemented at a later stage. Also, the equipment and software relied upon is highly dependable, therefore we evaluate the overall risk of anything going wrong is very low.

The list below demonstates the groups strategy to solve any problem that may arise during the project:

1. Identify the problem

2. Insert enough resources to rectify the problem

3. Discover what caused the problem

4. Make necessary changes to ensure the problem will not occur multiple times

5. If necessary, set a new deadline for the task affected by the problem

4.6   Main activities

The table describes generally how the group should proceed in the first period of the this project. It displays a suggestion on how future work will be performed. Factors such as time and degree can be changed if unforeseen problems emerge along the way.

Nr.	Main activity	Responsibility	Costs/ Expenses	Time/degree
A1	Become familiar with the equipment and the use of unity.	The group	No costs	2 weeks
A2	Research	The group	No costs	8 weeks(this will be done parallel with other tasks)
A21	EEG's history	The group	No costs	
A22	Theory and principles of EEG	The group	No costs	
A23	Future application	No costs	The group	
A3	Explore methods of connecting Unity to Emotiv API	The group	No costs	2 weeks
A31	Connection through plug-ins	The group	No costs	1 week
A32	Connection through existing UDP client	The group	No costs	1 week
A4	Expand the UDP client to distinguish between cognitive functions	The group	No costs	1 week
A41	Optimize reliability	The group	No costs	1 week
A42	Debugging and establishing connection with Unity 3D UI			
A5	Make a Unity-3D environment	The group	No costs	4 weeks
A51	Create Graphical User Interface that connects all software	The group	No costs	2 weeks
A52	Exploring further possibilites in the Unity envoirment	The group	No costs	Continous, no time cap
A6	Experiments	The group	No costs	2 weeks
A7	Finishing the report	The group	No costs	2 weeks
A8	Make a project poster	The group	No costs	1 week

4.7   Progress plan – project management

4.7.1   Main plan

Main activities are mainly investigation of possibilities, and the with creative freedom develop an implementation that push the boundaries of what's possible. For instance, if it is possible to create a GUI application that ties together Unity3D and the Emotiv software, that will be done ensure greater usability. Typically challenges and different ideas will arise throughout the course of the project, so at this point in time, it is hard to say exactly what the main activities will be. As a bare minimum, the activities will include creating a communication line between the Emotiv software and the Unity 3D envoirment allowing interaction between the headset and the Unity envoirment. On top of that an application that ties it all togheter would be ideal, so efforts will be made to make that happen. Different reasearch can also be done when all of the above is finished. Some ideas has already been generated, for a two player game can be made where players can go brain to brain in a battle for who has the best ability to focus. Also internal testing can be done inside the group map differences in how people learn and use the headset. No brain is alike, and this opens up the possibility to see how it affects and

distinguish the users of the Emotiv Epoc headset. The litterature on the subject open up an explorable window to the the knowledge accumulated in this field. The group will use alot of time on investigation and learning about what's behind the technology that is used. The final report will carry an emphasis and ellaboration of the knowledge gathered through the study of scientific reports and papers on EEG.

4.7.2   Management tools

Throughout the project Gantt-diagrams will be made to create a visual representation of the process and how the project is proceeding. By using a Gantt-diagram and having regular meetings, workload and milestones will be administered and planned. The Gantt-diagram illustrates a project schedule in a simple and clear picture. This is both easy to understand and very manageable if changes will be done.

4.7.3   Development tools

Software such as Visual Studio, Unity 3D and the development kit(with the API) accompanied with the Emotiv equipment will be essential tools throughout the project. Also a computer owned by Aalesund University College is used since this has powerful hardware that is handy when developing 3D envoirments. Other than that, no special tools or software are needed. Chapter 8 shows a clear overview of essential tools throughout this project.

4.7.4   Internal control – evaluation

As described in the book "Praktisk prosjektledelse" [1], internal control are all systematic measures that a project organization should implement to ensure that activities are planned, organized, executed and maintained in accordance with the requirements and pursuant to law or regulation which group / supervisors have defined.

It will be the project manager's responsibility to maintain deadlines, and to ensure progress.

After reaching a goal or objective, evaluation in relation to the criteria set for each goal will be performed. The purpose of such evaluation is to determine the extent to which the group has achieved their goal. To clarify whether the goal or objective has been achieved, clearly defined critera has been made for this purpose.

4.8   Decision making

In the initial phase of a project, it is particularly important to make good decisions, the are the ones that often affect the project most. Also, since these elemental decisions create the foundation for the course of the project, further work and research are also affected by them.

The group will collectively make key decisions in cooperation with the supervisors during the project period. Through planning and good dialog the course of the project in its different phases will be set, in such a way that a road map will be laid out as the project progress. There is no specific protocol to follow when making these key decisions, the nature of each decision will determine how the decision will be made, the only thing in common for each decision is that each member of the group should have something to say about it. This comes down to group politics, each member of the group has an equal right to influence the course of the project. It is important to note that words uttered from any special area of expertise will weigh more heavily than opinions based on anything less.

5 Documentation

5.1 Reports and technical documents

All source code should be documented and commented throughout the code, making it as easy as possible to understand what each segment of the code does.

There will be a project report written with thorough explanations of all aspects of the project. This report will be written in a typical manner following the norms of how technical and scientific reports should be written. Both the preproject-report and the main project report will be written in LaTeX, a de facto standard for the communication and publication of scientific documents. Here the group will use ShareLaTeX, an online LaTeX editor which allows for real time collaboration and online compiling of projects to PDF format.

6   Planned meetings and reports

6.1   Meetings

One of the most common ways to maintain good communication during the project period, make sure that the project is prograssing as expected and that any issues are being addressed, is to arrange continuous project meetings.

6.1.1   Meetings with the board

There will be a meeting with supervisors every second thursday 12.30 pm. This will be planned and led by the project manager. To ensure effective projects meetings it will be filled out a project-progress report and made a list consisting of central themes that will be discussed during the meeting. Progress-project report, meeting themes, meeting time and local will be sent by email to the supervisor two days before agreed meetingday. To ensure that important discussed team are not forgotten after the meetings, the Secretary will be responsible to note such under each meetings.

6.1.2   Projectmeetings

The day to day activities of the group will consist mainly of individual work, located as a team in the same vincinity. To update each member of the group continuously, it will be performed a small meeting once day a week, ideally every friday. Here the group will summarize the week, and make plans for the the incoming week.

Also intensive meetings will take place within the group daily, where the group will discuss the current agenda, any challenges, problems etc.

6.2   Periodic reporting

The purpose of the status reports(project-process reports) is to provide that the supervisors are informed on project progress. It also allow the group to reflect on own performed work and how they will proceed in the further work.

6.2.1   Progress reports

Progress report will be written every second week to keep supervisors and the group updated on the progression of the project. This is important to ensure that milestones are followed according to the plan(Gantt-diagram).

It was given a template by the supervisor, showing how the progress report should be produced. In the report the group have to fill out following points listed below.

- Main purpose / focus of the work during this period

- Planned activities during this period

- Really performed activities during this period

- Description / justification for deviations between planned and actual activities

- Description / justification for the changes that are now desired in the project content or the further procedure - or progress plan

- Main experience from this period

- Main purpose / focus next period

- Planned activities next period

- Desire / need for guidance , thematic teaching - discussion otherwise

7 Planned handling of deviation

If any problems occur that might cause the project to go off track, neccesary adjustments in the plan needs to be made. Investigation as to why some things do not work as planned will be made. As this is a research project, knowing why something does not work can be just as valuable as to know why something works. The group as a whole is responsible for this. Specifically in this project, there will be a very low chance of not beeing able to reach the main goal, further than that the work will be highly exploratory and room for deviation is big. It is not clear what to make of the program as of yet, as long as the basic functionality is met, the elements that will go on top of the is defined by the group and the supervisors. The high level functionality of the product wil be flexible according to the ideas generated and what seems possible. But if any severe deviation occours the group needs to get togheter with its leader and supervisors to the discuss the next step.

8 Equipment requirements/ Conditions for implementation

This project relies on equipment given by the school, economically it is a cheap project that depends on equipment that is readily available on the market.

- Asus G750J gaming notebook pc
- Emotiv Epoc headset
- Emotiv Developers Kit (Research license)
- Unity 3D
- Visual Studio
- Dropbox
- Microsoft Project Professional
- Oculus Rift

References

[1] Rolstadås A, Olsson N, Johansen A, Langelo JA. Praktisk prosjektledelse. Bergen: Fagbokforlaget; 2014.