Initial Plan

A Simple IoT Prototype To Evaluate Sit-To-Stand Exercises For Older Adults

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1 Description

Physical inactivity is attributed as to over 5 million deaths worldwide each year.Lee *et al.* (2012) This global health issue has also been further aggravated by the global COVID-19 pandemic which has only increased the need for actions to be taken to prevent further deterioration in the health of the elderly population.Roschel *et al.* (2020)

The main focus for health technology aimed at increasing the amount of exercise has been in tracking activity and developing these such that they become habit. However less focus has been given to ensuring that the activities performed are done correctly, ensuring that the habits developed are as beneficial as possible for the user.

Common Barriers to Exercise in Older Adults	
Barrier	Approach
Self-efficacy	Begin slowly with exercises that are easily accomplished;advance gradually; provide frequent encouragement.
Discomfort	Vary intensity and range of exercise; employ cross-training; start slowly; avoid overdoing.
Disability	Specialized exercises; consider personal trainer or physical therapist.
Poor balance/ataxia	Assistive devices can increase safety as well as increase exercise intensity.
Fear of injury	Balance and strength training initially; use of appropriate clothing, equipment, and supervision; start slowly.
Habit	Incorporate into daily routine; repeat encouragement; promote active lifestyle.
Fixed income	Walking and other simple exercises; use of household items; promote active lifestyle.
Environmental factors (e.g., inclement weather)	Walk in the mall; use senior centers; promote active lifestyle.
Cognitive decline	Incorporate into daily routine; keep exercises simple.
Illness/fatigue	Use a range of exercises/intensities that patients can match to their varying energy level.

Common Barriers to Exercise in Older Adults. Nied RJ (2002)

Habit has been identified as the biggest predictor of inactivity in all age groups Nied RJ (2002), and so promoting habit building is justified as the main aim for these home health technologies. However other common barriers to exercise in older adults such as self-efficacy and cognitive decline are less often the focus of IoT solutions for home exercise.

Technologies such as the Microsoft Kinect and the Nintendo Wii have been used to address these barriers, especially habit and attitude, when exercising at home through the use of exercise games which help support habit building through integrating exercises into fun activities.Ganesan and Anthony (2012)

However, these solutions fail to address some of the other common barriers identified in promoting exercise in older adults. Games consoles such as the Kinect and Wii are expensive and can be a large investment for older adults to make when on a fixed income. The importance of starting with simple and easy to complete exercises is also not clearly addressed in these products and so

they risk discouraging users if the exercises are not appropriate to their strength levels.

I aim to address these issues by developing an IoT prototype which will provide users feedback on the quality of their exercise, in a way that is low cost, minimally invasive in the home, and which requires a minimal amount of overhead to set up and use effectively.

The prototype will focus on sit-to stand exercises as an example of the type of strength exercises prescribed to older adults in similar studies. Silveira *et al.* (2013) Sit-to-stand exercises have been chosen as the exercise can be done in various ways depending on the ability of the user, for example in using hands to support balance or with arms crossed for more able users. Thus, the prototype will be able to evaluate which variation is being performed and suggest different variations based on the ability level it identifies.

In order to address the issue identified with the costs of similar solutions, I aim to develop the prototype on a Raspberry Pi, a low-cost computer that is widely used for IoT prototyping. The prototype will use a camera peripheral with the Raspberry Pi to perform object detection, recognising the position of the limbs of the user in order to evaluate their positioning and thus the quality of the exercise being performed. The device will then be able to provide the user with simple feedback and suggestions on how to improve their form and suggest different variations of the sit-to-stand exercise based on the evaluation of their exercises over time.

This feedback will address the barriers around self-efficacy and cognitive decline, by proving the user with encouragement and feedback in a way that is simple and easy to understand, with the aim of building user's confidence in their ability to perform the exercise and that they are performing the correct variation of the exercise for their ability level.

2 Aims

- Develop an IoT prototype which provides users with guidance on the form of sit-to-stand exercises.
- Evaluate the feasibility of the developed prototype and implement suggested improvements.
- Publish code and documentation used in development for future studies / prototypes.

3 Objectives

1. Background Research
   (a) Identify Existing Solutions and review techniques used.
   (b) Identify hardware requirements and procure.

(c) Identify potential software frameworks / technologies for implementation.

(d) Complete ethics course.

2. Identify Prototype Requirements

   (a) Specify functional requirements for prototype.

   (b) Specify non-functional requirements for prototype.

   (c) Consider ethical requirements for prototype and submit ethic approval.

3. Implement Core Application.

   (a) Implement video processing on IoT hardware.

   (b) Encode basic exercise positions (2 positions minimum)

   (c) Implement basic recognition of exercise positions.

4. Implement Remaining Requirements

   (a) Encode and Implement additional exercise variations.

   (b) Implement user feedback for positioning.

5. Test Prototype

   (a) Develop usability and feasibility study.

   (b) Conduct usability and feasibility study.

6. Evaluation

   (a) Evaluate functional requirements based on implementation.

   (b) Evaluate non-functional requirements based on usability study results.

4 Work Plan

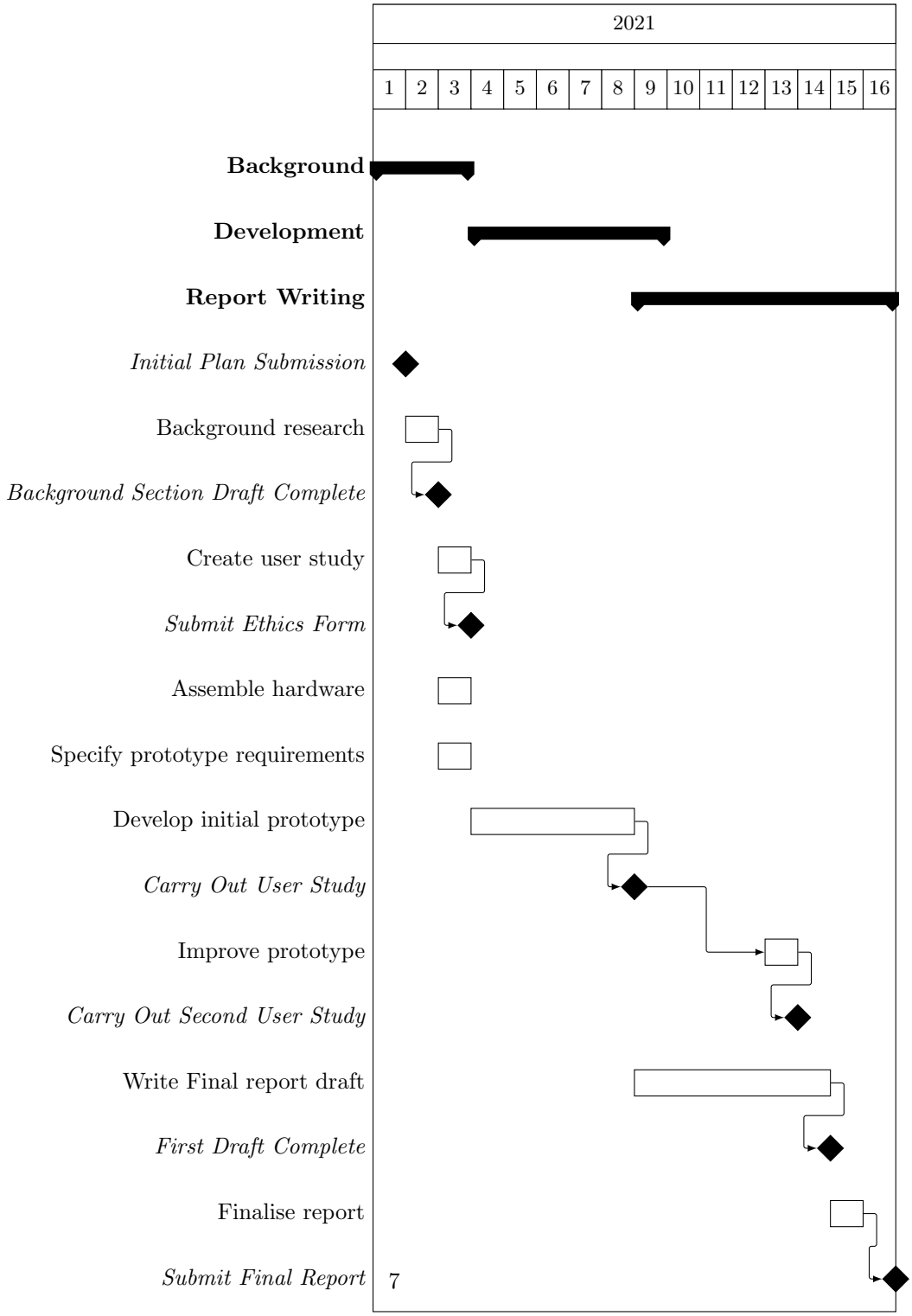
The following work plan covers the entirety of the project from 01/02/2021 until the submission date, 14/05/2021. Alongside the items enclosed within the work plan, I will also be meeting with my supervisor each week to discuss progress and any challenges encountered.

- Week 1 01/02/2021
  - Initial plan submission MILESTONE
  - Complete ethics course
- Week 2 08/02/2021

  - Background section for draft final report DELIVERABLE
  - Background research on similar products
  - Background research on sit to stand exercises
  - Background research on technologies and learning required
- Week 3 15/02/2021
  - List of requirements MILESTONE
  - Submit ethics form DELIVERABLE
  - Create usability and feasibility study
  - Specify functional requirements
  - Specify non-functional requirements
  - Assemble and test out hardware.
  - Confirm hardware able to meet requirements
- Week 4 22/02/2021
  - Begin development of prototype MILESTONE
  - Set up object recognition with hardware
  - Set up core posture feedback framework
- Week 5 01/03/2021
  - Continued development of core program
  - Encode key poses in sit stand activity
- Week 6 08/03/2021
  - Tie in activity states with object recognition for limb positions
- Week 7 15/03/2021
  - Implement user feedback for implemented exercises
- Week 8 22/03/2021
  - Finished implementation of prototype MILESTONE
  - Completed user study DELIVERABLE
  - Carry out usability and feasibility study
- Easter Recess 29/03/2021
  - Begin writing final report
- Week 9 19/04/2021
  - Improve prototype based on usability and feasibility study feedback

- Week 10 — 26/04/2021
  - Write evaluation section of final report
  - Carry out second usability and feasibility study
- Week 11 — 03/05/2021
  - Submit first draft of report — MILESTONE
- Week 12 — 10/05/2021
  - Finalise report and tweak based on any feedback
- Week 13 — 14/05/2021
  - Submit Final Report — MILESTONE

5 Gantt Chart



6 Ethics

The project will involve a usability and feasibility study in which participants will use the prototype and provide feedback and so ethical approval will be required to confirm the contents of the study and I must also ensure that consent forms are signed by all participants.

7 Risk Assessment

Risk	Risk Level	Likelihood	Mitigation
Data loss	Medium	Likely	Files to be backed up in Dropbox and code to be version controlled using git.
Hardware breakage	High	Unlikely	Hardware to be kept safely in a draw when not in use.
Delays in work plan	Medium	Likely	Two weeks are left at the end of the project for finalising and submitting the project report. In the case that this buffer is no enough extra work can be done over the Easter recess.
Project scope to large	Medium	Likely	Two cycles of development have been planned, in the case the objectives of the first cycle are not met, the first usability study can be sacrificed to give more time for development.
User injury during study	High	Unlikely	Users will be supervised while testing the prototype to stop incorrect usage and thus reduce any chance of injury

References

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