

StepQuest

Gamified Fitness Tracker



Divide & Conquer

EEL 4914 | Senior Design I

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Motivation & Background

Maintaining consistent motivation for fitness is a problem for many and this is due to many factors. Some factors include that fitness often becomes less motivating after the initial burst of enthusiasm or is seen as daunting by many that do not find that initial motivation. Maintaining and gaining motivation is a widespread problem amongst new and experienced athletes.

Motivation is crucial for a fitness routine. It is what keeps us going when we walk into the gym or head out onto the pavement for a run. It is what gives us that extra push. For many, keeping up this motivation or even acquiring it, is difficult. Once the initial motivation wears off, it is common for one to lose most if not all their motivation for fitness. This loss of motivation typically leads to giving up fitness altogether. This leads to an unhealthy lifestyle and an overall decline in health. We aim to solve this problem.

By gamifying fitness, it is possible that this will increase one's motivation for fitness. It can also serve to give motivation to those who lacked it initially. Additionally, it can make fitness more approachable and enticing to those who find it to be too boring or too daunting. By having a wearable game tied to one's fitness routine utilizing various biosensors to collect and use data, this could make fitness easier and more fun. By also using other functionality to remind users and gamifying their experience, it would also contribute to making fitness simpler. This solution would therefore make it easier to gain and maintain consistent motivation for fitness goals and allow one to stick to their fitness routine in a sustainable and long-lasting way.

The problems of fitness motivation have many sides to them and are something that have challenged many individuals. Gaining and maintaining fitness motivation is a problem that has permeated our society for a long time and has yet to see a long-lasting solution. Researchers and enthusiasts have tackled this problem many times before but the solutions that have been created have not fully solved the problem. We aim to research and address many of these complexities that are the reason behind the negative impact a lack of fitness motivation has on one's overall well-being.

The problem of gaining and maintaining motivation for fitness is something that goes beyond how old someone is, their gender, and their culture. A small subset of people has the distinct advantage of being able to conjure and maintain their own motivation for fitness and have no problem sticking to their fitness goals. However, most people tend to be on the opposite side of the spectrum. They typically have difficulty generating and maintaining this motivation for physical activity and struggle to stick to their fitness goals. An increasing intrigue has generated around this problem due to research suggesting how beneficial regular physical activity is. Understanding the fundamental factors of this fitness motivation problem is an integral part in delivering a solution that will truly solve this important problem.

An especially important aspect of this problem is the issue of how to make a solution that is sustainable for a lasting duration. Having a short-term rush of enthusiasm for fitness is common. Seasonal events are often the cause of this psychological phenomena. While they may be enjoyable, the motivation often does not last long, and it is therefore unsustainable. They are not effective and often lead to one discarding their fitness routine and goals.

The critical motivation for trying to solve this fitness motivation issue is the crucial value and significance of physical health. Many people today have very sedentary lifestyles and poor diets, causing many to have a myriad of physical health problems, many of which could be solved with fitness. Regular physical exercise is important for one's physical health. Fitness is closely tied with our lifespan, preventing illness, and our overall general wellbeing.

Besides physical health, consistent physical activity affects our mental health in many ways. When physically active, a decrease in stress occurs and the brain will generate endorphins increasing wellbeing, brain performance, mood, and mental tension. Physical activity aids mental health and helps in tackling the many mental challenges that affect us today. Getting people engaged in consistent physical activity can also be an essential element in aiding one's mental fortitude.

Seeing the complexities and importance of this problem, many have tried to solve the problem in a myriad of ways. Often using technology as a foundational aspect of their solution. Digital tracker apps or wearables are a common solution that many have delivered. They often track one's fitness statistics, deliver reminders, and other basic features, but they do not directly target the problem. They just make fitness easier and more convenient. They do not directly make it more motivating. Nor make it gratifying in any way.

StepQuest aims to actually make fitness motivating. The foundational aspect of our solution is to properly gamify fitness with an idle RPG like game. One controls and plays the game by being physically active. One's mindset is not necessarily focused on the physical activity, but on playing the game. We believe by adding this layer of gamification, this will help to increase one's motivation for fitness in a long-lasting way.

By solving this problem, we aim to create a new way to aid people in their fitness goals. This will result in many great benefits to one's wellbeing. These benefits include improved physical health, decrease in illness, stress relieving properties, greater mental health, and more. By researching and learning from prior solutions, our solution will address the many downfalls and fundamental errors of proceeding solutions. Our solution will address the fundamental root causes of the fitness motivation problem.

Background and Market Research

Background Research and Information

Some comparisons could be drawn between the StepQuest project and other applications and products currently on the market. According to Fortune Business Insights, “The global fitness tracker market size was valued at USD 36.34 billion in 2020 and is projected to grow from USD 36.34 billion in 2020 to USD 114.36 billion in 2028, exhibiting a CAGR of 15.4% in the 2021-2028 period.” [1] Not only are fitness trackers increasing in popularity, but games using tracked activity metrics are also on the rise. Niantic’s Pokemon Go and Monster Hunter Now, and Bandai’s Vital Hero bracelet are obvious mentions, with Pokemon Go quickly rising to the top of the revenue charts, beating out previous chart topper, Candy Crush. [2].

Our hope is to innovate on these designs given the shortcomings we’ve found that have precipitated this project.

Current Market Research

Pokemon Go

Pokemon Go was the runaway hit of 2016, becoming the most downloaded app in its first week ever [3]. Astoundingly, users reported taking about an extra 200 steps a day.[4] This is great news for users’ health and an obvious step in the right direction of what our team also hopes to achieve, which is helping users collect their health data and use it to make healthier lifestyle choices.

One major gameplay choice we would like to address about Pokemon Go’s system, and one that especially plagues Niantic’s newest game Monster Hunter Now, is the fact that users have to be constantly looking down at their phone during the gameplay experience. While this may seem normal for a mobile game, it is not ideal from a mindfulness perspective, nor is it ideal to be constantly looking down while exercising or being out and interacting with the world. In short, it’s too distracting. It is our opinion that users should be able to enjoy the outside while out walking, rather than having to check the screen and be pulled out of their experience, unless that is the experience that they wish to have.

Vital Hero [5]

Bandai’s Vital Hero bracelet is a closer step to accomplishing many of the goals that our team is looking to solve. It is a wearable technology that allows users to choose to engage in movement or exercise and motivates them to do so. It tracks steps using an accelerometer, and engages the user with elements of gaming for motivation.

The improvements we would like to implement upon this design is to move away from the “catch-em’-all” gameplay elements and move into more traditional RPG elements. We would also like to obviously get away from the Bandai owned intellectual properties. The idea for our project actually came about from one of our

member's trying to recreate his own version of the Vital Hero, and from there we are happy to pivot.

Habatica [6]

Habatica is an Android application that gamifies the process of the "to-do-list." This is a departure from the previous items on the list because it allows users to add their own tasks that they'd like to get done. Allowing a "choice" in what tasks to accomplish greatly increases intrinsic motivation, according to self-motivation theory [7]. There is an added bonus to having this app rooted in real-world accomplishments, so the better users do in game- the more they are accomplishing outside of the game. These are gameplay mechanisms we would like to incorporate, and this combination of user-goal setting and fitness tracking has not been present in a wearable option yet.

Finch [8]

Taking gamified task-tracking a step further, Finch attempts to gamify Cognitive Behavior Therapy. This app holds users accountable for taking care of a virtual pet's well-being and mental health.

"Every activity you complete on Finch gives you energy points, which you can then use to send your pet on adventures and level up. The adventures help your pet learn new things, develop its own personality traits, and grow, and completing more and more activities when they're away on an adventure helps them return home sooner." [9]

Idle Games

This genre of games allow the user to participate in the gaming process from a distance by checking in on their characters and making minimal inputs. The user still gets the dopamine hit from leveling-up and advancing the gameplay, but they are much less involved in the actual combat process. The core mechanic of an idle RPG is that characters automatically engage in battles or other activities without user's direct input. Characters fight enemies, collect loot, and earn experience points (XP) on their own, even when the game is not actively being played. We aim to adapt this style of gameplay system so that the user can focus on their life and not be pulled from the moment or forced to adopt bad posture from looking down at their phone more than needed.

Goals & Objectives

StepQuest aims to satisfy three overarching goals. Firstly, in an increasingly sedentary world, remind and encourage people to exercise in a way that is relatively unobtrusive to their day to day lives. Secondly, make that exercise fun through an interactive game that leaves users feeling both motivated to exercise and rewarded when they do. Finally, the device should offer a user-friendly experience where usage of the device is easy to understand, as is the game.

There are also more specific goals/objectives for both the physical device itself as well as for the software/game. Also worth mentioning is that some goals are considered stretch goals as it may not be possible to implement these features due to time and budget constraints.

The goals for the device are as follows:

- ◆ Convenient to wear or carry
 - Small
 - Lightweight
 - Rain-resistant
- ◆ Power
 - Rechargeable
 - Sufficient battery life
- ◆ Screen to display time and game elements
- ◆ Provides a way to interact with the game
- ◆ Able to record user footsteps
- ◆ Vibration capability

The stretch goals for the device are as follows:

- ◆ Power
 - Wireless charging
 - Full-day battery life
- ◆ Foldable display screen
- ◆ Touch Screen
- ◆ Able to record user Heartrate

The goals for the software/game component of the device are as follows:

- ◆ Idle-type game
- ◆ Avatar customization:
 - Skin tone
 - Eye color
 - Hair color and shape
 - Top color
 - Bottom color
- ◆ Interactive world map:
 - Town/City like locations
 - Dungeon like locations
- ◆ Travel between locations via number of footsteps:
 - Travel produces encounters:
 - Found currency
 - Combat

- Outcome determined by level, fitness stats, weaponry, armor:
 - Flee, no gained currency or experience
 - Success, gain currency and experience
- ◆ Town/City like locations have the following features:
 - Quest board:
 - Offers fitness and patrol tasks
 - All tasks reward currency and experience
 - Patrol tasks provide encounters
 - Shop
 - Purchase items with currency:
 - Cosmetics
 - Weaponry
 - Armor
- ◆ User level increased by:
 - Footsteps
 - Quests
 - Successful combat encounters
- ◆ Level influences quest difficulty
- ◆ Four fitness stats:
 - Endurance
 - Strength
 - Flexibility
 - Speed
- ◆ Fitness stats increased by increasing level
- ◆ Fitness stats influence:
 - Types of quests
 - Outcome of encounters

The stretch goals for the game component are as follows:

- ◆ Avatar customization:
 - Hats
 - Clothing
- ◆ More encounter types
- ◆ Add health mechanism
 - Add health items to shops
- ◆ Fitness stats leveled by completing certain types of exercises

Summary of Goals

In summary there are three types of goals, basic, advanced and stretch. These are listed below.

Basic Goals

- ◆ Convenient to wear or carry
- ◆ Sufficient Battery Life that is Rechargeable
- ◆ Records steps and heartrate
- ◆ Vibration Capability
- ◆ Idle RPG style game
- ◆ At least 3 in game locations
- ◆ Travel System
- ◆ Quest Board in Towns
- ◆ Level System

Advanced Goals

- ◆ Rainproof
- ◆ Avatar customization
- ◆ Shops in Towns
- ◆ Four Fitness Stats

Stretch Goals

- ◆ Wireless Charging
- ◆ Touch Screen
- ◆ Additional Encounters in Game
- ◆ Health Mechanism in Game
- ◆ Companion App for Game

Engineering Specifications

In this section, we discuss the engineering specifications for our project. Keeping a record of the specifications will help our group achieve the goals we have set for this project. These specifications are designed to get the best out of the device, hence the market will receive it welcomely. Since the general goal of the project is to gamify workouts so people will fight laziness and start having a healthier lifestyle, we chose convenience and entertainment as our top priorities in the design. From the size of the tracker to the details of the game, everything embraces convenience and merriment. Here, we divided the specifications into two parts. Device Specifications and Game Specifications. They are shown in the tables below.

Device Specifications

A brief outlay of the device specifications that our group decided to move forward with. The table shows the details and constraints of the components that make up

the device. Everything here is subject to change; however, this gives us an idea of the device's capabilities and functions.

Table 1. Device Specifications

	Device Specifications	Details
1	The size of the device is 43mm (about 1.69 in) at most.	This is an average height among watches. Any larger size will cause an uncomfortable wrist for the user, which will discourage the user from wearing the tracker.
2	The range of weight is between 27-35gm	Heavier items will abruptly affect the user while exercising or storing the device
3	Battery life is 8 hours after a full charge	Will allow users to use during substantial portions of their day-to-day life
4	Batteries are expected to be fully recharged in 150 mins. This device will use 18W USB-C adapter	This is a conservative figure as it could be lower than that.
5	Interaction between the user and device will be through touchscreen and tactile buttons	This gives the user the ability to control and modify the device as they please
6	Counting steps	Using a gyroscope component, we can count the steps of the user with accuracy of 90%
7	Heartbeat monitor	As this is an important measure of one's health, we included a heartbeat monitor on the device.
8	Timekeeping function	Through a Real-Time clock module this device is able to keep record of the real time
9	Turning screen on and off	This saves power as well as helps users rest better during downtime.
10	Useful information will be displayed for the user to make the exercise more practical	such as time, footsteps with 90% accuracy, duration since exercise started, heartbeat, as well as personal information

11	The Device will keep a record of the exercise pattern in a memory of 2mb. This means the user will be able to access their daily exercise for the last day, week or even month.	Showing the user their progress could help motivate them. Also, they can see what the downsides are that they have with their exercise routine
12	Alerts will be used to help remind the user of their last exercise day. A vibration will alert the user if they pass a threshold without exercising.	Many people can use this feature when forgetting to go for a walk or a run

Game Specifications

Here is a summary of the software specifications that we thought would increase the amusement of the user while exercising. Since we think taking care of our health is a personal responsibility, we felt it is only right to have an RPG style for the game. This way players can relate to their character and feel responsible for their wellbeing. We also included levels of difficulty that can be reached by achieving the number of steps or quests. As workouts take many forms, it was necessary for us to add stats for four different qualities. These qualities are endurance, strength, flexibility, and speed.

Table 2. Game Specifications

	Game Specifications	Details
1	RPG Style	The game is in a role-playing game style. That helps the user connect with the game.

2	Customized characters	Users can customize their avatars with the provided skin tones, hair shapes and colors, and eye colors. Players normally enjoy personalizing their characters to meet their aspirations.
3	Leveling system	Each level needs to be opened by footsteps, combat encounter and quests assigned to that level
4	Interactive Map	Digital towns and cities will be built in the software. Each has its own quests and obstacles.
5	Quest board	Each city or town will have a quest board where the user can choose to join a quest. Fitness tasks will reward the players with currency and EXP. Patrol tasks will raise encounters for the players.
6	Shops on the map	Here players can spend their currency buying cosmetics, weapons, and armor. This helps players improve their characters and gain skills and strength.
7	Travelling between various locations on the map	Using real world footsteps players can travel through various locations exploring new quests and combats

Summary of Engineering Specifications

Here, we picked the most important specification that will contribute the most to the efficiency of the project. The highlighted specifications will be demonstrated later in the next semester.

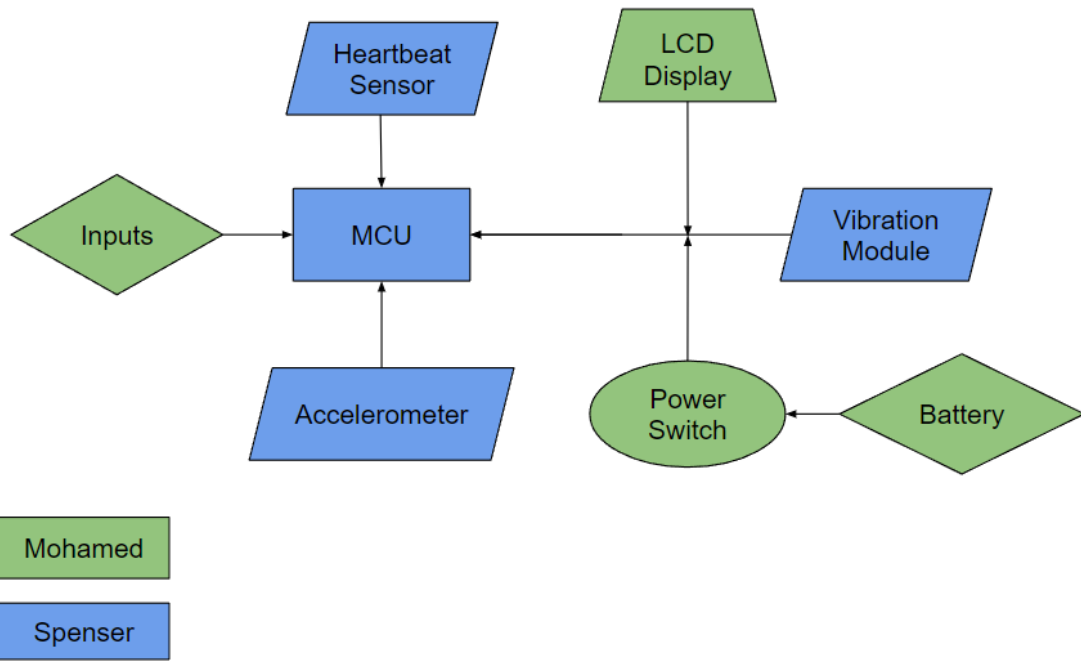
Table 3. Engineering Specifications in Summary

	Engineering Specifications	Details
1	The size of the device is 43mm (about 1.69 in) at most.	This is an average height among watches. Any larger size will cause an uncomfortable wrist for the user, which will discourage the user from wearing the tracker.
2	Battery life is 8 hours after a full charge	Will allow users to use during substantial portions of their day-to-day life
3	Counting steps	Using a gyroscope component, we can count the steps of the user with accuracy of 90%
4	Heartbeat monitor	As this is an important measure of one's health, we included a heartbeat monitor on the device.
5	Timekeeping function	Through a Real-Time clock module this device is able to keep record of the real time
6	RPG Style	The game is in a role-playing game style. That helps the user connect with the game.
7	Interactive Map	Digital towns and cities will be built in the software. Each has its own quests and obstacles.
8	Leveling system	Each level needs to be opened by footsteps, combat encounter and quests assigned to that level
9	Quest board	Each city or town will have a quest board where the user can choose to join a quest. Fitness tasks will reward the players with currency and EXP. Patrol tasks will raise encounters for the players.

Project Diagrams

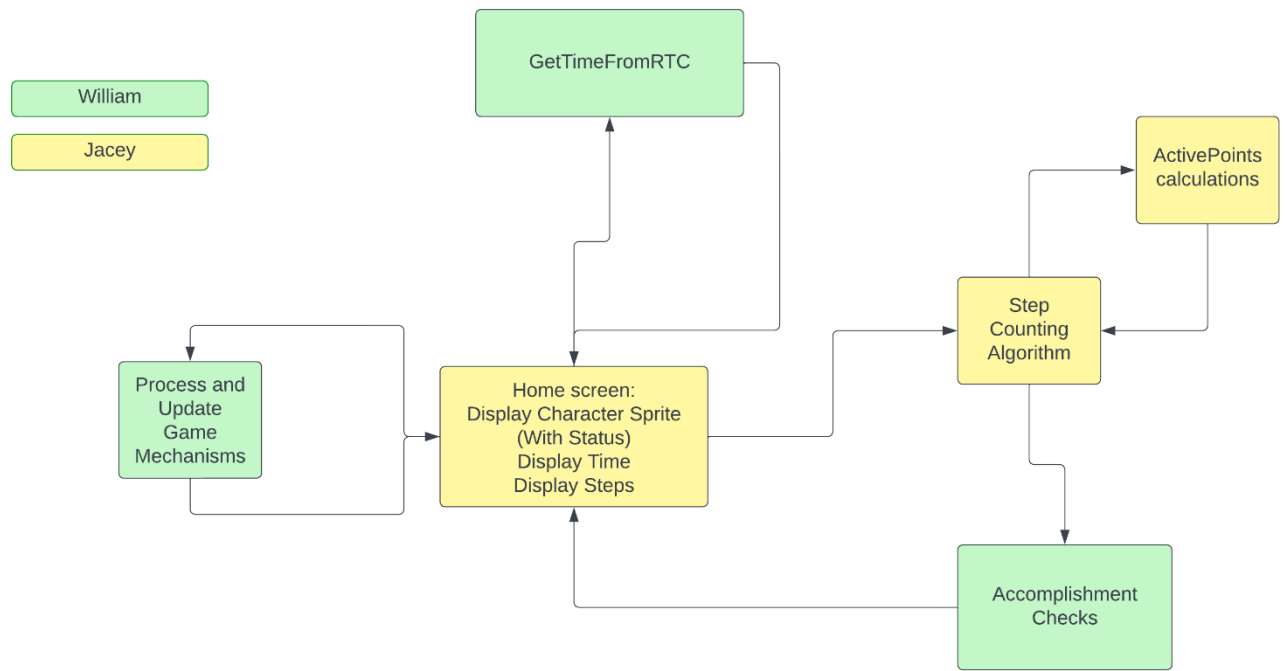
Hardware Diagram

Diagram 1. Hardware Diagram



Software Diagram

Diagram 2. Software Diagram



Gameplay Flow Diagram

As a large segment of our project is the game, which serves to both motivate people to exercise as well as provide gratification for doing so, the gameplay flow is rather important to the project. However, the gameplay flow is large and can be

difficult to view when all together. As such, the full diagram will be shown, alongside segments of the diagram to ensure legibility.

Furthermore, a simplified version of the diagram will show who is responsible for which features.

Diagram 3. Gameplay Work Divided

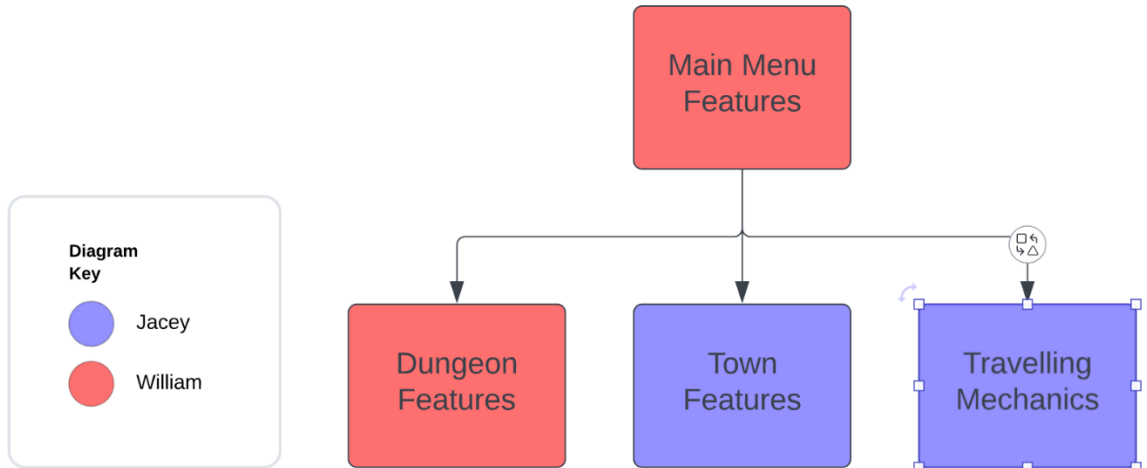


Diagram 4. Full Gameplay Flow Diagram

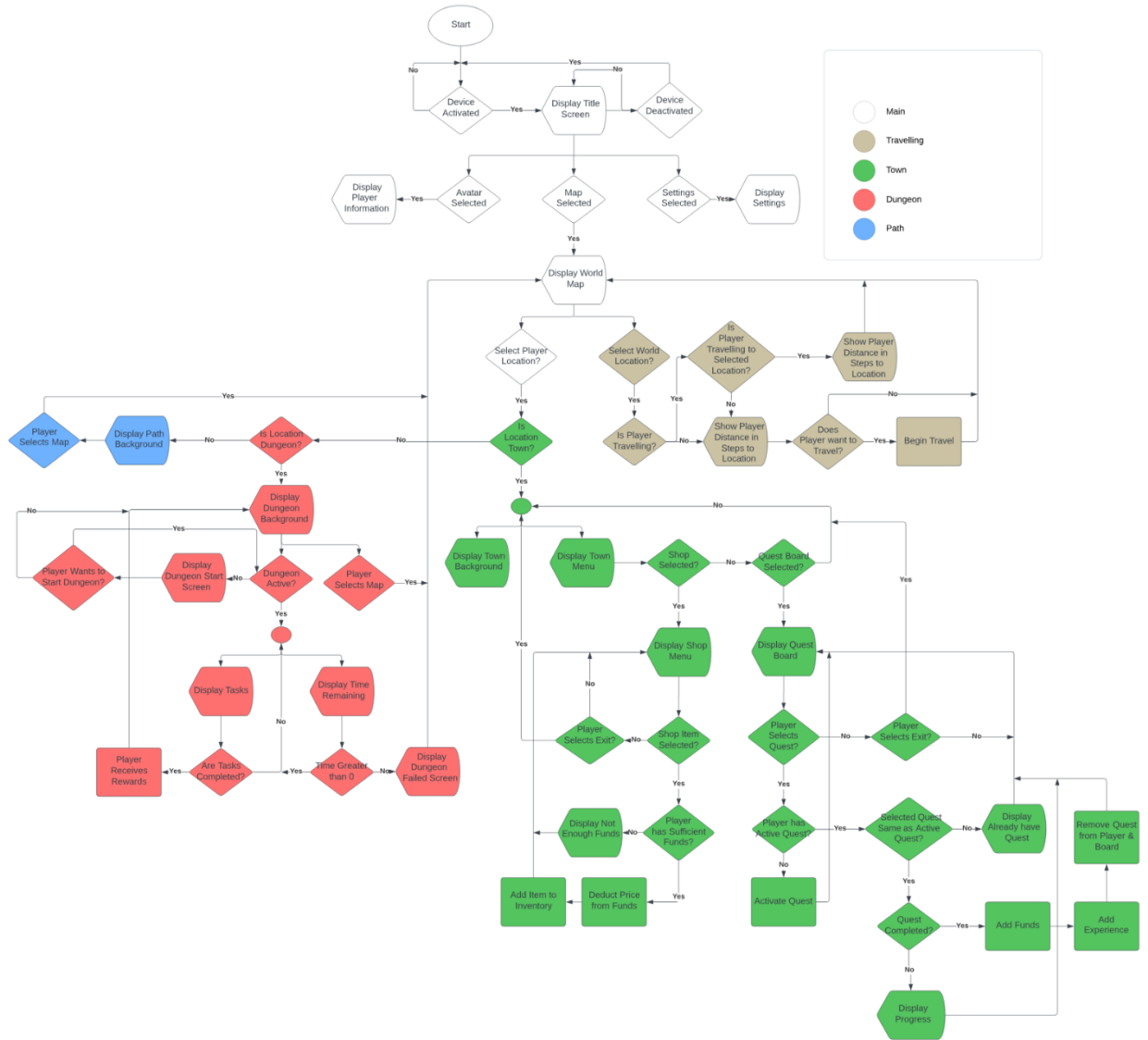


Diagram 5. Main Menu & Travelling Diagram

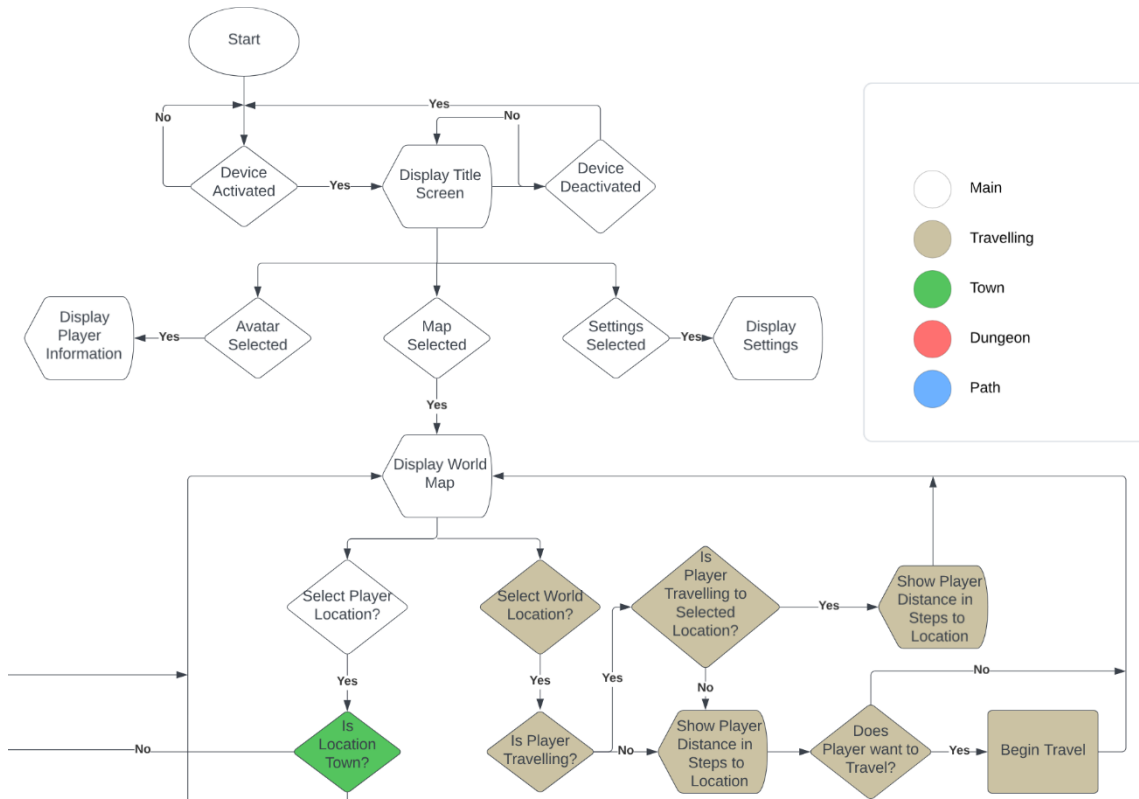


Diagram 6. Town Diagram

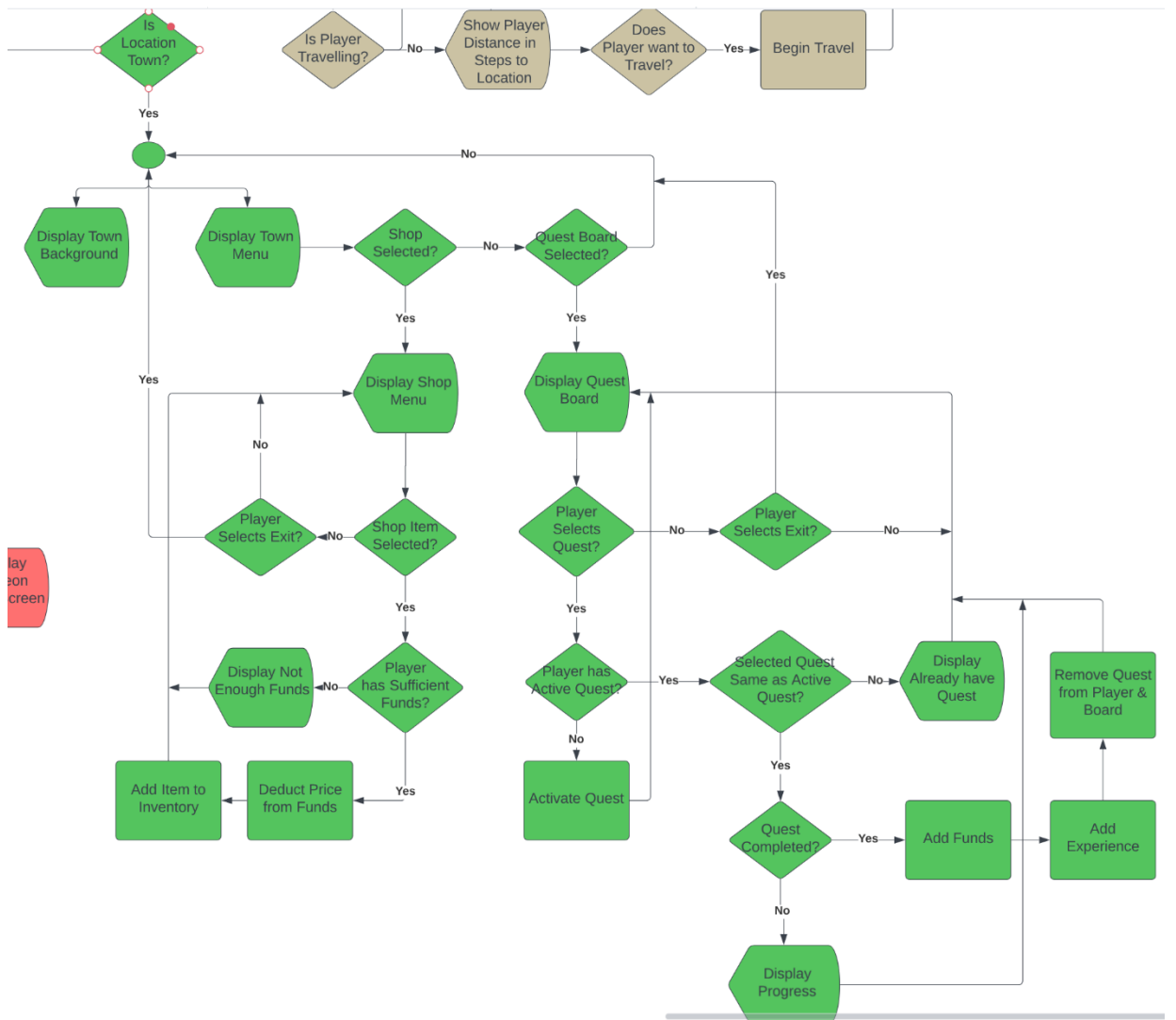
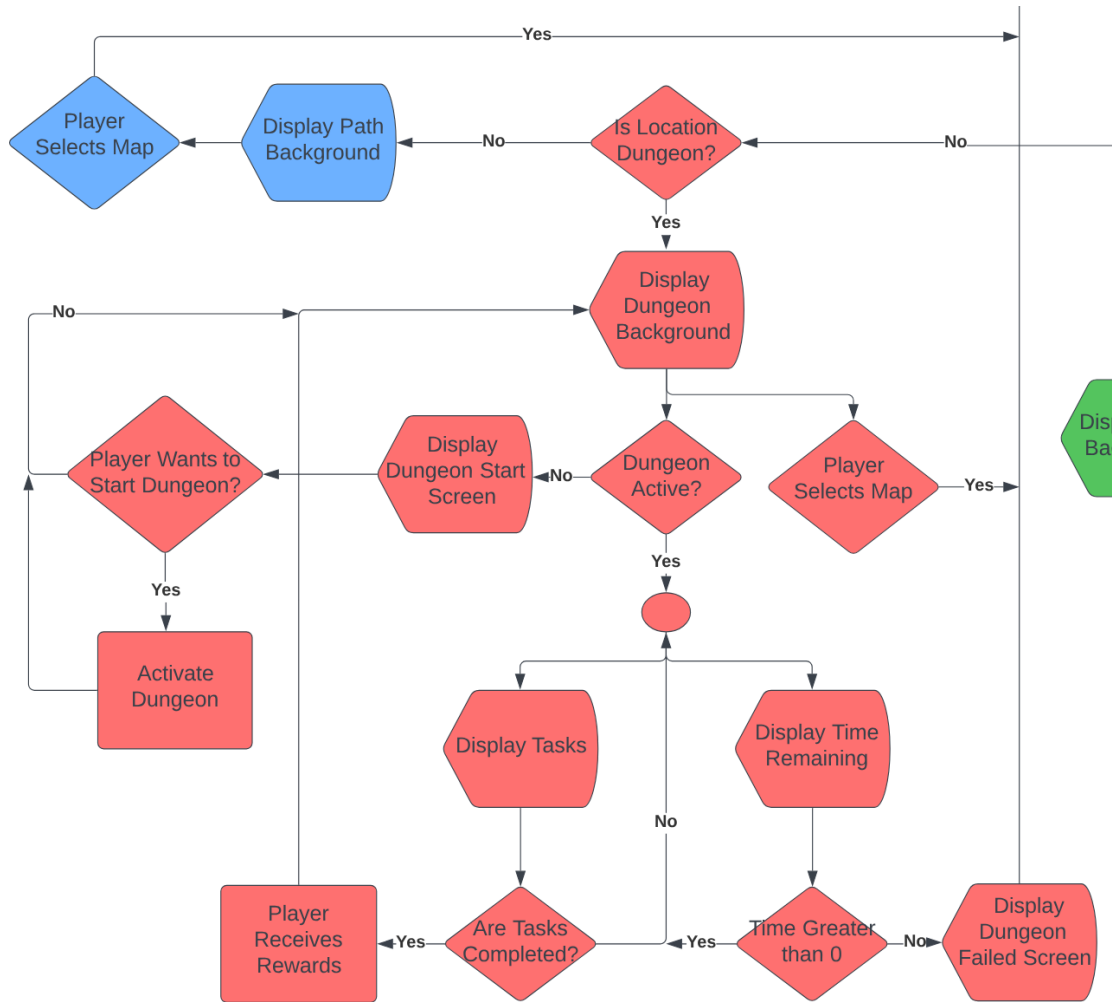


Diagram 7. Dungeon & Path Diagram



Project Budget

Currently, due to the scale of the project the group will be splitting the finances evenly. At this time, we do not plan to seek sponsors, but as we proceed, we may adjust this decision. Prices for items are purely for estimation purposes since we are still in the research process of which hardware we would like to go with, chip prices, PCB manufacturers, etc. Quantity currently also reflects items needed for research, and items that have not been eliminated from the realm of being used, so they will also be under continued evaluation. These quantities reflect having 2 prototypes that can be split among the group as needed. Most PCB houses require a minimum purchase of 4 boards, so some items are listed with this in mind. Tax and shipping are also not estimated, and the prices are rounded down.

Table 4. Estimated Budget

Item	Cost Per Item	Quantity	Total cost \$ USD
Microcontroller	\$10	2	20
OLED Display	\$25	2	50
Accelerometer	\$2	4	8
Heart Rate Sensor	\$2.5	4	10
LIPO Battery	\$10	2	20
3d printer materials	\$25	1	25
Watch band material	\$10	2	20
Various resistors and minor components	\$5	1	5
PCB Manufacturing	\$30	1	30
			\$188 188/ 4 = \$47 per member

Project Milestones

Senior Design 1 – Fall Semester 2023

The milestones for Senior Design 1 have been listed below, broken down into weeks as shown in Table 3.

Table 5. Senior Design 1 Milestones

Week #	Dates	Milestones
1	08/20 - 08/26	Form Project Group
2	08/27 - 09/02	First Group Meeting
		Determine Project Idea
3	09/03 - 09/09	Senior Design Bootcamp (09/05)
		Begin Work on Divide & Conquer
4	09/10 - 09/16	Finalize and Submit Divide & Conquer (09/14)
5	09/17 - 09/23	Attend Meeting with Dr. Wei at 4:30 PM (09/18)
		Begin Work on 60 Pages
6-10	09/24 - 10/28	Work on 60 Pages
11	10/29 - 11/04	Receive Feedback on 60 Pages
		Finalize and Submit 60 Pages (11/02)
		Purchase Necessary Materials
12	11/05 - 11/11	Begin Work on remaining 60 Pages
13-15	11/12 - 12/02	Work on Remaining 60 Pages
		Begin Testing Components
16	12/03 - 12/09	Receive Feedback on 120 Pages
		Finalize and Submit 120 pages (12/04)

Senior Design 2 – Spring Semester

Though the milestones for Senior Design 2 still have much to be determined, the known milestones have been broken down as shown in Table 4.

Table 6. Senior Design 2 Milestones

Week #	Dates	Milestones
1	01/07 - 01/13	All Necessary Materials Received
		Test Any Remaining Components
TBD	TBD	Work on Creating Prototype Device
		Work on Creating Prototype Game

TBD	TBD	Meet with Committee Members as Necessary for Revisions to Design, Requirement Specifications, etc.
TBD	TBD	Work on Final Device
		Work on Final Game
TBD	TBD	Test Device
		Test Game
TBD	TBD	Prepare for Final Presentation
TBD	TBD	Present and Conclude Project

References

- [1] <https://www.fortunebusinessinsights.com/fitness-tracker-market-103358>).
- [2] <https://venturebeat.com/games/pokemon-go-outpaces-clash-royale-as-the-fastest-game-ever-to-no-1-on-the-mobile-revenue-charts/>
- [3] <https://techcrunch.com/2016/07/22/apple-says-pokemon-go-is-the-most-downloaded-app-in-its-first-week-ever/>
- [4] <https://www.vox.com/2016/7/12/12159198/pokemon-go-exercise-increase>
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- [10] <https://www.androidauthority.com/best-idle-rpgs-android-3263720/>