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CMP6200/DIG6200

Individual Undergraduate Project 2024–2025

**A1: Proposal**

Gamifying Beneficial movements for upper limb stroke rehabilitation



Course: Computer Games Technology

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# Introduction

## Background and Rationale

Upper limb stroke rehabilitation typically sees heightened implementation after patients are discharged from the hospital. After returning home a patient should undertake home therapy programmes to further recover and better their quality of life.

Having a range of home therapy options is vital, crucially due to patient travel limitations. Almost 10 million people in England live in rural areas. In these areas there are more people aged 50-59 years than any other age group with one in four people being over 65 (Statistical digest of rural England). This correlates with the ages statistically vulnerable to having a stroke. According to the GRASP instructor manual the risk of stroke doubles every 10 years after age 55, with the typical age at the time of stroke being 70 – 75 and 25% of strokes occurring in individuals below the age of 65.

The brain has the most ability to repair itself in the first 3 months post stroke (GRASP) therefore it is vital that the patient completes as much therapy in this time as possible to maximise recovery. Currently there are home therapy programmes such as the GRASP manual. However contemporary home therapy programmes do not provide high levels of motivation to the patient, this can cause the therapy to be neglected leading to sub-optimal recovery or potentially other implications such as learned non-use syndrome (GASP).

Therefore, it is important to explore ways to provide more motivation to the patient. Gamification and even more so multiplayer gamification is one such way this goal can be achieved. Being able to play the game alongside family members, friends or caregivers may provide higher levels of motivation and reduce the neglect of home therapy, increasing its effectiveness.

## Key Themes/Topics

Use bullet points and key words here: upper limb exercise for example haptic control, multi player, game for rehabilitation

This project will cover an investigation into conventional home therapy treatments and what exercises are utilised. Additionally what characteristics are necessary to provide effective interventions. These investigations will inform the design of the game.

The project will result in the production of the game and will cover the technologies utilized to create the game as well as the project management methodologies used.

Finally, the game can be tested to see if it promotes movements beneficial to stroke rehabilitation and how much motivation it provides to the user relative to other contemporary methods.

# Aim and Objectives

## Project Aim

The aim of this project is to produce a multiplayer game, utilizing etee controllers, which encourages movements beneficial to Upper Limb (UL) stroke rehabilitation and provides more motivation than conventional home therapy treatments.

## Project Objectives

* Identify characteristics of effective rehabilitation treatments.
* Identify movements beneficial to providing effective rehabilitation treatment.
* Use knowledge gained from objectives 1 and 2 to design, scope and plan the development of the serious game
* Develop the game using the designs and plans produced in the previous objective using agile project management techniques
* Test the game with a group of adults to observe the repetitions of the intended motions and motivation to play the game relative to other therapy options.
* Use the knowledge learned from testing to evaluate the projects outcomes.
* Summarize and report writing

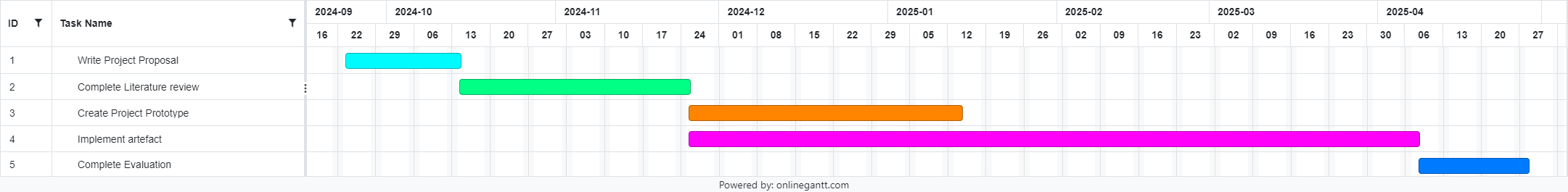
# Project Planning

## Initial Project Plan

Agile methodologies will be used during development. In this planning phase the different requirements of the project will be considered to create an exhaustive list of tasks which need to be completed. Then, each task will be assigned an estimated cost (time to complete task) on the scale of 1 – 3, additionally each task will be assigned a priority in the range of 1 – 3. 1 being high priority and 3 being low priority. This will be used in the development phase to calculate how many points can be created in a week and based off of how many points are being completed week by week and the exhaustive list of features it can be evaluated if the project is on track to be completed by its deadline. If the project seems to be going off track then the prioritys can be used to intelligently remove less important features to ensure the project will be finished on time.

Like RAD, following planning development will be separated into cycles consisting of gathering up tasks to complete, creating a prototype, testing this prototype (either by myself or getting others to test) and then iterating on this prototype.

Throughout the development of the project a kanban bord will be maintained to keep track of tasks to complete, tasks in progress and completed tasks.

The project as a whole will follow the following gantt chart. Where the project proposal will be written, following a literature review. Then the prototype will be completed and iterated upon to make the final version. Finally the project will be evaluated.

Design artefact, implement artefact (include implementation phases) too high level. Follow methodology

Lit review ends November time. Design starts then first prototype finish by jan. Evaluation needs to start February. Pilot test in February. Coud be another cycle of tests. April prepare submission.

List of development tasks to complete.(high level)

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| Task Name | Estimated cost (1-3) | Estimated Importance (1-3) |
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Research what movements are beneficial to stroke recovery.

Research the neurotherapy principles necessary to increase stroke recovery

Create the whitebox for the game

Playtest the whitebox

Add assets into the game

Playtest the game

Finally test the end product. These tests will look to see if the important movements are being performed along with how many repetitions. It will also assess the motivation to play the game again.

## Resources

To be successful in the project, resources for research, design as well as development / implementation will be required. Google scholar and the library services provided by Birmingham City University which will be useful for finding research papers, projects, past projects and other useful materials. Other resources include

* Computer (with internet connection), mouse and keyboard
* Access to someone knowledgeable in the field of upper limb stroke rehabilitation
* Unity game engine
* Version/source management software (github)
* An integrated development environment (IDE) such as Jetbrains Rider
* Access to adults with a varying prior experience with videogames for the final testing
* Home stroke rehabilitation items currently being used to compare the project artifact to
* A pair of etee controllers for development, testing and playing the game
* Access to someone knowledgeable with unity in case implementation issues and bugs arise
* Information such as the grasp manual to identify beneficial movements and/or exercises
* New people to playtest the game during development to check for quality, fun and userbility
* Access to copyright free music and sound effects to put into the game
* Access to copyright free art assets to use in the game
* Software to create art assets when needed for the game (visual and auditory)

## Risk Assessments

### Hygiene issues when testing and developing as many people may handle the etee controllers.

This will be mitigated by cleaning the controllers with antiseptic wipes between uses.

### The etee controllers being dropped or bashed during testing or transport.

The controllers will stay in one building for the majority of the project therefore transport only becomes an issue at the end of the project. To address this the controllers will be transported in their original packaging. To ensure that the controllers are not broken by a user during testing before using the controllers users will read through a short manual outlining how to use the controllers correctly.

### Hardware issues

Hardware issues may arise. For example mouses, keyboards or computers breaking. These risks can be mitigated by having spare mice and a spare keyboard which could be used. Regarding the computer it will be transported in a bag designed to carry and protect laptops. Additionally all work will be stored and versioned on github meaning if the computer the game was being developed on is completely destroyed the project can still be easily retrieved and worked on.

### Limited access to field specialists.

Where possible any communications will be made leaving plenty of tine for a response. Additionally resources can be shared allowing information to be gathered without directly involving the individals.

### Inexperience using unity networking solution

An inexperience with using unity’s networking solution may dampen the velocity of tasks being completed in the development phase and may cause delays.

To mitigate this risk preparations such as following online resources and tutorials and creating very simple test projects. This will build a familiarity with the systems prior to the implementation phase.

### First time using the etee development api

### Jetbrains rider licence expiring.

A student licence can be redeemed allowing the continued use of the editor. Alternatively free alternatives can be downloaded and used such as visual studio.

### Not being able to purchase home therapy kits / equipment

There are therapy plans which use little to or no equipment. These therapies could be used as the control to compare the enjoyment of using the artifact to.

### The home therapy treatments becoming damaged or lost.

As these home treatments commonly involve items to interact with which can be quite small it is a considerable risk some of these items may be damaged or lost. Before each testing session what items are being used will be recorded so that nothing gets lost. Alternatively as mentioned before there are home therapy methods which utilise no specialist equipment and only use pens, cups and chairs for example, these items are common and easy to replace.

### Implementation issues and bugs slowing progress

When planning the project every task will be broken down into its atomic elements. Each of these tasks will be given a rating 1, 2, or 3 depending on how long it is likely to take and another rating depending on its priority. This way the velocity (how many points are being completed each week) can be monitored. If implementation issues cause less points to be completed than initially planned the project can be rescoped and features can be removed (to be added later if time permits) and the decision of which tasks to remove can be made intelligently considering its estimated time to complete and importance to the project.

### Unable to access or create the art needed in the game

The two criteria’s being tested are if the correct movements are being performed and if so how many. And if the game is more or less motivating than other non-game based therapy methods. The art assets only impact the latter testing criteria so by nature the damage is limited. By keeping the game world small the art assets required are limited decreasing the probability of missing assets.

### Copyright materials being used in the game

Any third party assets will be checked for copyright.

# Project Review and Methodology

## Critique of Past Final Year Projects

## Literature Search Methodology

Google scholar, papers sent by supervisor

## Initial Literature Search Results

Less papers needed in this stage. Initial search results everything I say doesn’t need to be backed up. How it effected proposal

Serious games for upper limb rehabilitation after stroke: a meta-analysis,

Serious Game Design and Clinical Improvement in Physical Rehabilitation: Systematic Review

Development of a 3D, networked multi-user virtual reality environment for home therapy after stroke

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Triandafilou, K.M., Tsoupikova, D., Barry, A.J., Thielbar, K.N., Stoykov, N. and Kamper, D.G., 2018. Development of a 3D, networked multi-user virtual reality environment for home therapy after stroke. *Journal of neuroengineering and rehabilitation*, *15*, pp.1-13.

Vieira, C., da Silva Pais-Vieira, C.F., Novais, J. and Perrotta, A., 2021. Serious game design and clinical improvement in physical rehabilitation: systematic review. *JMIR Serious Games*, *9*(3), p.e20066.

Department for Environment Food & Rural Affairs. Statistical Digest of Rural England <https://assets.publishing.service.gov.uk/media/661d3b95ac3dae9a53bd3dd3/16_04_2024_-_1_-_Population.pdf>. Accessed 28/09/2024

Grasp manual <https://neurorehab.med.ubc.ca/grasp/grasp-manuals-and-resources/grasp-instruction-manual-2/>

Grasp patient manual <https://neurorehab.med.ubc.ca/grasp/grasp-manuals-and-resources/hospital-grasp-patient-exercise-manual-form/>

If talked directly about paper should go in references if its just something read should be in bibiography