Project Plan

Team Sparta
Group 15

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1 Introduction

This document outlines the project plan for Team Sparta's System Design Project. We have decided to build an assistive robot called Leonidas whose task is to help the elderly maintain their cognitive and motor fitness. The document describes the goals we have set out for ourselves and how we plan to achieve these goals. This includes further details on our organisational structure, communication methods and peer task monitoring.

2 Main Goals

One in fourteen people in the UK over the age of 65 will develop dementia.[1] However, even an aging brain is capable of learning from new experiences, so memory loss or motor dysfunction is not an inevitable result of aging. But just as it is with muscle strength, you have to use it or lose it. For example, Cambridge researchers found evidence to suggest that playing games can improve brain functionality and reduce the risk of dementia.[2]

Our robot will help the elderly maintain their cognitive and motor fitness by playing interactive games which will use lights and buttons. During the game, users will react to audiovisual stimuli and press buttons with different colours.

Robotic arms will move the buttons around to the beat of music played by the robot, in order to increase the playability and also sharpen the users sensory responses. On top of this, we will add functionalities such as speech commands, emotion recognition, an application for a better user interface, table edge detection to prevent Leonidas from falling and also add some visual functions so Leonidas always faces the user.

The user interface and human robot interaction aspects of our project are top priorities and there will be additional focus to make the robot come across as more of a companion.

Researching medical feasibility is an additional aspect we consider important. We have already met with Professor Siddharthan Chandran, the Director of the Euan MacDonald Centre for Motor Neurone Disease Research who advised us on how dementia patients react to robots. He has set up a meeting for us with Professor Thomas Bak at the School of Psychology at the University. We will continue to look into getting more advice from academics at the university who are focused on medicine.

3 Technical Subgoals

3.1 Having functional moving robotic arms

The goal is to have either two to four arms for the robot but four may be infeasible with the lack of motors and structural integrity concerns. The arms will hopefully have shoulder joints with three dimensional motion but lego's lack of structural integrity may reduce this to a single plane .

We aim to have a robot with a 2 arms by the end of Week 2 (January 28th). This will include figuring out how to use the provided button sensors and attaching them securely .

The next goal is to increase the surface area of the sensors that the users can press since the sensors are quite small. This will be demonstrated at the first client demonstration on February 7th. Following this we will have to make the final decision on whether we want two or four arms.

The next step will be to get all the arms to react based on the game being played by the user and to see if three dimensional movement is possible for the shoulder joints. This should be completed by the end of Week 4 (February 11th) and demonstrated during the second client demo.

The final task will be to figure out how to get LED lights attached to the buttons and programmed for use, this should be completed by the end of Week 6 (March 4th) and demonstrated during the third client demo.

3.2 Phone/Tablet application

The app is a vital part of the project. It will allow users to choose what games to play and let them track their results. The first step will be to make a simple app which sets up communication with the EV3 software. This should be completed by the first client demonstration. Ideally, the entire app should be complete by the third client demonstration. This will include showing game results and giving the user game and music choices.

3.3 Ability to stay on table

We expect the robot to get pushed around since users are expected to press buttons on it. Creating a system that identifies when the robot is being pushed too hard is crucial. Ideally, in this situation, the robot should be able to brake and return to its original position. This may require buying additional hardware which should be researched by the end of Week 3 (February 4th).

In addition to being pushed around, table edge detection is nessasary such that the robot doesn't walk off the table and damage itself. These tasks must be completed by the end of Week 6 (March 4th) and demonstrated in the third client demo.

3.4 Game design and construction

The games are an essential part of the project. Games will need to focus on actually helping users cognitive and motor fitness. This will require extensive research into current medical applications. Research on medical aspect of project that helps with game design is a milestone that will continue through the entirety of the project.

We hope to have the first functional game of any kind achieved by the end of Week 4 (February 11th) and this will be demonstrated during the second client demo. Creating a memory and pattern recognition will be a goal for Week 6 (March 4th) and will be demonstrated during the third client demo.

3.5 Human Robot Interaction

It is likely that most of our users will have had no prior interaction with a robot since our target demographic is the elderly. Making the robot look and feel approachable is decisive. We need to ensure the robot does not malfunction and frighten the user. In general this is goal which will be focused on throughout the project. However, special focus on how the robots looks and sounds will be the aim for Week 8.

4 Time Planning

This is the plan for time division on project work for the semester for each member roughly. (These are approximate hours we estimate to spend on scheduled sessions, planning, presenting and building. The hours allocated for building will be according to the milestone to be achieved for the given team (organisational structure below this))

4.1 Week 1 - 15 hours

- 4 hours - respective workshops and guest lectures
- 5 hours - initial meetings with client and mentor, workspace and kit introduction, pitch, and mentor/client feedback on pitch
- 6 hours - role allocations, determination of milestones and project path to follow

4.2 Weeks 2/3/4 (until the first client demonstration) - 30 hours

- 2 hours - guest lecture and client demonstration
- 3 hours - mentor meetings and planning
- 3 hours - contribution by each team member towards the project plan
- 10 hours - background research by each member into his specific role requirement
- 12 hours - work into building a basic robot with two arms and connecting it to a basic application

4.3 Weeks 4/5/6 (until the second client demonstration) - 40 hours

- 2 hours - guest lecture and client demonstration
- 2 hours - mentor meetings and planning
- 36 hours - all work concerning complete robot arm movement and response, user data collection through app and programming a basic game onto the robot

4.4 Weeks 7/8 (until the third client demonstration) - 40 hours

- 2 hours - guest lecture and client demonstration
- 2 hours - mentor meetings and planning
- 36 hours - most of the work concerning attaching the LED lights, finishing the app and creating memory/pattern based games for the robot

4.5 Weeks 8/9 (until the user guide submission) - 15 hours

- 4 hours - contribution by each team member towards the user guide
- 1 hour - mentor meetings and planning
- 10 hours - finishing the functional parts of the robot required for the user guide

4.6 Weeks 10/11 (until the investor demonstration and pitches) - 45 hours

- 3 hours - Guest lecture, final client demonstration and investor demonstration
- 2 hours - final mentor meetings and discussion
- 40 hours - working on the remaining additional features and extensive testing

4.7 Week 12 (until the technical report and individual report submission) - 15 hours

- 5 hours - contribution by each team member towards the technical report
- 10 hours - each team member will work on his individual report

4.8 Gantt Chart

In the following Gantt chart, the tasks and milestones that need to be completed before the first pitch and client demonstration are shown.

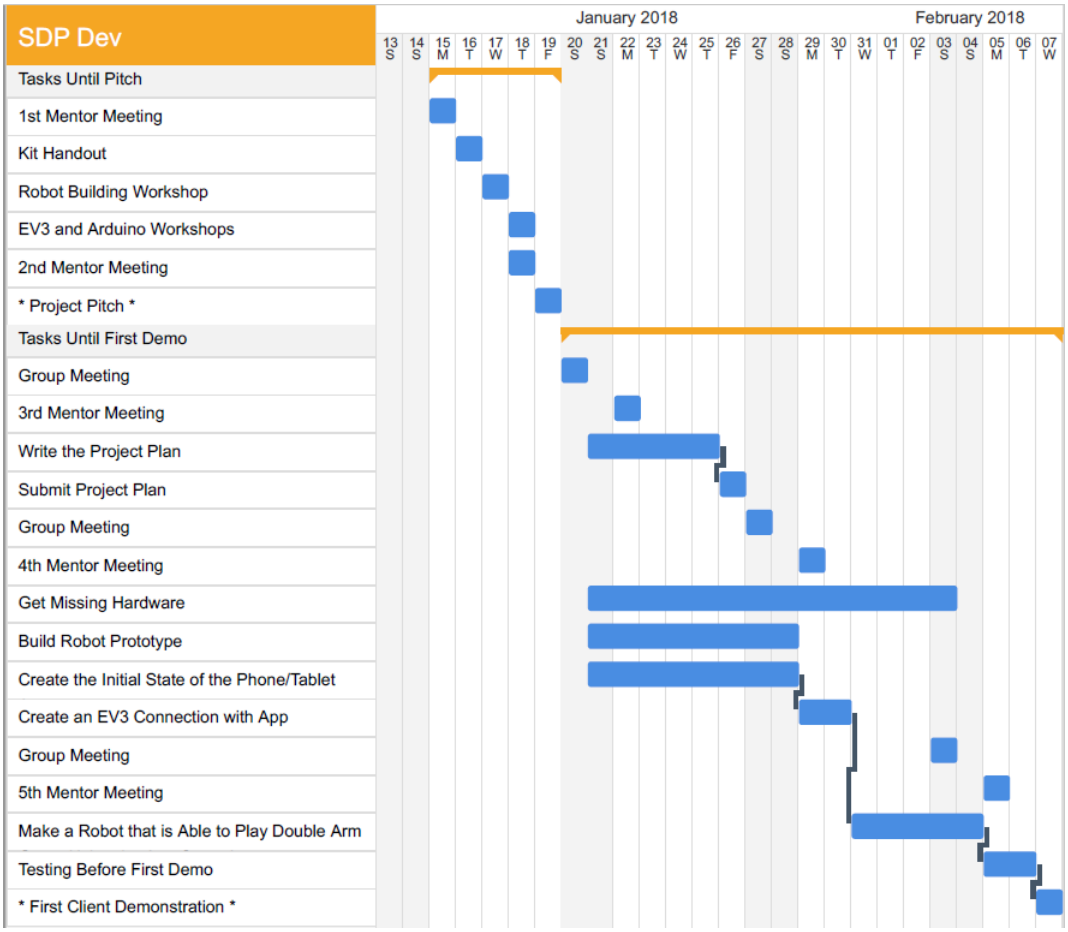

Figure 1: Gantt Chart Part 1

In the Gantt chart below, you can see the tasks and milestones that must be done before the second and third client demonstration.

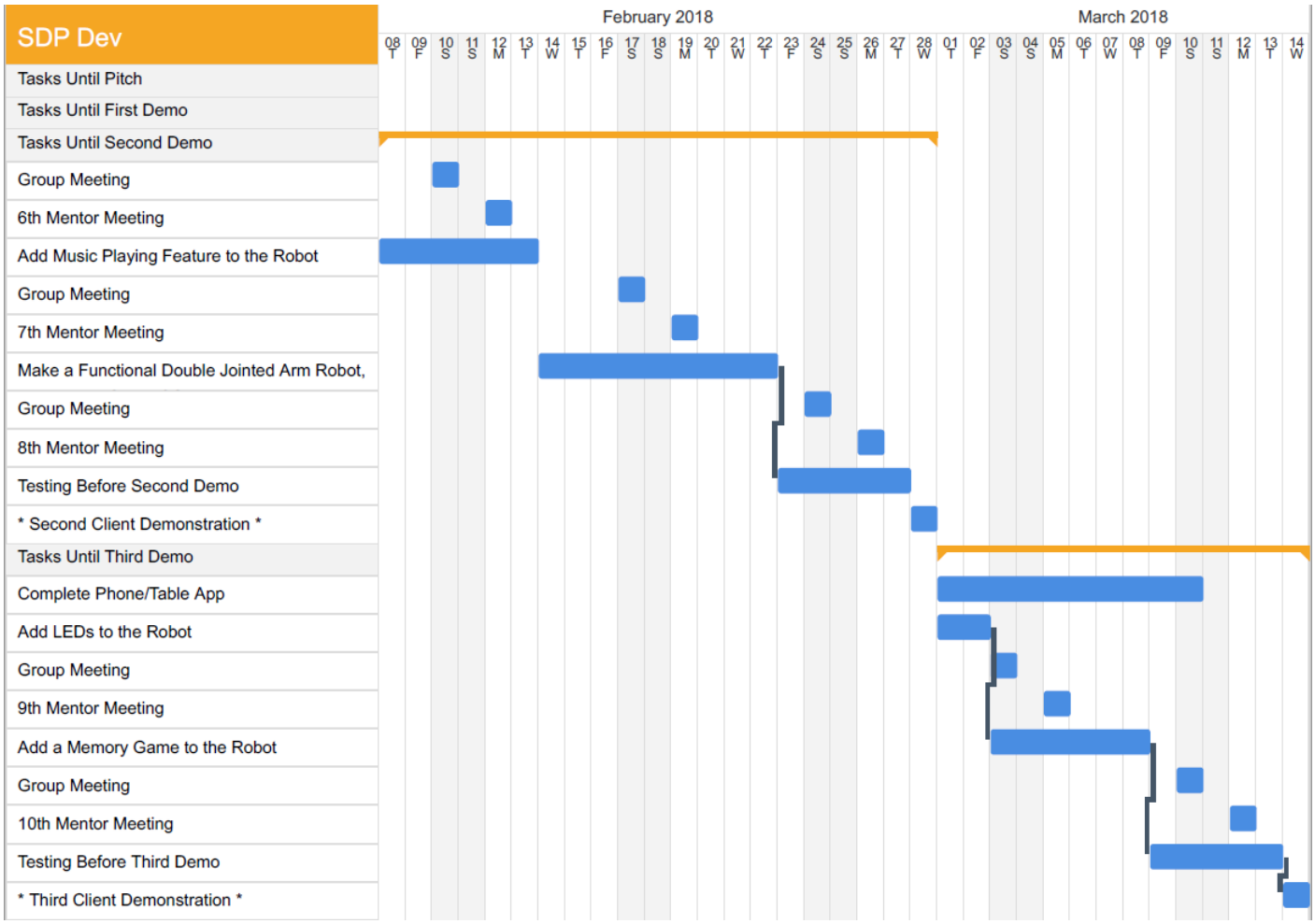

Figure 2: Gantt Chart Part 2

The last Gantt chart shows the tasks and milestones that must be finished before the final client demonstration and technical report.

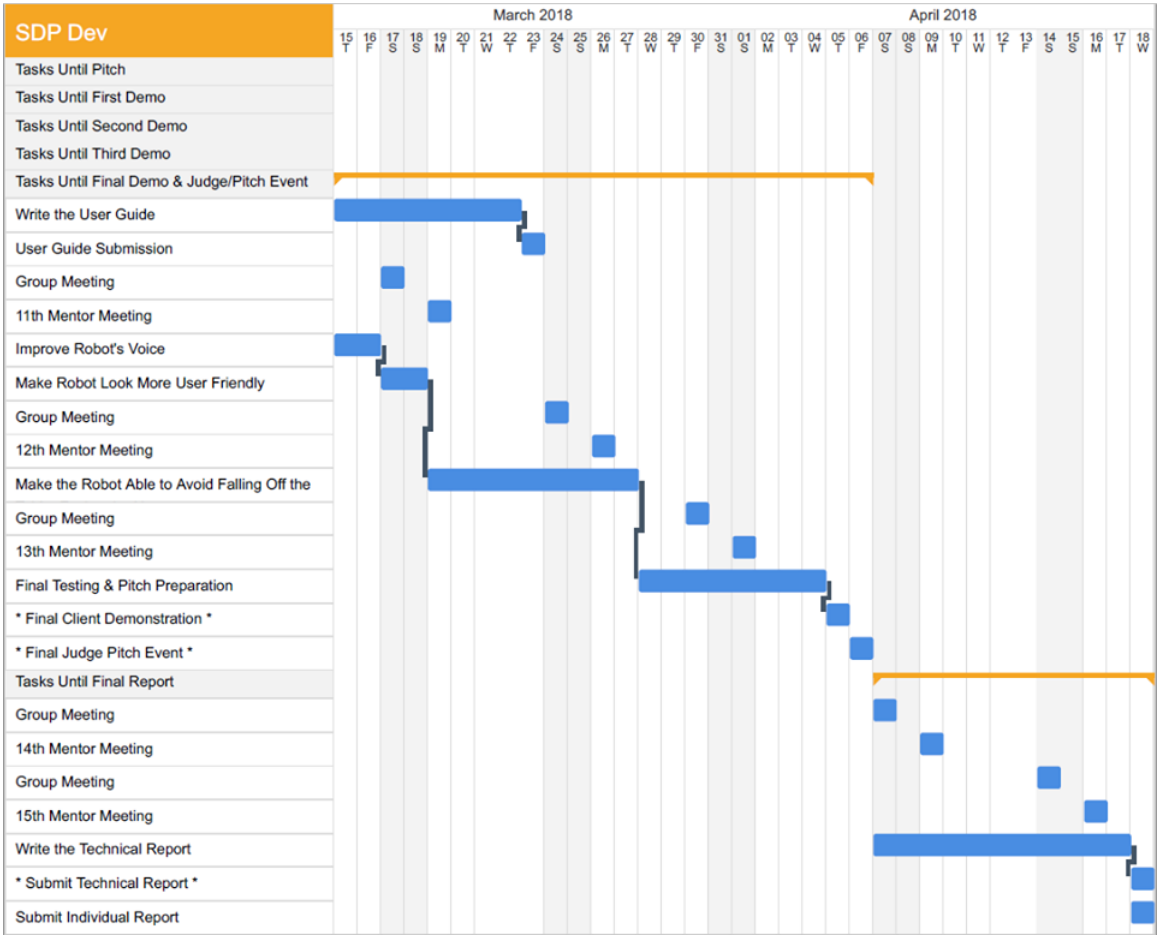

Figure 3: Gantt Chart Part 3

4.9 Risks

ID	Risks and Consequences	Probability (%)	Impact (1-5)	Priority	Response and Solution
1	Robot arms do not respond to the music	5	5	100	-Try to find solutions online. -Experimenting with the equipments until the problem is fixed.
2	Application bugs- i.e. can not communicate with the robot	5	4.5	90	-Debugging the system using varies tools provided. -Thinking about alternative methods.
3	Robot unable to detect the edge of the table	10	3	20	If current sensor does not work, search for alternative sensors to determine the edge of the table.
4	Bad robot appearance design	15	4	90	-Make the robot look more approachable and user friendly. -Ask end users which prototype is the least frightening.
5	Game interaction is too simple or too complicated for the end user	10	3	30	-Adjust the setting according to the feedbacks. -Add possible DIY options.
6	Delayed communication between the application and the robot	20	1.5	25	Find the cause or use an alternative communication service if possible. (i.e. switch to LoRa from bluetooth)
7	End user/ Client have low interest with the project	5	5	100	Talk to the Client/ End user to figure out the problem and try to resolve the conflict.
8	Change in features	1	4	80	Find out the reason behind it and adjust the features accordingly.
9	LED lights does not work/ not working accordingly	3	3.5	50	Adjust the LED and the code to make it sync with the application.
10	Robot might fall over if the user hit it too hard	10	3	35	Redesign or adjust the bottom half of the robot to make sure it would not happen.
11	Team member can not finish their work due to sicknesses	10	4	80	Another team member will continue his work and meet the deadline.
12	Holidays or absence	10	4	80	Notice all other team members before hand and try plan ahead.

Figure 4: Risk table

5 Organizational Structure

We have 7 members on our team and have decided to split into two groups of three with a manager/coordinator to help keep both teams communicating. We have split the groups based on overall tasks, one team will focus on the gaming aspect of the robot, the other team will focus on human robot interaction. This is the general structure of our group:

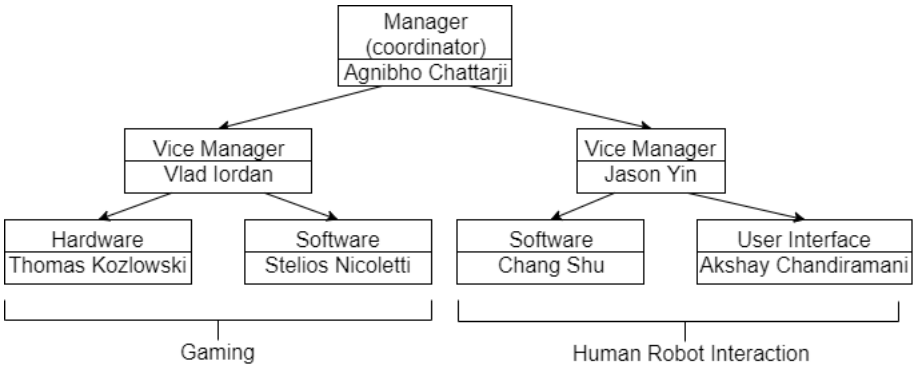

Figure 5: Organizational Diagram

5.1 Meetings

Weekly meeting with our mentor Connie will take place on Mondays at 4PM in Appleton Tower. Vice Managers are in charge of meeting their group members regularly. The manager will usually meet the Vice Managers to get updates on progress and is also in charge of helping and meeting individual members when needed. Other than that the entire group will also meet at least once a week.

5.2 Individual Roles

Agnibho Chattarji- Coordinating between the gaming and HRI teams and suggesting improvements to both teams. Also responsible for helping individuals with specific tasks if required, in charge of presentations and writing the reports.

Vlad Iordan - In charge of the gaming team. Responsible for the structure and functioning of the wheels. Also responsible for reviewing code related to the gaming features of the robot.

Thomas Kozlowski - Responsible for assembling and designing the robotic arms and making adjustments to the robot design as needed.

Stelios Nicoletti - Responsible for programming and designing games and in general coding for the EV3.

Jason Yin - In charge of the HRI team. Will work on audio aspects of the robot. Also focusing on visual sensors and visual detection.

Chang Shu - Developing computer vision part including enhancing companionship and table-edge detection; Optimizing the functionality and complexity of codes.

Akshay Chandiramani - Creating the main application, to program different possible games into the EV3 and collect user data from the EV3. Also responsible for developing/optimizing other code related to the HRI component of the EV3. Assisting in review of the reports as well.

6 Communication and Code Sharing

6.1 Facebook Messenger

Used for general communication between group members. Discussing meeting times and general progress.

6.2 Trello and Slack

Used for collaboration, task allocation and tracking progress.

6.3 Github

Code sharing and version control for the EV3, arduino and application.

6.4 Google Drive

Used as a backup to store every files.

References

[1] Alzheimer's Society. Dementia UK, 2017.

[2] B. Sahakian et al. Cognitive training using a novel memory game on an ipad in patients with amnestic mild cognitive impairment. 2017.