Master thesis

Jacob Sandve

Sau and Go

Supervisors

Svein-Olaf Hvasshovd

Nina Kristin Langhelle

2018

Abstract

The goal of this project is to build a prototype of a game, that will encourage families with children to engage in outdoor activities and become more motivated to go hiking. We want to do this by utilizing the GPS tracker that some of the grazing sheep are wearing. There are two main objectives for the game project. One is to encourage people to be more physical active, and the second is to scare off sheep predators.

The end goal of this master thesis is to finish the prototype of the game, and discuss the advantages and disadvantages of the design and technological choices, that were used to build it. This can help others to kick-start a working game, based on our ideas.

Sammendrag

Målet med dette prosjektet er å bygge en prototype av et spill, som vil inspirere familier med barn til å gjøre flere utendørsaktiviteter og bli mer motiverte til å gå på tur. Vi ønsker å oppnå dette ved å ta i bruk GPS sendere som finnes på sauer på beite. Det er to hovedmål med dette spillprosjektet. Det første er som sagt å oppmuntre folk til å bli mer fysisk aktive, og den andre er å holde rovdyr unna beitedyrene.

Masteroppgavens mål er å lage en prototype av spillet, og ta for seg fordeler og ulemper ved designet og de teknologiske valgene som har blitt diskutert. Dette vil forhåpentligvis hjelpe andre med å kickstarte utviklingen av et slikt spill basert på ideene vi har tatt opp.

Preface

This thesis is made as a completion of the master education at NTNU.

Several people have contributed academically, practically and with support to this master thesis.

I would therefore first like to thank my supervisor Svein-Olaf Hvasshovd and co-supervisor Nina Langhelle for their guidance and support throughout the entire master project.

I would also like to thank Halvor Mjøen from Find My, as well as farmer Frode Havdal for all their input.

Finally I would like to thank my family and friends for being so incredible helpful and supportive.

Table of contents

1 Introduction

1.1 Background

Today there are about as many sheep as humans in Norway. Most of these are pasturing without supervision during summertime. According to statistics released by Miljødirektoratet in January 2017 there were about 17.500 sheep killed by predators in 2016 [1].

Our idea is to prevent some of these deaths by bringing humans and sheep together, making families with younger kids go hiking in areas where the sheep are pastured. We hope to do this by utilizing the children's interest for games combined with their innate fondness and curiosity for animals.

Today children are getting introduced to technology and video games at a very early age, and they spend more time playing games and using apps than they did before.

We propose a video game that takes inspiration from games such as Pokémon Go, that will make hiking more fun for the kids and help them find the sheep out on pasture. We expect that the game will be interesting for kids between the age of 5 to 15 with the focus area of 7 to 13.

1.2 Aim

The aim of the master thesis is to create a game prototype that incentivize children to spend more time outdoors. This can be done by creating an engaging game with smaller goals to achieve. More and more sheep is tracked by GPS, something that can be taken advantage of. In the Oslo area alone there were around 1600 marked sheep in 2016 [2]. This amount has been increased significantly every year since 2008.

As mentioned earlier, an added benefit would be to scare off potential predators as human smell lingers in the area, which will ward of predators. The farmers we were in contact with to were showed interest for this, making them receptive to the idea of sharing their data.

1.3 Objectives

The main objectives are to create a prototype of the game, give an overview over different technological choices and get feedback from the user group. The prototype will be using GPS and real world locations, encouraging the player to visit these locations to gain points and level up.
The thesis will discuss different technologies that were taken into consideration and give a run-down of the different strengths and weaknesses of these.
It will look at the feedback gathered, and discuss areas to further improve upon with the current prototype.

1.4 Limitations

Since the game is designed for mobile phones, all the limitations that follow smaller hand-held devices apply to this project as well. Examples of this are: battery limitation, screen space and computing power. All of these will affect the design of the game.

The animals themselves also put limitations on the game design, as their position is only updated a couple of times a day at best, and they are usually not in same place for long. Some estimation of where they have moved can be made, but it is unreliable and the uncertainty increases exponentially over time.

Fig 1: *Sheep with GPS tracker*

2 Related Work

This chapter will look at similar existing applications for mobile devices. For each of these the similarities, strength and weaknesses of the applications are considered.

2.1 Similar game applications

Pokémon Go

Pokémon Go is most likely one of the most known mobile games, and also one of the main sources of inspiration for Sau and Go. As users walk around the real word, virtual Pokémon characters appear on the game map. When users come within a close enough proximity to the Pokémon, they will appear on their device screen and the users can capture them. The aim of the game is to collect as many different characters as possible. The map the app is using is a stylised version of Google maps. It replaces real street names and landmarks with Pokémon related names and in game buildings. Pokémon Go is more gamified than what Sau and Go aims for. It is a game in and of itself, and the goal of a trip is to collect Pokémon. Sau and Go on the other hand, aim for a more additive style, when going for a walk or hike. Pokémon Go is also somewhat lacking when the player enter wilderness areas. The game has a city focus, with Pokémon and collectibles spawning around the landmarks, and where there are other players with phones.

Pokémon Go does have users in the same age group as Sau and Go, but the majority of their playerbase is older. Forbes [3] found almost 46% of users were age 18 – 29.

Ingress

Ingress is also an augmented-reality game for mobile phones, where the user physically interact with real world locations. The game has two factions that play against each other, where players go to specific places, such as landmarks or monuments, to capture these geographical points. The player and their team is supposed to link up multiple of these points and get control over all the points in geographical areas.

Ingress has a complete focus on competition and PvP, even though players don't fight directly against each other. When a point is captured there is nothing more to do until an opposing player has recaptured this point.

While it is possible to play this game when going from A to B, it is not very helpful as you get points for setting up "fields". These fields are calculated by surface area so the player needs to move in a circle or work together with someone else.

The user groups targeted by both games are again widely different, since Ingress target audience is young adults and adults, with only 3% of the player base being under 18 years old [4].

Both games can be played as a part of a trip, and can be used to motivate someone to keep active. A survey found that 72% used Ingress because they liked to find new places to explore, and as general entertainment. This is definitively overlapping with the goals of Sau and Go. Ingress takes full advantages of competition and the engagement this brings to a game, something that would be an ambition for Sau and Go in the future.

Geocaching

Unlike other games mentioned, Geocaching is not a direct product from a particular developer, but rather a community-driven activity. It started in 2000 when the GPS standard was made available. It is also a lot less gamified, with less game incentives, but is supported with real world logbooks and "gifts". Players hide GPS-enabled containers all over the world and then other people use the coordinates to find the containers and see what they hide. They always contain at least a logbook that players can sign, but some has other items included.

This might be the most similar game, aside from Pokémon Go, but for completely different reasons. Geocahing can easily be played as an addition to an excursion. It is still massively popular, and the community website [5] claims to have 7 million users worldwide. It also has no in-game transactions similar to Sau and Go.

Both the age group of the targeted audience and demographic composition is however very different. Geocaching is aimed at travelling adults. It is somewhat

limited to its communities, since someone needs to set up real world locations first, before the game can be played. Sheep and Go however has children between 7-13 as its targeted core user group. Sau and Go works optimally as long as there are sheep in the area, and requires little to no set-up time or maintenance once the GPS coordinates are downloaded.

2.2 Other applications

Outtt

Outtt is a Norwegian hiking app that makes choosing where and how to get around in nature easier. While Sau and Go aims for a more interactive experience, this app has excellent map details and show possible nice hiking trips close to the users location. The hikes themselves are hand-made, however there is a lot to learn from this application. The smallest trails are shown when zoomed in, even if the user is not following a pre-made hike.

Find My

Find My is a Norwegian company that uses GPS devices to help keep track of animals that are released into the wilderness. The application's main user group are farmers that want to keep track of their grazing animals during summer. This enables the farmers to more easily locate them, when it is time to herd the animals back inside, at the end of the season.

The master project is based on the system that Find My is using, where we got permission from the farmers to use their sheep's locations. Fig 2 is a screenshot from Find My. Here one of the sheep has had its locations and routes plotted, during the summer of 2018.
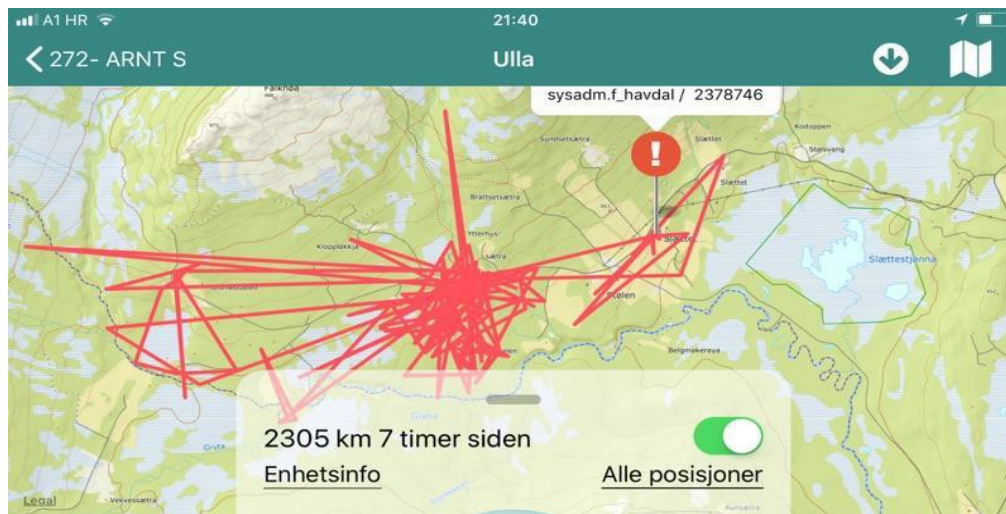
Fig 2: *Screenshot from the Find My app*

2.3 Conclusion

There already exist games that tries to make the user more active, however all of them, except geocaching, were made with a focus on earning money. This might be a reason why the targeted audience is older for all of these games. All of the games in this section, has a focus on users and events in cities. Sau and Go on the other hand encourages families to go hiking off the beaten track. There are still many nice features and solutions that can be reused from these applications. Both the stylised map choices and the level of detail on all of these maps needs to be noted. Ingress and to a certain degree Pokémon Go also both use competition and player interaction to keep their playerbase interested, something Sau and Go would benefit from.

3 Requirements

Requirements of the application will be discussed and explained in this chapter.

3.1 Functional Requirements

The functional requirements will be divided into three categories, high, medium and low priority. This will be an indication of how important each parameter is for the user experience. High are basic features required to be able to play the game. Medium is still of importance and are viewed as integral parts of a finished game. Requirements with low importance are more for the flow of the game, or extra features. These were only added when it was easy to incorporate them, or they were specifically requested by a test group.

Requirements	Priority	Achieved - notes
Easy to use UI	High	Yes
Map 2. Detailed map with points of interest on the map	High	Yes
Map 1. Local map centered on GPS	High	Yes
Map 2. Showing player and game elements on map		
Interacting with the points of Interest	High	Yes
Score/Level system 1. Moving to real world locations with sheep/ trip scores	Medium	Yes
Score/Level system 2. Extra points for spotting other animals/tracks/trip	Medium	Partial – Possibility to notify the game when other animals are spotted

length		which gives points – points for trip length not yet added
Working GPS system	High	Yes
Settings-Different Map types/How often location updates/Sound etc	Medium	Yes – Turned out to be more important than expected since map style helped orientating users
Save user data 1. Settings/Score/level/User stats	Low for prototype testing	Yes
Save user data 2. Sheep visited/Sheep stats	Low for prototype testing	Each sheep has a unique ID so possible to track how often the user visited certain sheep
Sheep leveling system		Partial, not online
Power ups/ more interactions		Partial

Table 3.1 *Table of the functional requirements*

As can be seen in Table 3.1, the highest priority were given to the core game mechanics, and features that would make a prototype playable. This includes a working GPS system, and a way to show the user's position on a local map. These features were implemented first so that user tests could be started as early as possible. The first playtest were run with only the high priority tasks completed, to get an early feedback, so the project could focus on player enjoyment. Dedicated tests were also run on simple features such as user interface and the intuitiveness of the map controls.

The score and level system will be discussed in future chapters, but is an integral part of what keeps the player engaged. The save system stores relevant user stats such as levels and experience as well as sheep visited and how many hikes the user has completed.

3.2 Non-functional requirements

The non-functional requirements are focus-points that can not be defined as specific game features.

<u>Maintainability</u>
The project was designed to be maintainable, and use a black box design pattern. This makes it very easy to add and test, or even remove features, as they work independently from each other. This leads to a modulated design. The singleton design pattern was also used to make a "game master" to keep track of game state, score and so on.

<u>Performance</u>
Because the game is supposed to run on different mobile devices, the application has to be quick, easy to run and stay responsive. This affected decisions in development such as having as few game objects as possible on screen in each scene, and divide content into multiple scenes, when appropriate.

<u>Intuitive User Interface</u>
Another non-functional requirement that had high priority was the user interface. The game needs to have an easy to understand and easy to use UI. The menus were designed to have as few buttons as possible, and if there were too many options,the menus were split into sub-scenes.

<u>Game flow</u>
Another goal was to have the game flow be as good as possible, which proved hard, since the user is constantly switching their focus between the game and navigating the environment. The goal was therefor to keep the gameplay engaging and rewarding by having the player interact with it in short bursts. The game will also have almost all the player actions give instant feedback. The feedback is given for example with points for level-ups or graphics interactions.

4 Planning & design

Chapter 4 will explain the most integral parts of the game design. Both the thoughts and how the systems were design to work and keep the player engagement high. The end of the chapter will have a short discussion on the limitations of the current game design.

4.1 Game design

Trip

When a new game is started, the app finds the GPS coordinates of the device and downloads a map from MapBox, that are generated from these coordinates. It then parse through the list of sheep that was downloaded when the game initialized, and draws all sheep within the boundaries of the map. If any of the sheep has been visited the app has a different graphical representation of these than if they still would generate points.
It is important that the map is easy to read and understand, so that the user can navigate easily.

Every time the GPS coordinates are updated, the app checks the sheep list for any instances within 100 meters. If any are found, the player gets a massive point bonus. It then sets that sheep to "Visited", which is also graphically represented to the player with a change in graphics. The 100 meter limit was chosen after testing with the app, as well as feedback from the user groups. For most mobile phones the GPS has an inaccuracy of 5-20 meters, and finding the exact locations proved hard and frustrating when hiking in woodland outside roads and trails. The GPS signals from the sheep update only a few times a day, and as mentioned the sheep are not likely to stay in the exact same spot for long.

Leveling system

Carlo Fabricatore [6] found that a good way to keep players engaged and wanting to play more was to introduce progression systems. This can include parameters like getting new and better equipment and gear, increasing player

levels, as well as meeting new enemy types and maps.

Focus was therefore put on a leveling system when designing the game. To level up, the player needs experience points, that they can earn in different ways.

- The player can visit locations where sheep have updated their coordinates through their tracking system.
- The player can find and manually add signs and observation of other animals, including sheep without the GPS trackers, to the app.
- The player gets points for the distance traveled, as well as a percentage of all the experience earned on a trip after its completion.

The fastest way to gain experience is by visiting the GPS coordinates of different sheep.

It is however also possible to earn experience points even if the player goes for a walk in areas with no GPS marked sheep.

Friendship Level for Sheep

The friendship leveling system is a separate system from the player leveling system. The friendship system works both as a progression system to keep the players engaged, and tries to add familiarity to sheep that are visit multiple times. It is also a possible link to multiplayer and competitiveness. This will be discussed further in the future works section.

When getting the list of the sheep and GPS locations from Find My, each sheep has GPS coordinates, time since last update, name and unique ID that is connected to the GPS collar they are wearing.

By tracking the unique ID of the sheep the player has visited, it is possible to have a separate friend level with each sheep. This is to encourage the player to keep visiting the same sheep even if it changes location. This might both lead to longer trips, meaning that sheep off the beaten track gets visited, as well as creating a real life bond between the child and the sheep.

Game loop

The basic game loop

1. Decide to start a new trip
2. Find sheep close to the path you are choosing

3. Navigate the landscape and map to find the sheep location
4. Look for signs of other animals to score extra points, until you reach the location
5. GoTo 2 if trip is not finished
6. Finish trip and get points for trip length /animals visited /etc

The user chooses to start a new game/ go on an new trip. The game then initializes and all sheep in the proximity are drawn on the map. The user then picks a path and sheep that are close to the path they have decided on. The player then has to navigate the terrain with help of the map and GPS to find the location of the sheep. On the way they can also score extra points by finding other animals, tracks or other signs, keeping them engaged and focused on both the game and the nature around them.

After finding the location the player gets a large point boost, and will then have to decide if he wants to find a new sheep, or finish the trip and return home.

At the end of the game the user gets a large point payout that is affected by the total amount scored on the trip, as well as the length of the trip.

4.2 Limitations

Currently there are no offline possibilities. This could easily be achieved by downloading area maps either when the app is downloaded the first time. Alternatively local maps could be downloaded manually by the user, and stored on the phone. The app could then use the GPS and the stored maps when it cannot contact the server.

5 Technological choices

This chapter will look at the programming language chosen, the IDE that will be used and the OS the prototype will be developed for, and give some explanation of these choices. It will also discuss different map solutions and the final choice.

5.1 Language & Integrated Development Environment

Sau and Go was developed in Unity. Unity is an engine with an integrated development environment, and was created first and foremost for games development. It was decided early on in the development cycle that Unity would be chosen as the game engine, as it is very good for prototyping and speeds up the background game development process immensely. It also has a free license until the product has sold a certain amount of copies. This makes it ideal for small scale studios and projects. The developers of Sau and Go also had some knowledge of Unity from earlier projects, meaning more time could be spent on the main project, instead of learning new tools.
Unity is set up to use Visual Studio as its IDE, which was an excellent choice for this project. Sau and Go uses C# as programming language as this is the supported language in Unity, as well as the most commonly used language for non-AAA games, smaller indie studios or smaller games made by bigger studios, for example blizzards Hearthstone [7], or the critically acclaimed Ori and the blind forest [8].

5.2 Platform

Sau and Go will be played while the user is outside, and will have to run on a mobile device with a built-in GPS. The market for operating systems on mobile devices is now dominated by Android OS and iOS from Apple. Currently Android OS is sitting on around 70-85% of the market share and iOS on 11-20%[9]&[10].
Sau and Go was therefore created for Android systems, as it is both easier to develop for on windows computers, and is the more common OS on mobile devices.
One of the reasons for choosing Unity however, was that it is easy to do cross

platform development. This means that the application only needs to be created once, and with very little effort and time can be ported to other platforms. Unity currently supports 27 different OS's [11]. While the game is developed for Android phones, the game already works with mouse and keyboard on windows computers and will require almost no extra development time to be playable on windows phones. Some screen ratios are currently off on computers and tablets, making buttons and text appear off screen, so some button layouts would still need to be changed.

Even porting to iOS will take little time, with only certain keywords, file/path locations and system related function calls that will need to be changed.

5.3 Map and Orientation

The location of the user is found using the mobile device's built-in GPS. This works well for Sau and Go as its intended use assumes that the game will be played from the user's phone. The first time the game is started, it will ask for access to the device's GPS system, and cannot be played without these rights. There are differences in accuracy regarding GPS, depending on the age and type of mobile phone used. However this was taken into account during the development of the game. When finding the coordinates of the phone, the GPS is pinged multiple times and the data is averaged. This makes it possible to find an approximate location, to correct for the inaccuracies of older devices. The animals are also most likely not in the same location as they were when they last updated their GPS coordinates. Therefore the game is quite lenient on how close the player has to get to the exact location before they are rewarded points. Currently it is set to a 50 meter radius,which seemed ideal in the users tests, so even with an older phone the inaccuracy of the GPS is negligible.

Map solutions
When looking for a map solution, the two most important attributes were that the maps had to be well detailed, so even small tracks are shown, and be customizable when it comes to scale and style.
Some of the viable map options that were explored were Google Maps [12], OpenStreetMap [13], Norkart [14], Geonorge [15] and MapBox [16]. In the end

the decision was down to Google Maps and MapBox. They were the best when looking at the level of detail that could be achieved outside of cities, and flexibility in both detail and styles, which user tests proved was valuable when navigating in forested areas.

MapBox was chosen as it is free for a large amount of mobile units per profile, can be used with only GPS coordinates and the maps are very detailed, as even smaller trails are shown. It also delivers maps in formats that are easy to integrate and modify in the Unity Engine.

6 Implementation

Chapter 6 will explain the implementation of the design and technological choices, and give an overview of the final product.

6.1 User Interface

The user interface was developed with respect to what was discussed in chapter 3 and 4, as well as user testing and feedback. This part is split into two main categories: menu UI and game UI.

Game User Interface

The game UI was intentionally kept as minimalistic as possible. With only three buttons at the bottom of the screen to not draw any focus away from the game, or clutter up the game space, as can be seen in Fig 6.1. Even when interacting with the game, almost all of it happens by moving in the real world. Not by clicking on the phone. One major point of discussion was if it should be possible to change map styles from the game screen, or if the player had to return to the main menu. Even though there are pros and cons for both, it was decided to move anything that could distract the player, away from the main game screen.
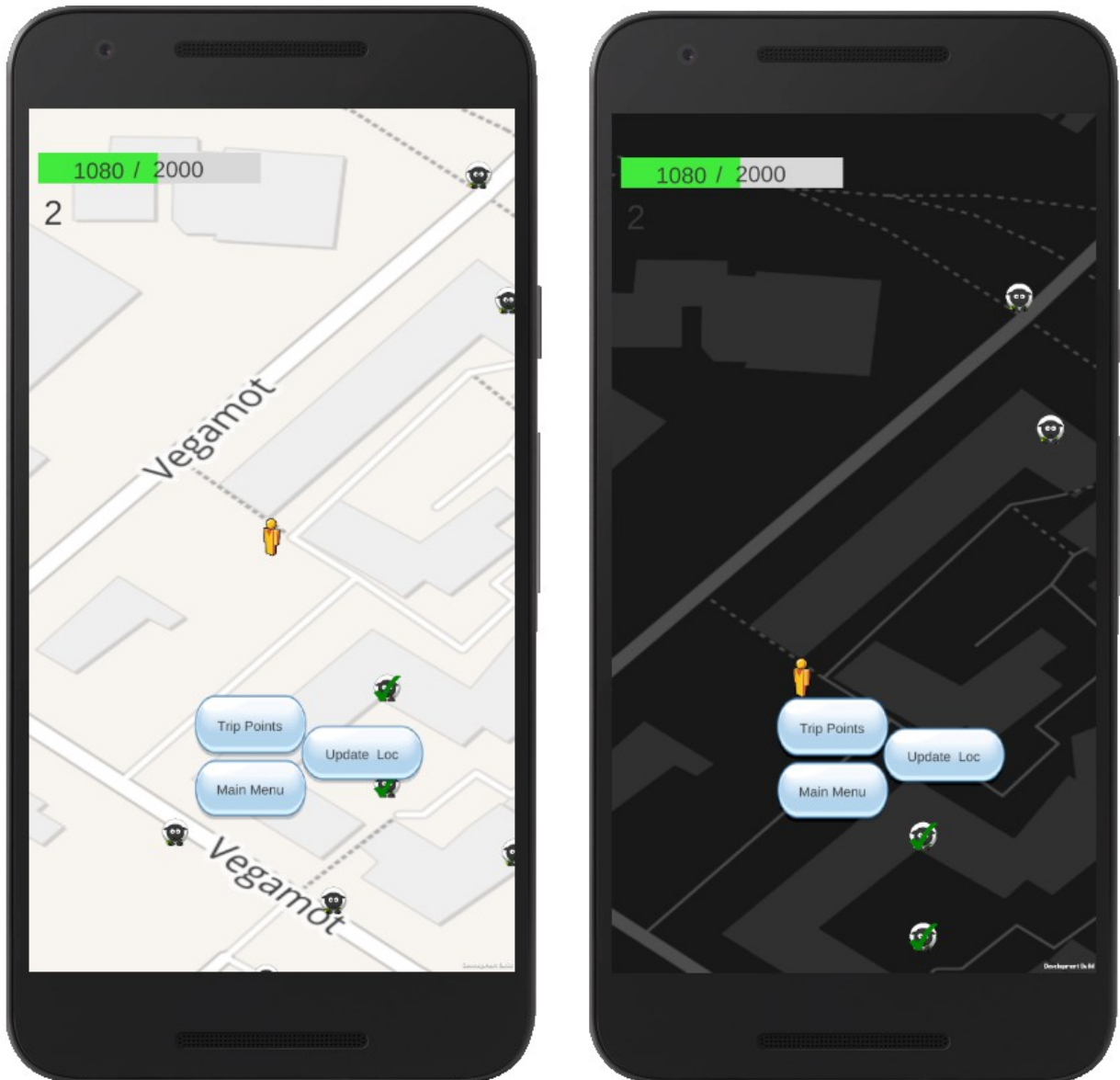
Fig 6.1 *Game screen with two visited virtual test sheep,with light and dark theme*

6.3 Navigation

As discussed in technological choices, the maps themselves get downloaded from MapBox using the mobile phone's GPS location. The data is converted to an object in the Unity game engine and can be navigated by moving the viewpoint with finger drag movements on the phone screen.

A zoom feature was requested by the first test group, and is possible to do by using two fingers and drag them apart to zoom in, or move them closer to zoom

out. There is still a max zoom level as the only intended use, is to navigate the local terrain, and the maps get unreadable if zoomed out to far. By tapping twice you center the map on the player position, to make it easy for the user to reorient themselves.
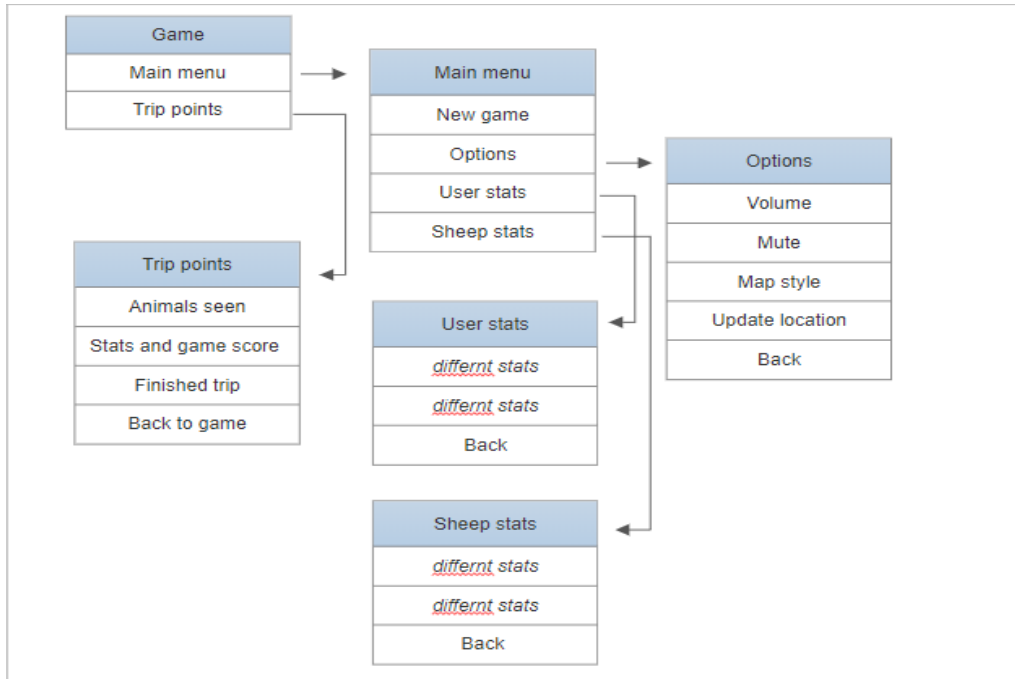
6.4 Menu layout

Fig 6.2 *The different game scenes*

When the game boots up, the user is always brought to the "Main menu". From here it is possible to either start a new game, go to the options menu, or go to the two stats menus, as can be seen on fig 6.2 . The "User stats" show statistics linked directly to the user. For example: total trips undertaken, total sheep visited and experience gained. The "Sheep stats" on the other hand shows the player statistics in relation to the specific sheep. Each unique sheep the player has visited, has stats and info such as: a name the player can edit, the number of times the sheep has been visited by the player, and so on.
In the "Settings menu" the user can change the volume, or they can mute the game completely. The user can also change the different map styles between: Light theme and dark theme, shown in fig 6.1 , emerald theme or aerial photo. The "New trip" button, on the main menu, brings the player to the game screen,

where he will navigate and find potential sheep. From this screen the player can either finish the trip and go back to the main menu, or go to the trip points screen. The trip points screen should be accessed by the user if they spot any animals, or any sign of animals such as footprints. Here the player can add which animals they have spotted, to gain extra experience points.
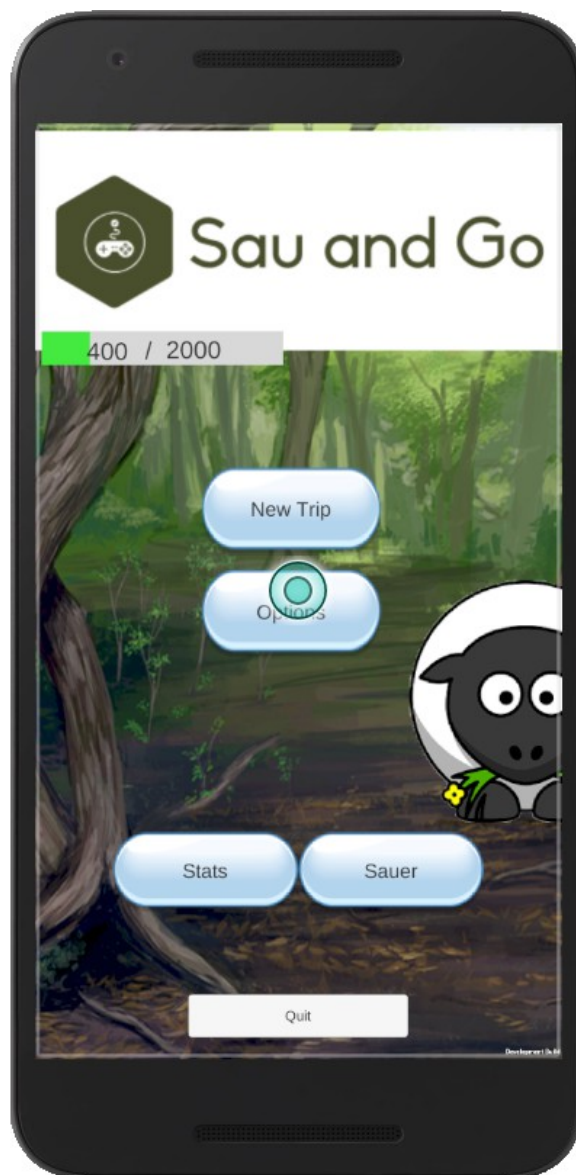
Fig 6.3 *Main menu screen*

6.5 Current Issues

Buttons, music and art are all royalty free. They were found on the internet, or is art made by non-artist team members, and was made only for the prototype. All of this needs to be remade for a full game release.

7 User testing and evaluation

This chapter explain the user tests and interviews and how they were conducted during the development process.

7.1 User testing

The user tests were carried out in three rounds. The first test focused on menu layout and usability. This test was done with people who had experience in game and UI design. The two following user tests were carried out with two different groups, in pairs of two. These test groups consisted of kids within the target age group. Before the tests started, they were given a short explanation on how the application worked and the goals of the test. The users then got the mobile phone with the game running, and were told to play around with the game on their own. One person took notes on how the app was used. These included situations where the users seemed to have trouble. He also answered any questions the users had.

After the playtest the user pair were interviewed. They were first asked general questions about the experience. Then more specific follow-up questions that differed, depending on their previous answers, and where in the development process the test was conducted.

The first playtest with the children focused on starting a new game, using the menus and navigating the game and map. The second was a more general playtest, where focus was put on overall gameplay experience.

For the purposes of the tests, virtual sheep were generated near the locations the tests were carried out. One test was done in the suburbs and one in a forest close to the city.

7.2 Interview

The general questions asked after the playtest were:
- How did the UI feel; was everything intuitive?
- How was using the map feature and hiking part of the game?
- Anything that could be done better, on this part?

- How was the scoring and experience system?
- What did you like about this system?
- What could be better here?
- Other thoughts and comments.

As mentioned, the follow-up questions that were asked differed between each interview, depending on the answers and the development progress of the game. In both interviews the children started with very brief answers, and it was hard to get any in-depth answers. However the further into the interview, the more thoughts and ideas came forward.

The 'other thoughts and comments' section were answered with a plethora of ideas both times. Most of them were unrealistic to fit into this project due to the scope and time constraints, but some contributed to make the end product better. For example double-tapping to center the map on the player after dragging the map around. The balancing of the bonus points earned was also a result of the feedback.

7.3 Summary

User testing was an integral part of the design and development process, and changed the final product significantly. Both during and after both of the playtests, the kids were enthusiastic. Especially during the last test with the most complete prototype. They enjoyed the game and having to navigate through the forest to try and find the location of the virtual sheep. After the last test there were more ideas than ever, and it is a shame that not more of the ideas could be implemented. Some ideas from this session included: how to do multiplayer interaction and tracking the speed of the player to prevent cheating.

Another good idea was to introduce a cool down on how often sheep should be able to give the player points. This means that a player cannot stand next to a sheep, and start and end trips over and over, to get the visited sheep's point bonus.

8 Future work

This section will be discussing the different parts of the prototype that could be improved. It is always possible to add more features and mechanics to a game. The features mentioned here are elements that were either requested during user tests and interviews or were discussed during the development process. The chapter is divided into features that would be quick to develop and add to the game, and features that would need a more significant rewrite of the code base or for a completely new system to be added.

8.1 Short term

Achievements and progress tracking

Some of the users asked for more achievements and ways to track their own progress. For example stats on how many sheep they had personally visited, or which sheep they had visited the most. This is a good idea, as it keeps the player motivated and helps them set smaller, achievable personal goals. Most of the stats are saved as data in the user profile already, such as how many sheep they have visited, and many more stats are easy to add to the save profile data structure. What will take the most time would be to decide which stats are interesting for the user, and find a way to extract the data and present these stats to the player.

Interactive game objects

The testers also requested more things to interact with and visit on the map. For example different power ups that could be randomly distributed throughout the map and trigger when the user gets close. Some of the power ups that were discussed were:
- A timed score multiplier, that would give percentage bonus points while it lasted.
- Increased player radius for picking up sheep, for example from the 50 meter radius to a 100 meter radius.
- Spawning virtual sheep, that could be visited to gain the extra experiences point bonus.

All of these things should take little time to add because of the architectural design, and most of the effort would be to test it and balance the features.

Compass

From the user testing and follow-up interviews it became clear that some users had difficulty at times to orient themselves when they were in the woods. They were uncertain in what directions they were moving and what track they were on, so adding in a north/south compass in the corner of the map would be helpful, even if the map is locked north.

Offline maps

As mentioned in an earlier chapter, it should be possible to download a map and current sheep coordinates for that area at home, and play without access to the internet when outside . It is unlikely that any new sheep coordinates have been updated and this would not have a big impact on the game. This would also save battery and mobile-data for the user.

8.2 Long term

Player interaction

The developers discussed advantages and disadvantages of adding interaction and competition between players of the game. Studies done, for example "Game-Based Learning Effectiveness and Motivation Study between Competitive and Cooperative Modes"[17] and "The effect of competition on learning in games"[18], show that both engagement and enjoyment rise significantly when players can compare themselves, or interact with other players.

If save files that are currently stored on the users phones would be moved or copied to a server, adding functions such as leader boards and gift exchange would be possible to set up.

Especially stats such as who visited certain sheep the most times, and how close another player is to surpass this, or adding gifts to friends such as power-ups that could be used on the next trip, would be beneficial.

Game side

As mentioned in chapter 6 both graphics and music needs to be remade. Custom graphics needs to be drawn with a unifying theme. This includes things like the graphical user interface, such as buttons and sliders, to backgrounds and text styles. For a full game, sound is of high importance, as discussed by [19] and [20] . Therefore both soundtrack and custom sounds for clicking buttons, leveling up and so on need to be improved.

9 Conclusion & discussion

This final chapter will first give a brief summary of the different chapters. Then a discussion of the master thesis will follow.

9.1 Summary

Chapter 1 Motivation and goals, explained the motivation and objectives for this thesis.

Chapter 2 Requirements, discussed the requirements for the application to be considered a working and complete game.

Chapter 3 Related work. Here the pros and cons of similar games and applications were discussed. Both what the compared applications do well, and how they differ from Sau and Go.

Chapter 4 Planning and design. The game design and GUI design is discussed in more detail, as well as the limitations of developing for mobile-devices.

Chapter 5 Technological options, took a closer look at the choice of programming language and game engine.

Chapter 6 Implementation, showed how the design decision where implemented and how they were affected by the technological choices.

Chapter 7 User testing and evaluation, gave a brief overview over the user testing and feedback received.

Chapter 8 Future work, listed the different ideas and features that should be considered added to the game.

9.2 Discussion

A prototype game has been developed that uses GPS and real world coordinates and navigation to be played. The game was made using state of the art and relevant technologies. This allow for easy continued development and changes. The game can currently be played on Android devices, but can easily be converted to other platforms.

After user testing and interviews this project was a success as the building of the prototype was achieved. A few features were omitted such as the power-up systems. Other good ideas were never added because of time limitations.

However the prototype can still be considered a playable game. It includes GPS and real world to phone interaction, as well as a working score, save and leveling systems.

Literature:

[1] Miljødirektoratet - Historisk lave tapstall
, 2017 URL:
 http://www.miljodirektoratet.no/no/Nyheter/Nyheter/2017/Januar-2017/Historisk-lave-tapstall/

[2] Fylkesmannen - Oppsummering elektronisk sporing av sauer på utmarksbeite i Akershus, 2016 URL: https://www.fylkesmannen.no/globalassets/fm-oslo-og-akershus/dokument-fmoa/landbruk-og-mat/husdyr/rapport-om-elektronisk-sporing-av-sauer-pa-utmarksbeite-i-akershus-2016.pdf

[3] Ryan Mac. More Women Than Men Are Playing 'Pokémon GO'--By A Lot
, 2016 URL: https://www.forbes.com/sites/ryanmac/2016/07/26/more-women-than-men-are-playing-pokemon-go-by-a-lot/

[4] Beth Winegarner. The 2015 Ingress demographic survey,
 2015 URL: https://medium.com/@beth_winegarner/the-2015-ingress-demographic-survey-6e7181790069

[5] Audrey Kettler. 3 million geocaches: the infographic. , 2017 URL:
https://www.geocaching.com/blog/2017/04/3-million-geocaches-the-infographic/

[6]Carlo Fabricatore. *Gameplay and game mechanics design: a key to quality in videogames* 2007 URL: http://www.oecd.org/education/ceri/39414829.pdf

[7] inc. Blizzard Entertainment. Heartstone, 2018 URL:
https://playhearthstone.com/en-us/

[8]Microsoft. Moon studios, 2010 URL: https://www.orithegame.com/blind-forest/

[9]Statcounter. Mobile & Tablet Operating System Market Share Worldwide
, 2018 URL: http://gs.statcounter.com/os-market-share/mobile-tablet/worldwide/#monthly-201702-201802

[10] Statista. Global mobile OS market share in sales to end users from 1st quarter 2009 to 2nd quarter 2018, 2018, URL:
https://www.statista.com/statistics/266136/global-market-share-held-by-smartphone-operating-systems/

[11] Unity Technologies. Unity: the game engine for mobile, 2018 URL:
https://unity3d.com/unity/features/multiplatform

[12] Google inc. Google maps, 2007 URL: https://cloud.google.com/maps-platform/

[13]Inc. OpenStreetMap, 2014 URL: https://www.openstreetmap.org/

[14] Norkart. 2016 URL: https://www.norkart.no/

[15] Kartverket. Geonorge. 2016 URL: https://www.geonorge.no

[16 Inc. MapBox, 2010 https://www.mapbox.com/

[17] Chang-Hsin Lin.Shu-Hsien Huang, 2017 "Game-based
learning effectiveness and motivation study between competitive
and cooperative modes," URL: http://ieeexplore.ieee.org/document/8001737/

[18] Nergiz Ercil Cagiltaya, Erol Ozcelikb, Nese Sahin Ozcelikc 2015 "The effect of competition on learning in games", URL:
http://www.sciencedirect.com/science/article/pii/S0360131515001001

[19] Lennart E. Nacke, Mark N. Grimshaw, Craig A. Lindley. 2010 URL:
https://dl.acm.org/citation.cfm?id=1837819

[20] Jiulin Zhang, Xiaoqing Fu. 2015 URL: https://www.omicsonline.org/open-access/the-influence-of-background-music-of-video-games-on-immersion-2161-0487-1000191.pdf

Appendix.

Appendix A – Overview of the reading list and relevant articles

Appendix B – Notes from the interview after the first playtest

Appendix C – Notes from the interview after the second playtest

Appendix A

Name	Method	Positive Negative	Keywords	Relev
From game design elements to gamefulness: defining "gamification"	Paper - ++ Literature Review Close look at what gamification is	Easy to understand – With examples - good definitions	No techniques s, gamification, pervasive games, play, playful design, playfulness, serious games	GM -SG
Gamification by Design – Implementing game mechanics in web and mobile apps	Book -			
Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification	Paper - Literature study of hundreds of articles.	Does work	Unclear on best methods	GM
A Meta-Analysis of Serious Digital Games for Healthy	Paper - a meta-analysis of 54 serious digital game studies		Serious games, digital games, systematic review, meta-analysis,	SG

Lifestyle Promotion	for healthy lifestyle promotion,		tailoring, multicomponent, health promotion	
(Serious) Games Development: The State of the Art	Paper - discuss different types of video game and introduce the concept of serious game. discuss the critical elements of the game design.	Talks about how hard it is to rate serious games.	video game, game design, game development, quality, serious game	SG
Gameplay and game mechanics design: a key to quality in videogames	How to design a good game, talks about core gamplay and minimalism	Good video game design	Video game, game design,	GD
The Development and Effect of Serious Games	Paper - development of this mobile multi-platform serious game	++ - - Undergraduate		SG
Design Patterns in Serious Games: A Blue Print for Combining Fun and Learning	Paper – Design patters for how to make serios games	++ Really good, exactly what I need -- For teaching skills, not motivating but same	serious games, game-based learning, design patterns.	SG

Design patterns for learning games	More patterns			
Game object model version II: a theoretical framework for educational game development	Paper – Designing engaging educational games		Game object model , Educational games ,Narrative social spaces, Ideologies , Challenges–puzzles–quests	
Summer habitat use and activity patterns of domestic sheep on coniferous forest range in southern Norway	Paper - Activity peaks were at mid-morning and late evening camped in groups at midday and at night, always further upslope at night than during the day. Sheep were less active in cold, wet weather. Habitat selection and activity patterns observed in	++ Pretty perfect Easy to follow pattern -- Old few sheep	radiotelemetry, sheep diet, sheep grazing, forest grazing	SB

	this study were similar to those of both wild and domestic sheep studied elsewhere			
Sheep Behavior Under Unherded Conditions on Mountain Summer Ranges	Under unherded conditions Rambouillet sheep travelled greater distances and spent more time resting, while Columbias travelled the least distances, rested least and grazed longer than the other breeds.	++ Travel distance and pattern - - Bit too detailed and too focused on other behaviours than movement. Very high with sparse veg 2000m	Sheep, movement, breeding, grazing, mountain.	SB
Density-dependent foraging behaviour of sheep on alpine pastures: effects of scale	Sheep kept at high (80 sheep km−2) and low (25 sheep km−2) population densities during summer	++ Looking at foraging behavior and difference between density (might be usefull) Norway	Sheep, Population processes, vegetation types	SB

	in high mountain pastures in Hol, Norway	-- More on type of vegitation eaten Mountain		
MPQ: Design Patterns in Video Game Programming		https://web.wpi.edu/Pubs/E-project/Available/E-project-071113-100005/unrestricted/MQP_Master.pdf		

Appendix B

User interface

Mer responssive knapper (lyd)

Færre knapper (muligheter i hovedmeny)

Bruk mer spillignende knapper

For kart/tur

Bra med manuell oppdatering av kart pga strømbruk og ikke et stort trekk, men burde være mulig å sette på automatisk oppdatering om dette ønskes. (Flere muligheter med hvor ofte den oppdateres?)

Andre ting man kan besøke på kartet en GPS markert sau?

Flere typer kart, kanskje et som er letter å bruke i terreng – satellitt kart?

3d kart muligheter

Andre kommentarer:

Balansering av hvor mye poeng man får av å se forskjellige dyr trengs å justeres. Selv om man leter etter sau burde man få mest for å se skjelnede/ spennende dyr som gaupe og ulv.

Flere undermenyer, for å gjøre det mer oversiktlig, to muligheter er Sett/Sett spor av.

Anti cheat som sjekker hvor rakst man beveger ser.

Tid og lengde for nytt besøk av en sau.

Poeng for lengde gått på tur, både meter og tid.

Maksgrense for ekstra poeng/ en prosent av besøkte sau på turen?

Bilde bevis av funnet sau/dyr.

Appendix C

Brukertest 2 Prototype

<u>User interface</u>
Store knapper, lette å lese
Bra Options meny

<u>For kart/tur</u>
Veldig bra med forskjellige kartstiler/typer
Bra størrelse på kartområde lastet ned
Rotering av skjerm gjør knappene sidestilt.
'Er du sikker på du vil slutte' advarsel

<u>Level system:</u>
Bra men kunne skjedd noe når man grafisk når man levler opp
Hva får man for å levle opp?
Kult med en spiller avatar som kan få ting som klær eller bevegelser

<u>Andre komentarer:</u>
Hadde vært gøy med "achievements" for eksempel finn 100 sau.
Nord/sør kompass, for å gjøre det letter å finne fram.

Mulige ting å finne på kartet kan være power-ups eller en versjon av pokestops

Pokestops, som kan gi poeng/power-ups, gaver.

Power-ups kan være:

- 2x Poeng
- Spawne virtuelle sauer
- Større innsamlings radius
- Double score i en stund

Multiplayer :

Leaderboards hvor man kan se venner/top scorer/andre spillere som er omtrent like gode som man selv.

Flere forskjellige stats som: Skritt gått, sau møtt, gjennomsnittlig sau møtt pr tur, gaver gitt, turer gått, power-ups funnetpokestops funnet.

Må ikke være mulig å starte og stoppe turer ved siden av sauer for å tjene masse poeng.

Level ups kan gi nye power-ups, la dem vare lengere, gjøre dem kraftigere.