Masteroppgåve

NTNU
Noregs teknisk-naturvitskaplege universitet
Fakultet for informasjonsteknologi og elektroteknikk
Institutt for elektroniske systemer

Øyvind Sørdal Klungre

Narrative's Impact on Quality of Experience in Digital Storytelling

Masteroppgåve i Elektronisk systemdesign og innovasjon
Veileder: Andrew Perkis
Juni 2019

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Kunnskap for ei betre verd

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Contents

Samandrag

Så lenge der har vore menneske har historieforteljing også vore til. Måtane vi fortel historier på har utvikla seg saman med teknologiske framsteg. Dette har ført til tilsynekomsten til digital historieforteljing, som legg vekt på multimodalitet så vel som interaksjon. Blant dei nylege framstega i digital historieforteljing vil denne rapporten fokusere på lokasjonsbaserte prosjekt og sensorbaserte narrativ.

Dette prosjektet ser på korleis narrativet påverkar opplevd kvalitet til ein brukar i ei digital historie. Dette er gjort ved å lage og implementere ei lokasjonsdriven digital historie basert på trollhistorier frå Trollheimen i Noreg. Narrativet presenterast til brukaren gjennom ein utvida røyndom-applikasjon laga i Unity på ei mobil eining. Narrativet er drive av lokasjon som skaffast ved å spore brukarens rørsler med OptiTrack-systemet.

Dette narrativsystemet har så blitt evaluert av 30 personar som har delteke i ei subjektiv evaluering. Dette har blitt gjort med to forskjellige eksperimentoppsett: eit som er narrativbasert, og eit som er instruksjonsbasert. Resultata viser at narrativoppsettet resulterer i ei rikare, meir levande og meir engasjerande erfaring. Denne effekten minkar viss ein eksponerast for begge oppsetta. Når det gjeld vanskegrad viste vi at for deltakarane som gjorde begge oppsetta, så viste instruksjonsoppsettet seg å vere signifikant enklare enn den narrativdrivne tilnærminga.

Summary

As long as there have been humans, storytelling has existed as well. Our ways of telling stories have evolved along with advances in technology. This has led to the emergence of digital storytelling, which puts emphasis on multimodality as well as interactivity. Of the recent advances in digital storytelling, this report will focus on location based projects and sensor based narratives.

This project looks at how the narrative influences the Quality of Experience of the user in a digital story. This is done by creating and implementing a location driven digital story based on troll stories from the Trollheimen area in Norway. The narrative is presented to the user by an augmented reality application made in Unity on a mobile device. The narrative is driven by location obtained by tracking the user's movement with the OptiTrack system.

This narrative system has then been evaluated by 30 people who have participated in a subjective evaluation. This has been done with two different experiment setups: one that it narrative based, and one that is instruction based. The results show that the narrative setup results in a richer, livelier and more engaging experience. This effect is diminished if one is exposed to both setups. As of ease of use we showed that for the participants who did both setups, the instruction setup proved to be significantly easier than the narrative driven approach.

Preface

I am submitting this thesis to fulfill the requirements for a Master of Science (MSc) degree at the Norwegian University of Science and Technology (NTNU). The work related to this thesis has been done over the course of five months, from January to June 2019. There are several people who have helped med with this project and who I would like to thank.

Professor Andrew Perkis has been my main supervisor. He has given valuable and detailed feedback and kept watch over the project. PhD student Asim Hameed has done an excellent job at supervising me as well. He also helped with implementing the story and making drawings for this report. PhD student Shafaq Irshad helped me with debugging and conducting the experiments.

My classmate Jomar Brudeli filmed the videos that were put out on YouTube, and my father John Willy Klungre provided photographs for the story. Staff engineer Christer Nesset made and set up the wooden pieces for the story, and senior engineer Krzysztof Orleanski provided technical assistance.

Chapter 1

Introduction

Storytelling has been a part of human culture through all human history. With technological advances, new ways of telling stories have emerged. Our new digital tools let us deliver different kinds of content to small devices at various locations. These opportunities have led to the emergence of digital storytelling.

Digital stories are characterized by the digital tools that are used, as well as how they are told [1] [2] [3] [4]. The content often comes in the form of several modes and modalities [34] [36]. And digital stories are often interactive, giving the participant an active role [6] [7] [8] [9].

Another field that has emerged as a result of technological advances are locative media, or location-based projects [10] [11] [12]. In these projects, your location determines what content is delivered to your devices [13] [14] [15]. This can be effective if the goal for example is to tell the history related to a historic site. When the tourist reaches the destination, he or she will get content that tells the story of the place based on their actual location [28] [29]. This can be done as simple as delivering text to a mobile device, or by using augmented reality (AR) to recreate structures that no longer exist [30] [33] .

An example of a location based application it the mobile game Pokémon Go. It uses GPS combined with Google Maps to give people an AR experience where they find and collect virtual creatures [17] [18] [19] . This shows how a location based project can make us engage more with our environments [20] [21].

A concept that is closely related to digital stories is sensor-based storytelling, which uses sensor data to tell narratives [37]. This leads to more possibilities to create richer narratives, and to increase the participant's immersion .

With these new possibilities, new questions arise as well. Given an interactive, digital storytelling application or service, what role does the narrative itself play in the participant's experience? How will the user perceive the system if parts of the narrative is removed? Models like Quality of Experience can be used as frameworks to investigate such questions.

This project looks at the narrative's role in digital stories. This is done in collaboration with the company iTrollheimen, which offers tours in the Trollheimen area in Norway. They want to make trolls into a species, and let their quests experience the trolls and their stories while wandering in Trollheimen. Their innovative approach to their experience is looking into how new technology can be used to enhance their tourist destination.

Based on stories from iTrollheimen, a digital story will be made an implemented at the lab Sense-IT at NTNU in Trondheim. An augmented reality application will be developed in Unity for a handheld device, and the OptiTrack system will be used to detect and trigger events based on the participants' positions. An experiment involving two different experiment setups will then be conducted on 30 participants, with the goal of doing a formal, subjective evaluation of the system.

The following research question was formulated:

RQ1: Does the story affect the user's Quality of Experience (QoE) in digital storytelling?

In an interactive digital storytelling, it could be possible that the narrative played no or little role, and that the interaction and the output gave the participant a good experience. This project will look into whether the narrative actually has an impact. The following hypothesis is based on the research question and will be tested:

The story affects the user's QoE in digital storytelling.

This thesis is structured in the following way: First, relevant concepts will be presented, as well as a case study. In the method chapter, the implemented system and its components, the progress of the work, and the experiment setup is explained in detail. Finally, the results are presented, as well as a summary with a conclusion.

A video that shows the whole story can be found on a YouTube channel accessible through the following link: `https://www.youtube.com/channel/UCvALP0r62xw4UM5NKczSXAA`

Chapter 2

Background

2.1 Digital storytelling

Digital storytelling is a way of telling stories by using digital tools. As our devices have gotten smaller and it has become possible to deliver high-quality content to them at different locations, the number of possibilities for these stories has increased.

There is more to digital stories than digital devices. The content is often expressed through several modes and modalities [34] [36]. The story can unfold within a space, so that the participant has to move around [3] [7]. While the stories we know from books and movies are linear, digital stories are often non-linear.

An important component of digital storytelling is the interactivity. Rather than being a passive observer, the participant is given an active role, and may become a part of the story [8]. This has led to experimenting regarding how to tell stories [1] [2] [3] [25]. For example, the participant can be motivated by a goal to move forward. This can make digital stories resemble games sometimes [4]. Games and stories are different things, which should be remembered when making digital stories.

2.2 Locative media

In locative media, the content you get depends on your location [13] [14]. This location can be a small spot, or a larger area. Instead of talking of locative media, one can talk about location based projects [15]. Location based projects are linked to digital storytelling, since digital stories can have locations as parts of it [4]. It is because of new technologies that location based projects are possible to realize [10] [12] [22].

Location based projects can be effective in projects that have a historical nature. You can visit a historic site, and then get some content delivered to your device that tells the story of that particular place [15]. This could be as simple as a text message delivered to your mobile device, or by using AR [29].

More generally, location based projects can use locations that in themselves have no particular significance. If a location based story is implemented indoors, this may happen in a space where the various areas have no meaning in themselves. The locations will then get meaning in the context of the story. Or they can just have an interactive function, meaning that some event is triggered when you move into a particular area.

We need small devices that can receive and output content with high quality. And it is necessary to detect a person's position. An example of how to do this is to use the GPS [11]. Many location based projects have used GPS, and this will be a natural choice for many outdoor projects. Implementing a location based project indoors requires an alternative to GPS [22]. This can be done with advanced equipment which allows high precision when detecting the user position.

2.3 Sensor-based storytelling

Sensor-based storytelling is about using sensor data to tell narratives. This can happen because of an interaction that the participant is conscious of, for example pressing a button or touching a screen. But the data can also be collected without the participant being aware of it. An example of this can be that a person moves into a predefined area which triggers an event, like playing a sound.

This concept is related to the two previous topics. Digital narratives can use sensor data to increase the participant's feeling of immersion. The challenge can be to find ways to collect the data and process it. The processing can be simple, for example if one interaction always leads to the same reaction. Another possibility is to collect sensor data that accumulates over time, and use these to trigger more sophisticated event series [37].

2.4 Case study: Rediscovering Daereungwon

An exampla of a location based AR application is *Rediscovering Daereungwon* [4]. It is based on a cultural heritage site in Korea called Daereungwon. The site consists of old royal tombs. The application tries to give the visitor a more immersive experience by using an interactive approach with gaming elements. By using the application, the visitor becomes a scavenger who trespasses the forbidden burial grounds of the Silla royalty. The goal is to steal two treasures of Daereungwon. While following the route, augmented content appears in the form of objects and people. The application can run on the visitors' own mobile devices.

A picture of Daereungwong with the route associated with the application is seen in Figure 2.1:

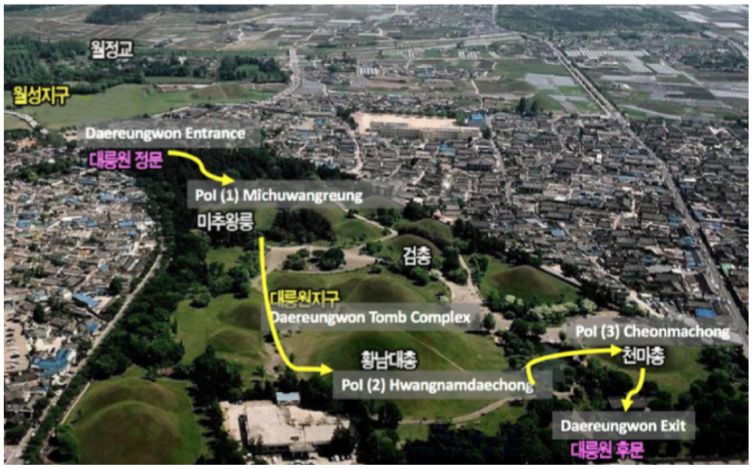

Figure 2.1: The Daereungwong Tomb Complex, with the route and stages of Rediscovering Daereungwon [4].

2.5 Quality of Experience

The Qualinet White Paper gives the following definition of QoE [38]:

Quality of Experience (QoE) is the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and / or enjoyment of the application or service in the light of the user's personality and current state.

Chapter 3

Method

3.1 System overview

An overview of the final system is shown in Figure 3.1:

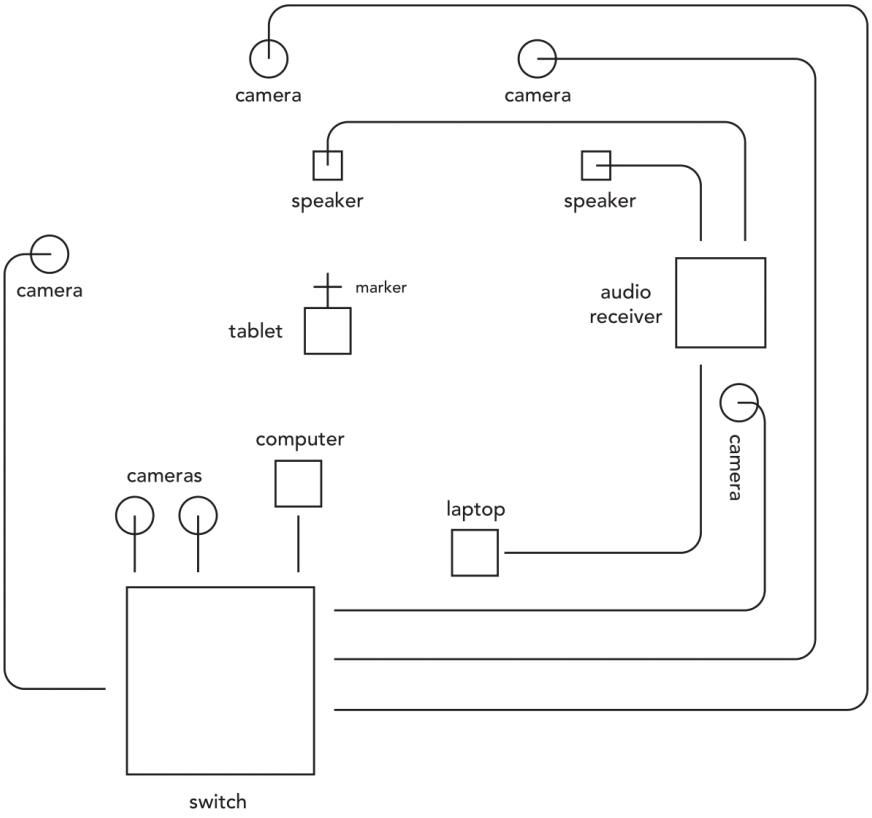

Figure 3.1: Overview of the final system.

An AR application made in Unity runs on a Surface Go tablet. This application uses image detection to trigger output in the form of images and sounds from the tablet. A marker is attached to the Surface Go, and this marker is tracked by six cameras which constitute the OptiTrack system. The cameras are connected with Ethernet cables to an 8-Port PoE switch, and this switch is also connected to a stationary computer. This computer runs the Motive software, which captures the

recorded data from the OptiTrack system. The tracking data is live streamed to a laptop over a local Wi-Fi network. This laptop runs the Unity editor. The laptop is connected to a multi-channel Harman/Kardon AVR 445 audio receiver, which is used as an audio amplifier for two loudspeakers. The loudspeakers are two-way Bowers & Wilkins speakers.

3.1.1 OptiTrack

OptiTrack is a motion capture system developed by NaturalPoint. It has become popular in several areas, including virtual reality. The OptiTrack cameras track surfaces which are covered with retroreflective material. Retroreflective materials reflect incoming light back to its source. Infrared light is emitted from the OptiTrack camera and is reflected by the markers. It is then detected by the camera's sensor. 2D images from several cameras are then used to compute 3D coordinates.

An example of markers that OptiTrack can detect is seen in Figure 3.2:

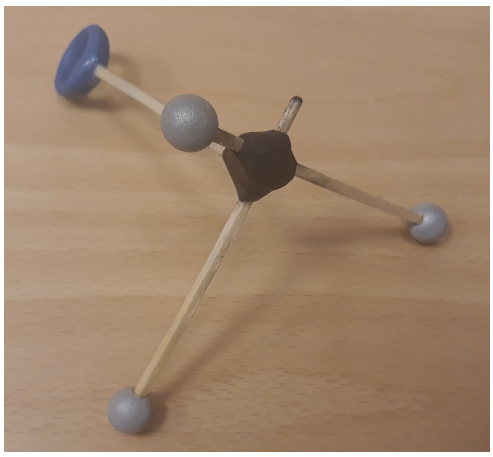

Figure 3.2: Example of markers used by the OptiTrack system.

It is possible to do tracking with OptiTrack both outdoor and indoor. One effective way of doing tracking is to capture motion within a volume. The cameras should then be placed so that each camera captures a unique viewpoint of the target capture area.

3.1.2 Motive

Motive is a software platform that controls motion capture systems for different tracking applications. It is also made by NaturalPoint. Motive provides interfaces for capturing and processing of 3D data. The 3D coordinates are obtained from reconstruction, which is the process of compiling several 2D images of markers to get 3D coordinates. Motive can get 6 Degree of Freedom data for both rigid bodies and skeletons. This makes it possible to achieve tracking of complex movements in 3D space.

The captured data can be recorded or live streamed to other pipelines. NaturalPoint does now offer a Unity plugin. This plugin enables streaming of tracking data from Motive to the Unity editor, or applications made in Unity. The tracking data can be used to control GameObjects in Unity.

3.1.3 Unity

Unity is a popular game engine developed by Unity Technologies. It is used to create games and interactive experiences, in both 2D and 3D. Unity supports over 25 platforms, on desktop as well as mobile devices. On Windows and Mac, the development can be done with the Unity Editor.

One way to get content when developing in Unity is through its Asset Store. There it is possible to get 3D models and other kinds of content, either for free or by paying. Unity has become popular for making virtual reality and augmented reality applications.

3.1.4 Vuforia

The Vuforia Engine is a software platform for creating augmented reality applications. It is developed by the computer software company PTC. Unity now integrates the Vuforia Engine, so that Unity projects can be built for the Vuforia augmented reality platform.

The Vuforia engine detects and tracks images by detecting features in an image and comparing these against an image target database. To create a database, images can be uploaded to the Vuforia Target Manager, which is a tool to create and handle target databases online.

If Unity is used, the databases can be imported into a Unity project. The images can then be used as GameObjects in a Unity scene. Afterwards, a 3D model can be made a child of the image, so that the model is shown when the image is detected. The detection of the image can also trigger other events, like playing sounds.

3.1.5 Surface Go

The Surface Go is a tablet device developed by Microsoft. The model used in this project uses Windows 10 Pro. It has a 128 GB solid-state drive storage, and the processor is an Intel Pentium Gold 4415Y. The rear-facing camera is an 8-megapixel camera with autofocus, and the display is a 10-inch PixelSense Display. To login to the device with the username *multimedia*, type in the password *Signal12*.

A Lenovo tablet was used early in the project. It turned out that devices with android may not be compatible with Motive's Unity plugin, and the Surface Go was therefore chosen instead.

3.2 Story overview

The project, Home of the trolls, tells a fictional story of the troll world in Trollheimen, Norway. It brings to life the everyday affairs of trolls who reside in this fantastical area. It explains how several natural phenomena that we observe are related to the trolls. The story is comprised of five smaller stories, each of different trolls or features of the troll world.

3.2.1 Story 1: Fausk

The first story is of Fausk, who lives in the forest. The word "Fausk" comes from a word in Surnadal which means "dry, old, rotting tree." All creatures in Trollheimen fear Fausk, including other trolls. He has a foul fur which releases a lot of dandruff. This causes branches and old tree pieces to to light up with a soft, green glow in the evenings. What science associates with mushroom with fluorine bindings is actually the dandruff of Fausk. His dandruff also brings dying trees back to life.

3.2.2 Story 2: Boll and Bulu

The twin trolls Boll and Bulu live amongst the stones. They are always keen on making mischief. They usually help animals escape from hunters. The two trolls are quite different. Boll is not so smart, but he is strong, a property he has inherited from his father. He has the property that he is consciously naive, so maybe he is not as stupid as many would like to believe.

Bulu is taller and slender, and the one with a brain in the duo. He is the one who comes up with the ideas, while Boll must act them out most of the time. They are friends with the local snow weasel, maybe because they like to scare and tease humans.

3.2.3 Story 3: The Raven Stone

This story in the series is not about any troll. Rather, it is about a special kind of object, called the raven stone. This is a stone found in raven nests. It has a special property which makes you invisible if you put it in your mouth. The trolls have known about this for centuries, and they use these stones to walk through Trollheimen unseen.

The only other way to see a troll, is to go out in the evening and play an instrument and sing as loudly as possible. The trolls love music, if someone plays well, they might start dancing to it. When they open their mouth, you may get a glimpse of them. But very few have witnessed this.

3.2.4 Story 4: Fold

Fold is the king, and one of the oldest trolls in Trollheimen. When the trolls meet for councils in the mountain Snøhetta, he is the one who has the last word. He regularly visits all valleys in Trollheimen to maintain affairs. His advisor is the northern mountain goat. Fold can talk to the rivers, and he gets to know what the river has seen through its path. Fold is knowledgeable and considerate. He listens to everyone regardless of their species and status. For his youth and immortality, he drinks from the youth spring of Mellomfjellet.

3.2.5 Story 5: Minill

Minill is the queen of Trollheimen. She is kind, and beautiful. Her long hair is similar in color to cotton grass. She is responsible for the life of the marshes in Trollheimen. When she bathes, the water that trickles from her hair provides nutrients to support the flora of the marshes. She loves peat moss and grows it everywhere. The nutrients from her hair make the peat moss antiseptic, which is useful for wound binding and reducing itching.

3.3 Prototype 1

Prototype 1 took place in a predefined area, see Figure 3.3:

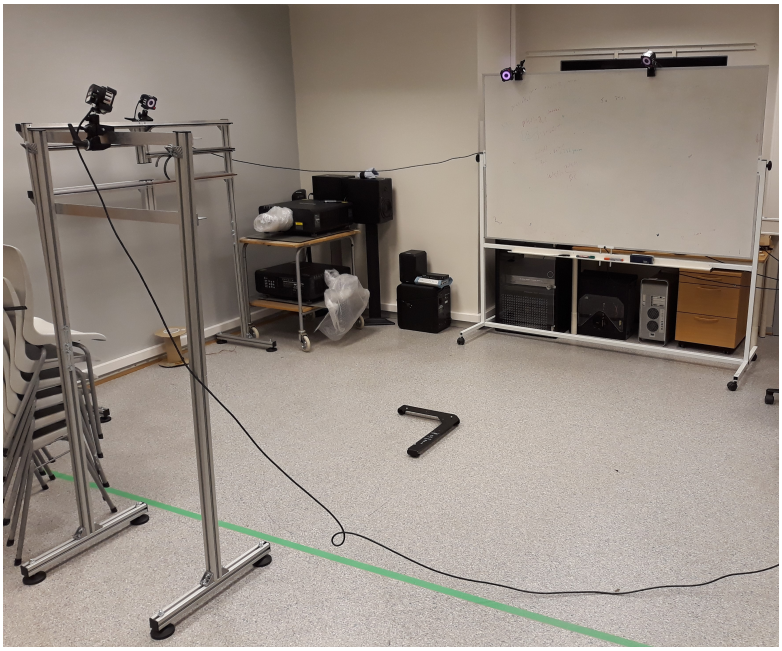

Figure 3.3: Picture of Prototype 1. The calibration square on the floor sets the coordinate system.

This area was marked by using a green masking tape. Cameras were positioned to cover the capture area. The goal of Prototype 1 was to implement simple but fundamental functionality which depends on detection of image targets as well as user position. This was achieved by dividing the area into two equally large parts. Figure 3.4 shows this division, as well as the coordinate system that was set with the OptiTrack system:

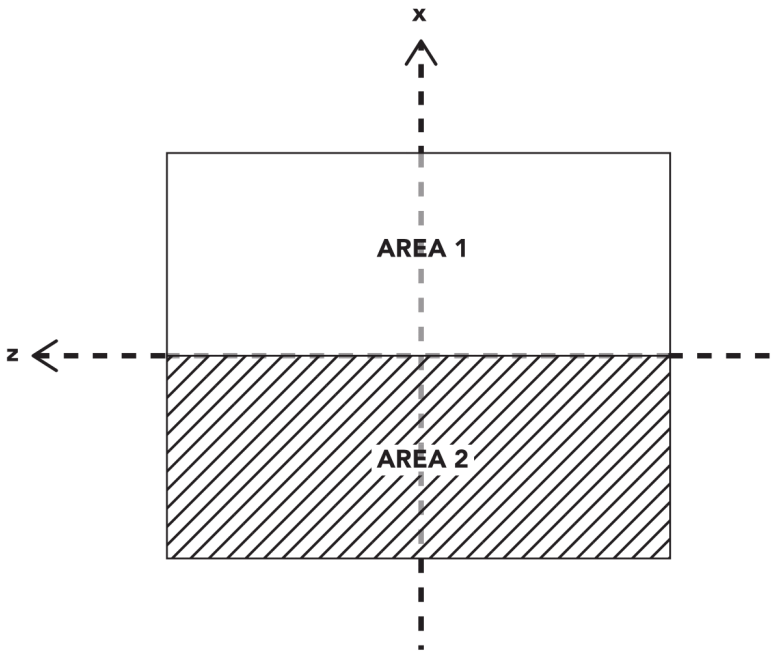

Figure 3.4: Division of floor area for Prototype 1.

User position in these two areas either actives or deactivates a virtual model. Area 1 is programmed to activate the virtual model, as shown in Figure 3.5:

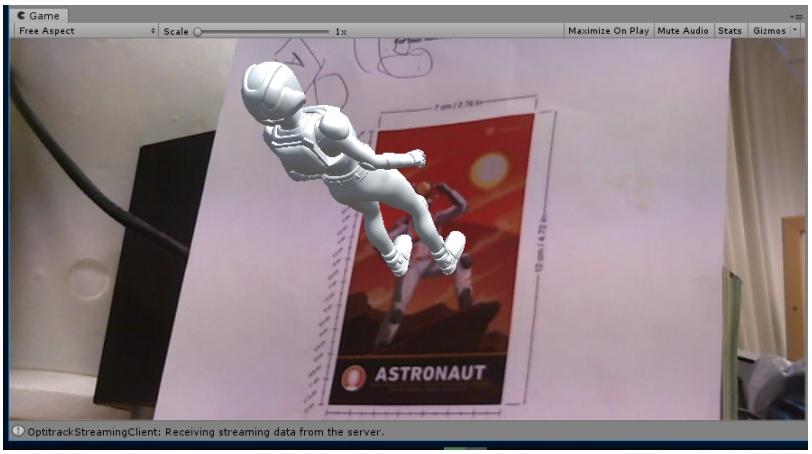

Figure 3.5: Screenshot from Prototype 1. Here the astronaut model is visible since the user is positioned in Area 1.

The model is associated with the picture it stands on. So, in addition to being in Area 1, the user must detect this image with the camera. The model disappears as soon as the user vacates Area 1 and moves into Area 2, as illustrated in Figure 3.6:

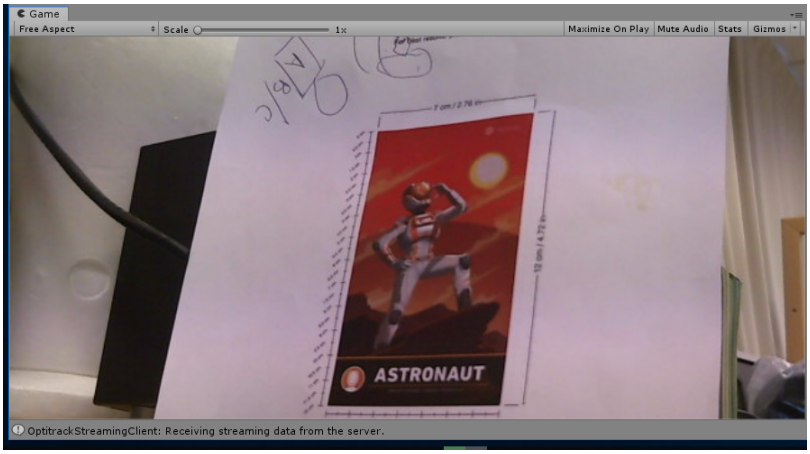

Figure 3.6: Screenshot from Prototype 1. Here the astronaut model is gone, since the user is in Area 2.

Another purpose of this prototype was to accomplish streaming from Motive to the Unity editor. This was first done while both Motive and Unity was running on the same stationary computer. Later, wireless streaming was achieved to a laptop over a local Wi-Fi network.

3.4 Prototype 2

The goal for Prototype 2 was to generate a trail within the area defined by the first prototype, as well as implementing the story. This was achieved through a further subdivision of the area. Where Prototype 1 divided the area into two, Prototype 2 divided it into five, as seen in Figure 3.7:

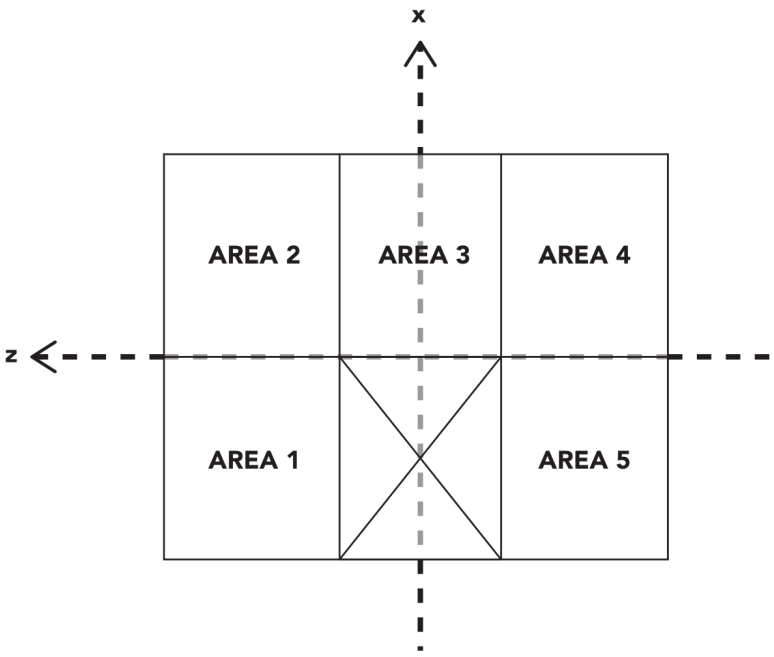

Figure 3.7: Division of floor area for Prototype 2.

It was also important to use the functionality of the OptiTrack system in a way that would fit

the story. For this, a different sound unique for each area was played.

Figure 3.8 shows the wooden plates that were attached to the racks, as well as the island that was placed in the middle:

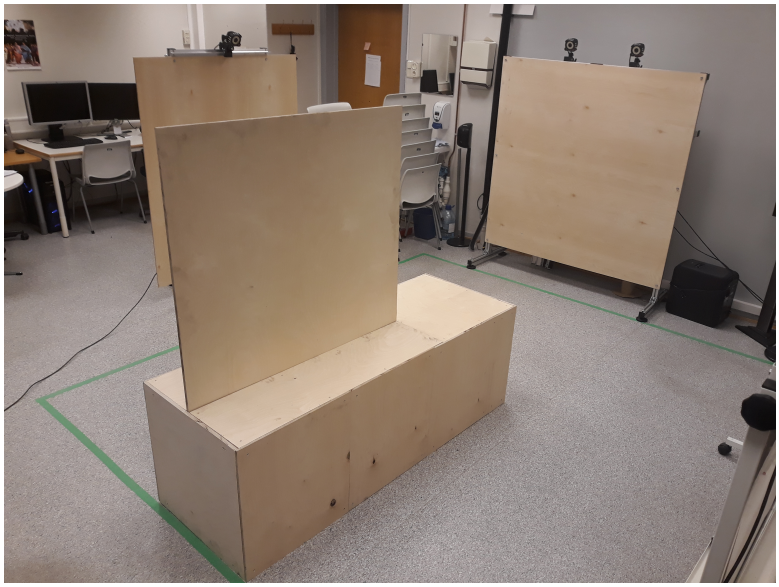

Figure 3.8: Picture from the development of Prototype 2.

By adding this island, a trail was generated. This trail would start in Area 1 and end in Area 5. The island and the plates also provided more surfaces that could be covered with pictures and sheets with texts. Pictures were necessary since the AR application triggered events by detecting pictures. Also, the pictures would contribute to the immersion of the participant. The end result is seen in Figure 3.9:

Figure 3.9: Prototype 2 after pictures and sheets were attached to the surfaces. The panorama picture on the wooden plate functions as a focal point in addition to playing a role in the story.

Drawings of the setup with measurements are found in appendix B.

An application was deployed to the Surface Go tablet. The laptop that ran the Unity editor which received the tracking data was connected to the audio receiver. This audio receiver was connected to two loudspeakers as shown in Figure 3.1. The two loudspeakers would play the sounds that depended on user position, while the tablet would play sounds caused by image detection. To detect the user position, a marker was attached to the tablet as seen in Figure 3.10:

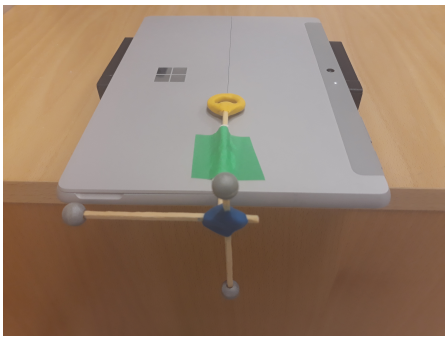

Figure 3.10: A marker was attached to the tablet for Prototype 2.

The participant would use the tablet for interactions. Detecting of images could lead to 3D models appearing, sounds being played, or texts being shown. Any combination of these at the same time would be possible. It was a goal to have variation regarding the interaction and to avoid predictability. This would keep the user involved and increase the immersion. Interaction would also happen when the user moved between the areas, which the OptiTrack system would detect. In addition, the story could be told through texts on physical sheets and by pictures.

3.4.1 Interaction 1: Fausk

Interaction 1 takes place in Area 1, seen in Figure 3.11:

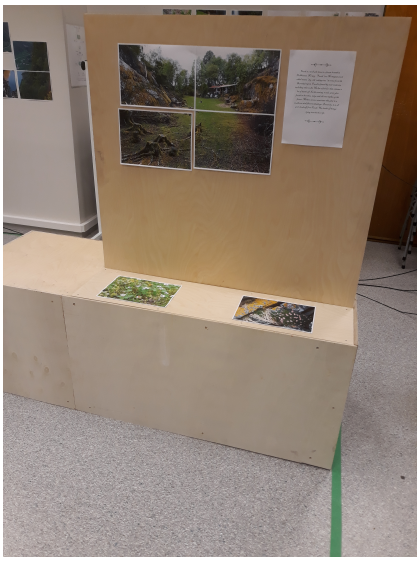

Figure 3.11: Area 1 in Prototype 2.

In this area, the user has not yet used the tablet to interact. Fausk is introduced through the text on the sheet. Detecting pictures with the application makes 3D models of branches appear. One of the images triggers the sound of a narrator as well. The narrator elaborates on the story

of Fausk and guides the participant to the next area. Forest sounds with bird chirps are played in this area. One of the branch models is seen in Figure 3.12:

Figure 3.12: One of the branches in Area 1.

3.4.2 Interaction 2: Boll and Bulu

Interaction 2 takes place in Area 2, shown in Figure 3.13:

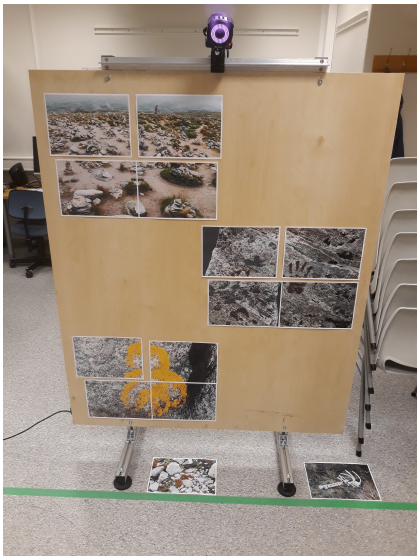

Figure 3.13: Area 2 in Prototype 2.

Here, the participant will have an idea about what to expect. Virtual sheets with texts appear when detecting images, as seen in Figure 3.14:

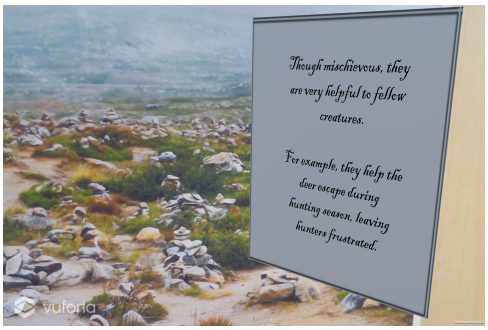

Figure 3.14: Virtual sheets with texts appear in Area 2.

A handprint and a footprint become visible when detecting two other images. Figure 3.15 shows the handprint:

Figure 3.15: The handprint that is found in Area 2.

Two troll models resembling Boll and Bulu appear when detecting the floor images. By placing images on the floor, the participant is forced to bend down. This is also a way to create engagement. The trolls present themselves, and Boll provides the link to the next area. The sounds of a thunderstorm are heard here. Figure 3.16 shows the model of Boll:

Figure 3.16: The troll model which resembles Boll.

3.4.3 Interaction 3: The Raven Stone

This interaction takes place in Area 3, seen in Figure 3.17:

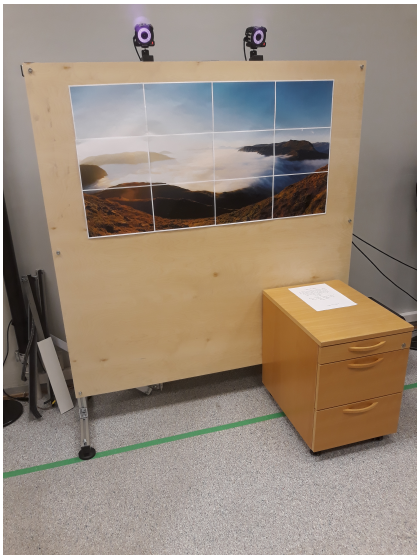

Figure 3.17: Area 3 in Prototype 2.

Instead of nature sounds, the user hears music played with piano and melodica. The participant will probably try to detect the images that make up the panorama picture, but that causes no events. The text on the sheet tells the user to search for a nest, which is partially hidden. The nest image triggers the narrator's voice as well as making the rave stone appear. The user then gets directions to the next area. The nest with the stone is seen in Figure 3.18:

Figure 3.18: The nest image is placed on the face of the wooden island.

3.4.4 Interaction 4: Fold

Interaction 4 takes place in Area 4, which is displayed in Figure 3.19:

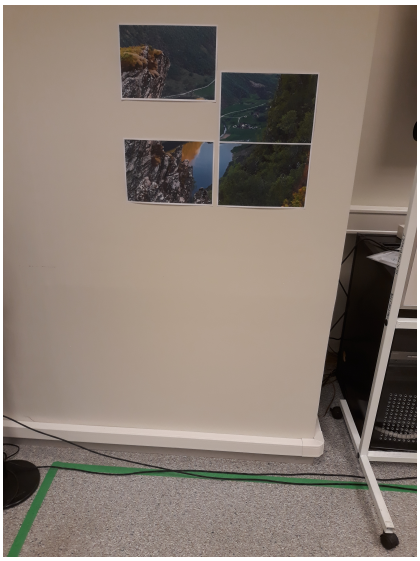

Figure 3.19: Area 4 in Prototype 2.

Nature sounds in the form of bird chirps return here. An image makes the narrator start talking, without any text or model appearing. This is the only image on the trail that only triggers sound. This might cause the participant to waken a bit. Another image makes the mountain goat appear as well, as Figure 3.20 shows. While the goat is visible, the participant also gets guided to the last area.

Figure 3.20: A picture of the mountain goat can be found in Area 4.

3.4.5 Interaction 5: Minill

The final interaction takes place in Area 5. It is shown in Figure 3.21:

Figure 3.21: Area 5 in Prototype 2.

The user is told of Minill through text on a sheet. None of the images triggers sounds. Instead, flowers, bushes and moss appear. This happens while river sounds are heard from the loudspeakers. Figure 3.22 shows some of the models that appear when detecting the images:

Figure 3.22: Plants appear in Area 4.

3.5 Formal experiments

There are no standards for evaluating the QoE in interactive digital stories. As a point of departure the ITU BT.500 standard can be used [42]. It is a standard used for subjective evaluation of television pictures. When measuring QoE, the Mean Opinion Score (MOS) is frequently used. The MOS is calculated as the arithmetic mean over single ratings from participants in a subjective quality evaluation.

Two different experiments were set up to test the hypothesis. One experiment which was narrative driven, on one that was instruction driven. In the narrative experiment, an overarching narrative ties the stories together and instructions are part of this narrative. In the instruction experiment, the narrative is replaced by instructions. More details on the experiment setups are given sections 3.5.3 and 3.5.4. 30 persons participated in the testing. They were split into three groups with 10 people in each group. From now on, these groups will be referred to as group 1, group 2, and group 3. The participants in group 1 did the narrative experiment, while the participants in the group 2 did the instruction experiment. In group 3 every participant did both experiments.

A 25-item questionnaire was made which the participant would answer after the experiment. This would ask the participant about his or her experience during the story. This survey was synthesized from the following standardized questionnaires: the Temple Presence Inventory (TPI) questionnaire [39], Core Elements of the Gaming Experience Questionnaire (CEGEQ) [40], and Game Experience Questionnaire [41]. The questions were adjusted to fit the experiment, and some new were added. Each question was answered with a 7-point Likert scale. Most questions were formulated so that the answers were from 1 (negative response) to 7 (positive response).

The results would be analyzed by comparing the MOS of each question between the two experiments. This was done with the t-distribution, which is based on normally distributed data along a continuous scale. Here, a discrete seven-step scale is used, so the assumptions for the t-distribution might not be fulfilled. But it was assumed that the t-distribution could still give valid results. Unpaired t-tests were used to compare the responses from group 1 and group 2, while paired t-tests were used for group 3. This was done while assuming normal distributions and equal variances. Computations were done in Excel.

To ensure a consistent testing scheme, a research protocol and a running plan was written.

A consent form, an introduction and a demographic questionnaire were also made, which the participants would fill out before the experiment. These documents, as well as the survey, are found in appendix A.

3.5.1 Demographics

Figure 3.23 shows the gender distribution of the participants, while the age composition is given by Figure 3.24:

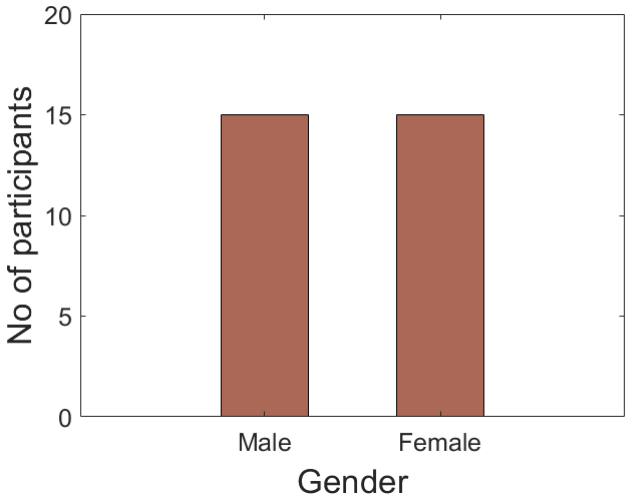

Figure 3.23: Gender distribution of participants.

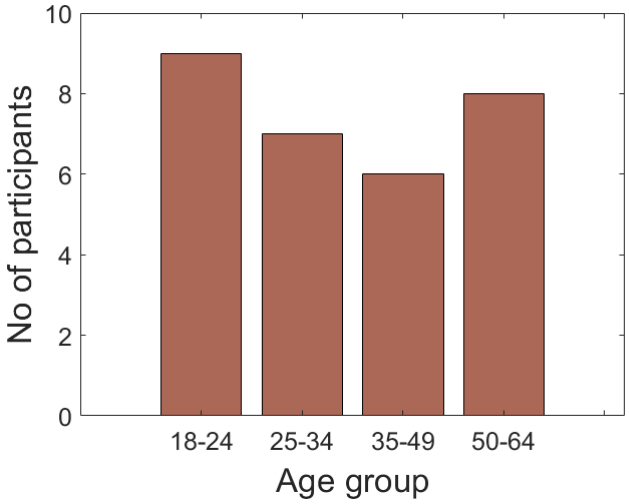

Figure 3.24: Age composition of participants.

3.5.2 Experiment procedure

The experiments were done over the course of 16 days, at daytime between 10:00 AM and 6:00 PM. The participants who did both experiments did them on separate days. Each session took about

30 minutes. The experiments were carried out in the following way: After a participant entered the room, he or she was greeted by a person who would conduct the experiment. The participant would then sit down and read an introduction. After this, the participant would fill out the consent form and the demographic questionnaire. The person who conducted the experiment would repeat the main points from the introduction and show how to hold the tablet, before the participant would start the story. While the participant went through the trail, the responsible person would watch over the Unity editor, and be available if the participant needed assistance.

After the participant finished the story, he or she was led back to the starting area. The participant would then fill out the survey. After this, a cinema voucher was handed over, which concluded the session.

A picture from one of the experiments is shown in Figure 3.25:

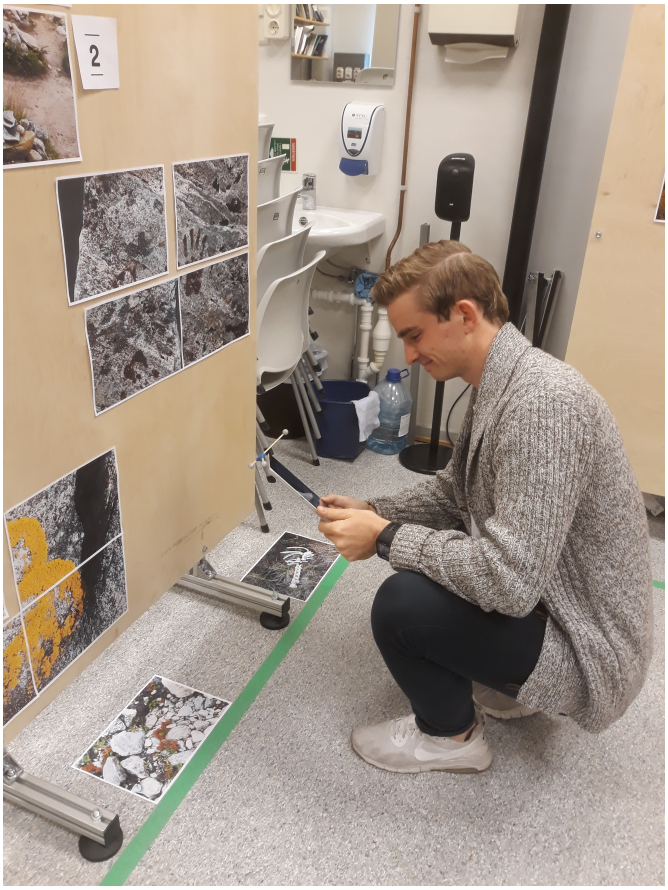

Figure 3.25: A picture from one of the experiments. It was a point to let the participants explore different heights.

3.5.3 Narrative experiment

This setup has an overarching narrative. Before starting the trail, the participant reads an introduction that tells of Trollheimen and the troll world. In each area, there are parts of the story that give directions to the next area. These directions are given in the spoken narrative. The texts are written with the Blackadder ITC font.

3.5.4 Instruction experiment

The overarching narrative is removed in this setup. In the introduction, the user reads that he or she will participate in an interactive multimedia experience, using an AR application. The participant also reads that there are five events with separate troll stories. Each area is labeled with a numbered sheet to tell the participant where to go. The individual stories remain. But the parts of the spoken narrative that refer to the other parts of the story are removed. The Calibri font is used for the texts in this setup. The labeling of the areas can be seen in Figure 3.26:

Figure 3.26: In the instruction setup, the areas are labeled with numbered sheets.

Chapter 4

Results and discussion

4.1 Results

This section presents the results from the post experiment surveys. This is done in the following way: First, five questions from the survey are presented. The results from group 1 and group 2 are then given as MOS bar charts. The bar charts give the arithmetic means for each question over the participants. They are plotted with error bars representing 95 percent confidence intervals. After this, observations regarding the results are given. The results for group 3 for the same questions are presented next, and then comments for these results. This is repeated for five questions at a time, until all questions in the survey are covered.

The first five questions in the survey were: **Q1.** *"Did the experience seem more like looking at the events/people on a movie screen or more like looking at the events/people through a window? (Like a movie screen - Like a window)";* **Q2.** *"To what extent did you feel mentally immersed in the experience or distant from it? (Distant - Immersed)";* **Q3.** *"To what extent did you feel a part of the experience? (Uninvolved - Involved)";* **Q4.** *"How exciting was the experience? (Boring - Exciting) ";* **Q5.** *"Was it emotionally engaging? (Unemotional - Emotional)".*

The results for group 1 and group 2 are shown in Figure 4.1:

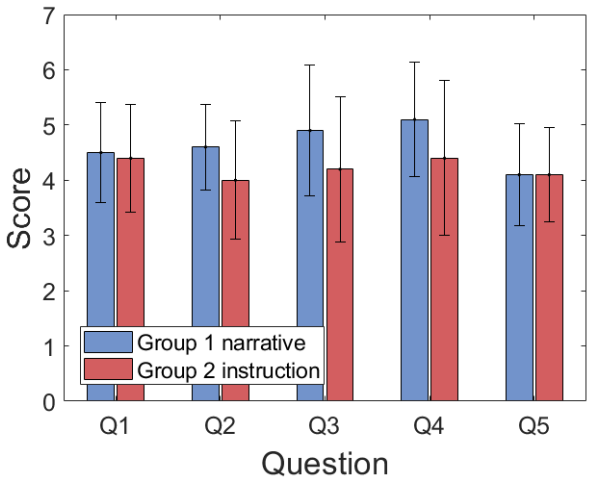

Figure 4.1: Average scores for questions 1 to 5 in groups 1 and 2.

Question 5 has the same average value for both setups. Except from that, the differences favor the narrative experiment. The difference is small for question 1. For questions 2, 3 and 4, the differences are more notable. The narrative setup was expected to give better responses for these

questions.

Figure 4.2 shows the results for group 3 for the same five questions:

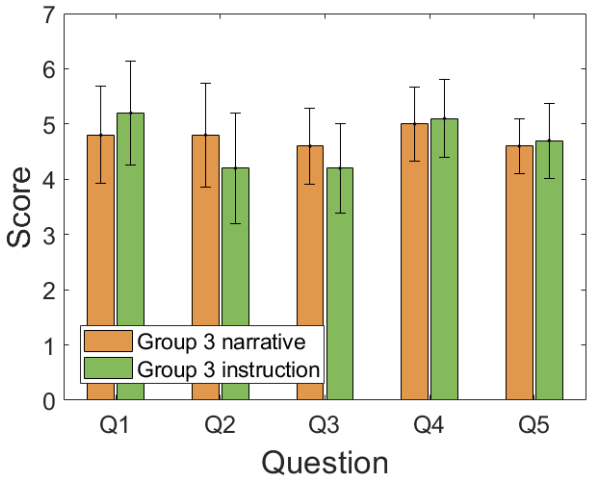

Figure 4.2: Average scores for questions 1 to 5 in group 3.

Questions 1, 4 and 5 have differences which benefit the instruction setup, while question 2 and 3 have differences in favor of the narrative setup. Question 1 may seem ambiguous regarding which end of the scale is more positive. The differences are small for questions 4 and 5, and more noteworthy for questions 2 and 3. For questions 2 and 3, the differences are like those of groups 1 and 2.

The next five questions were: **Q6.** *"Would you evaluate the experience as dead or lively? (Dead - Lively)";* **Q7.** *'How annoying or enjoyable was the experience? (Annoying - Enjoyable) ";* **Q8.** *"Did you find the experience surprising or predictable? (Predictable - Surprising)";* **Q9.** *"Did the directions you got along the trail seem obstructive or supportive? (Obstructive - Supportive)";* **Q10.** *"Did the experience feel complicated or easy? (Complicated - Easy [7 points])".*

Figure 4.3 shows the results for groups 1 and 2:

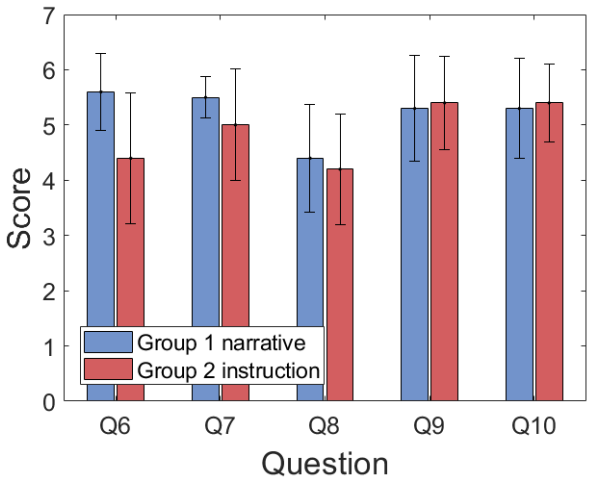

Figure 4.3: Average scores for questions 6 to 10 in groups 1 and 2.

For question 6, there is a notable difference which favors the narrative experiment. This difference corresponds to a significance level of 0.10. Questions 7 and 8 also have differences which

serve the narrative setup, while questions 9 and 10 have small differences in favor of the instruction setup. Given the nature of questions 9 and 10 it seems reasonable that they benefit the instruction setup.

The results for group 3 are presented in Figure 4.4:

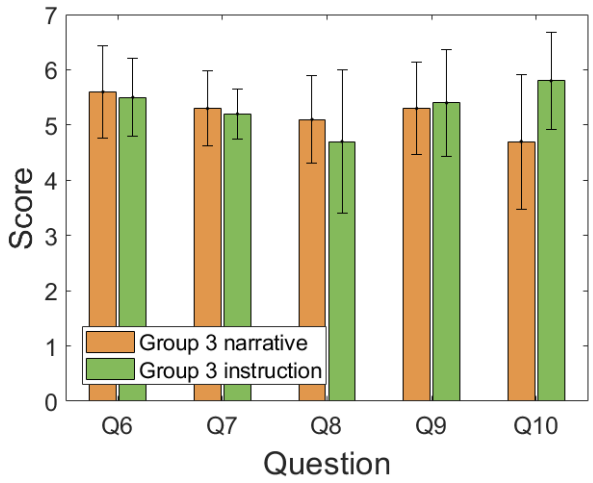

Figure 4.4: Average scores for questions 6 to 10 in group 3.

Question 6 favors the narrative setup with a small difference. Questions 7 and 8 have small differences which benefit the narrative setup, while question 9 have a slight difference in favor of the instruction setup. For question 10 there is a noteworthy difference. The difference corresponds to a significance level of 0.05.

Questions 11 to 15 were: **Q11.** *"Was the experience motivating or demotivating? (Demotivating - Motivating)"*; **Q12.** *"Did you find the experience clear or confusing? (Confusing - Clear)"*; **Q13.** *"Did the trail you followed seem organized or cluttered? (Cluttered - Organized)"*; **Q14.** *"Did you feel that you could explore things? (Could not explore - Could explore)"*; **Q15.** *"How was the experience in essence? (Poor - Rich)"*.

The results for group 1 and group 2 are shown in Figure 4.5:

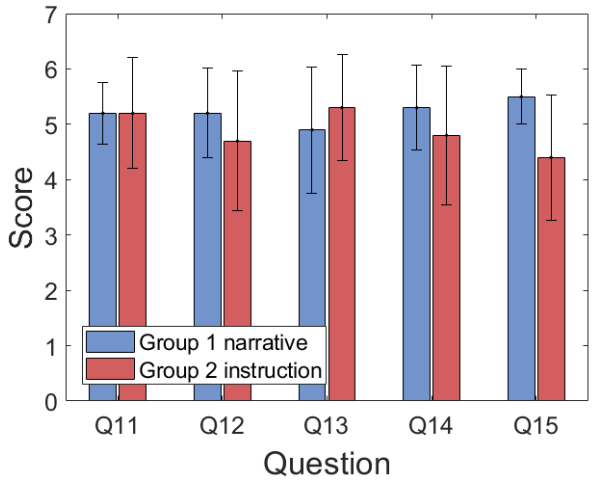

Figure 4.5: Average scores for questions 11 to 15 in groups 1 and 2.

Question 13 has a difference that serves the instruction setup. This seems fair since it asks

about how organized the trail was. Except for question 11, the rest of the questions have differences in favor of the narrative setup. The difference is noteworthy for question 15, where the significance level is 0.10. Question 15 can seem related to question 6, which also had a significant difference in favor of the narrative setup.

Figure 4.6 gives the results for group 3:

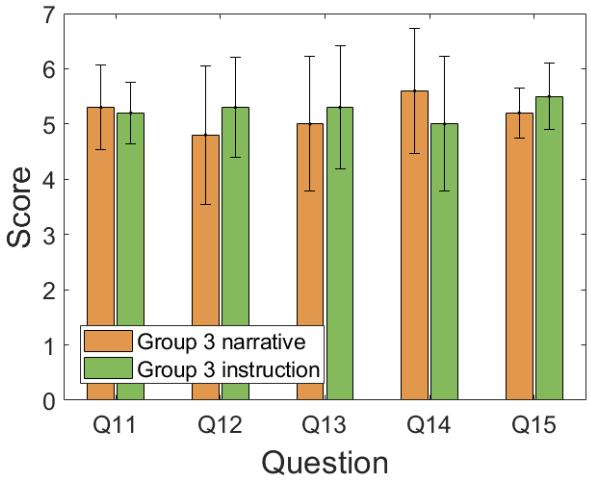

Figure 4.6: Average scores for questions 11 to 15 in group 3.

Questions 11 and 14 have differences that benefit the narrative setup, while the differences are in favor of the instruction setup for the remaining questions. Question 15 had a significant difference in favor of the narrative setup for groups 1 and 2, but here the difference is in favor of the instruction setup. But both setups get a higher score for this question than from group 2.

The next five questions were: **Q16.** *"How imaginative did you feel along the trail? (Unimaginative - Imaginative)"*; **Q17.** *"Did you feel free or pressured during the experience? (Pressured - Free)"*; **Q18.** *"Did you feel exhausted or relaxed after the experience? (Exhausted - Relaxed)"*; **Q19.** *"What was your sense of achievement? (Meaningless - Purposeful)"*; **Q20.** *"How did you feel during the experience? (Bad - Good)"*.

Figure 4.7 gives the results for group 1 and group 2:

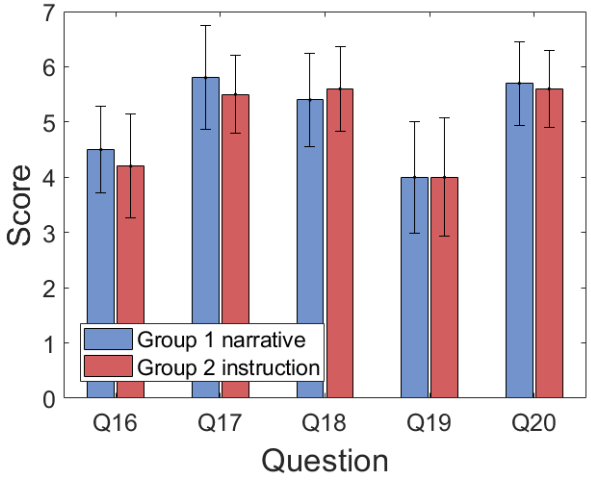

Figure 4.7: Average scores for questions 16 to 20 in groups 1 and 2.

Question 19 has no difference, while the remaining questions have small differences. Except for question 18, the differences are in favor of the narrative setup. One could expect that questions 16 and 17 would result in higher scores for the narrative setup. Regarding question 18, it was not expected that either setup would make the participant more exhausted or relaxed than the other.

Figure 4.8 gives the results for group 3:

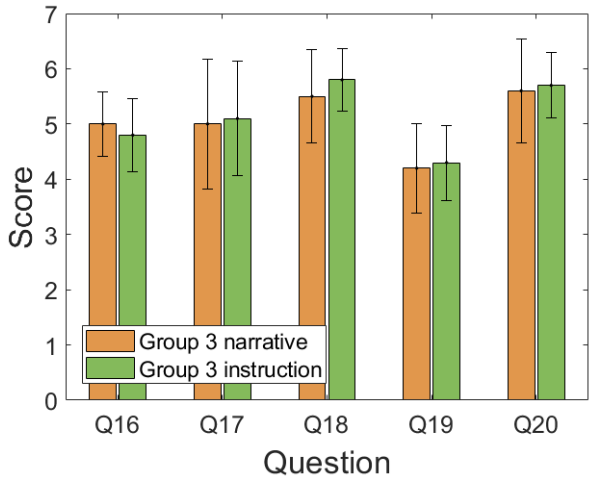

Figure 4.8: Average scores for questions 16 to 20 in group 3.

The differences are small here as well. For question 17, group 3 scores lower than both group 1 and group 2.

The last questions in the survey were: **Q21.** *"How easy was it to get back to reality after the experience? (Hard - Easy)"*; **Q22.** *"How gratifying was with the experience for you? (Irritating - Satisfying)"*; **Q23.** *"How effected were you by the experience? (Unengaged - Engaged)"*; **Q24.** *"How much did you feel like yourself in this experience? (Participant - Explorer)"*; **Q25.** *"What was memorable from the experience? (Sights and Sounds - Characters)"*.

The results for group 1 and group 2 are given in Figure 4.9

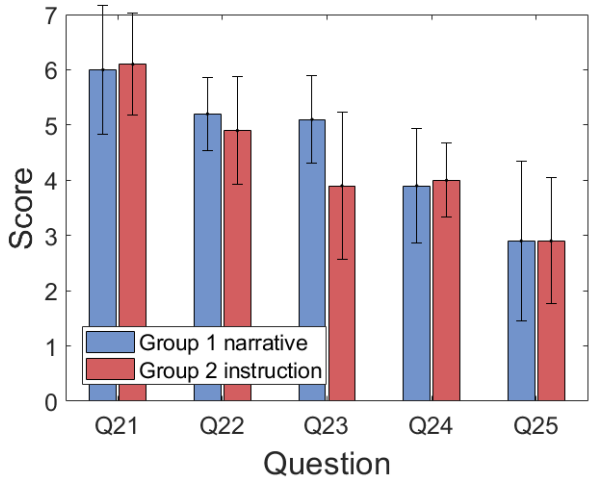

Figure 4.9: Average scores for questions 21 to 25 in groups 1 and 2.

There are small or no differences between the scores, except for question 23, which has a significant difference in favor of the narrative setup. The difference corresponds to a significance

level of 0.10. Question 25 shows that in both setups, sights and sound are more memorable than characters.

The results for group 3 are given in Figure 4.10

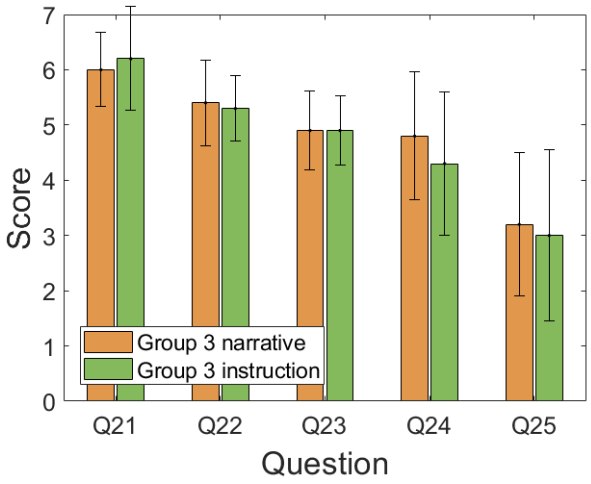

Figure 4.10: Average scores for questions 21 to 25 in group 3.

Here, there is no difference for question 23, but both setups get a higher score than from group 2. Question 25 shows that sights and sounds seemed to make a bigger impact than the characters of the story for group 3 as well, regardless of the setup.

4.2 Summary

It was expected that the narrative experiment would give a better experience. More specifically, it was expected that the narrative setup would score higher on questions like question 2, which asks about immersion. For groups 1 and 2, there were notable differences for questions 6, 15 and 23, which asks respectively about how rich, lively and engaging the experience was. All three questions gave a difference with a significance value equal to 0.10.

The difference was less significant for questions 2. The same goes for question 3, which asked about how involved the participant felt. This happened even if questions 2 and 3 seem related to questions 6, 15 and 23. It may be easier to understand a question about how rich an experience is, than a question that contains the term immersion. The concept of immersion may seem foreign to many people. Also, none of the participants were native English speakers. A question about involvement, like question 3, may be easier to understand, but maybe hard to answer. These aspects can explain why questions 2 and 3 did not get the same significant differences in the responses. Apart from that, these results were expected and are in accordance with the hypothesis.

Another expectation was that the differences would be greater for group 3, since the participants in this group could compare the experiments. Instead, the differences were in general smaller for group 3. It seemed like the participants in this group carried their impressions from the first experiment over to the second, and that their responses reflect the overall impression. Questions 6, 15 and 23 did not give significant differences for group 3, as they did for group 1 and group 2. But both setups got scores that were higher or equal than the score from group 2, which did only the instruction setup.

This suggests that the instruction setup in isolation had the potential to get more negative responses than the setups combined. Several participants in group 2 gave positive responses, but this was also the group were the lowest scores were found. The instruction experiment did not give the same level of rejection from the participants in group 3, who also were exposed to the narrative setup.

A surprising result was that the participants in group 3 found the instruction setup to be significantly easier. Question 10 resulted in a significance level of 0.05 for this question. This happened even if the participants did not do the setup in a fixed order. One participant who did the instruction setup first said that it was confusing the second time, when the numbered sheets were gone. Another participant, who did the narrative setup first, explained that it was easier the second time when he did the narrative setup.

The results indicate that the proposed hypothesis is true, that is that the narrative affects the QoE.

4.3 Further work

This experiment was about whether the narrative affects the QoE. Other experiments could investigate how the narrative affects different aspects of the experience. This has been a lab prototype. The goal is that this story will take place in nature along a trail. While the conditions in a lab are controllable, we must deal with changing weather and light outside. GPS coordinates may not always be accurate, and practical problems not directly related to science may arise. This means that there is work to be done regarding further implementation.

Taking the trail out in nature also opens for story possibilities. This concerns especially the location aspect, which may seem a bit superficial in the lab. In nature, the story can revolve around the troll who lives in the valley the tourists are walking in. This is an example that shows the possibilities of location based digital storytelling.

Chapter 5

Conclusion

We have performed a subjective evaluation on a location based digital story to investigate the influence the narrative will have on the QoE. The following hypothesis was formulated: The story affects the user's QoE in digital storytelling. This has been done by developing an AR application in Unity, and by using the OptiTrack system to detect the user's position.

The story is based on troll stories from the Trollheimen area in Norway. The experiment was done by 30 divided into three groups. The participants took part in two different experiment setups: one that was narrative based, and one that was instruction based. The setups were tested individually. Group 1 did the narrative setup, group 2 the instruction setup, while group 3 did both setups.

The results show the participants in group 1 had a richer, livelier and more engaging experience than the participants in group 2. In other words, the narrative setup gave a better performance. For other questions the narrative scores higher as well, but the differences were most notable for these questions. These results were as expected and according to the hypothesis.

For group 3, who did both setups, the differences between the setups were in general less clear. For the participants in this group, the responses seem to reflect their overall impression of both setups, rather than their evaluation of the individual setups. In general, these participants responded more favorably than the participants in group 2, meaning that being exposed to both setups seemed to outweigh the negative impressions that the instruction setup seemed capable of creating. But we showed that for the participants in group 3, the instruction setup was significantly easier than the narrative driven approach.

Based on the results, it is concluded that the proposed hypothesis is true, namely that the narrative affects the QoE.

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Appendix A

Documents

This chapter contains documents that are relevant to this project. They are presented in the following order: Research protocol, Running plan, Introduction, Consent form, Demographic questionnaire and Survey.

Research protocol

Master's thesis spring 2019

Øyvind Sørdal Klungre

1. Synopsis

New technologies give more storytelling opportunities. It is now possible to let the user's position play a key component in a digital story, which raises questions regarding how this affects the user's experience.

This study aims at testing a lab prototype for a location-based story in nature. This prototype uses location-tracking of the participants and uses this information to determine what output is delivered to the user. A group of people will participate in a formal test of the prototype and give feedback by doing a survey.

This study is a part of a project with three collaborators: NTNU, Nord University and the company iTrollheimen. iTrollheimen offers tours in the Trollheimen area for companies and other groups and would like to expand the experiences they offer by letting trolls be a part of them. A possible way to solve this could be to use AR technology in combination with location tracking technologies, such as GPS. The group from NTNU will design a prototype for this story, with the aim of doing research on the user's perceived experience. The prototype will be a simple AR application located in a room, where motion and position detection are achieved by using cameras. Nord University may provide digital content for the story. After the prototype is made, a group of participants will be gathered, with the goal of doing a formal test.

2. Introduction

Storytelling has been a part of human culture through all of history. As technology advances, new storytelling forms emerge. Multimodal output can now be delivered wirelessly to handheld, mobile devices, in practical speaking any location. In the past decades, major advances have been made regarding location-tracking technologies, with GPS being an important example. The combination of location-tracking and the new tools opens for new possibilities in storytelling, by making the participant's location a component in the story. With new possibilities, new questions also arise. What is the effect of the narrative in digital storytelling? How does it impact the user's experience? When dealing with these questions, concepts like Quality of Experience (QoE) and User Experience (UX) provide a framework to work within.

3. Hypothesis

The study will investigate the hypothesis

The story affects the user's QoE in digital storytelling

This means that when someone uses a system that tells a story, the story itself plays an important role for the perceived quality. If the story is location-based, the story plays an even bigger role. By removing the story components from the experience, the result is a diminished perceived quality.

4. Methodology and design

The lab Sense-IT at NTNU Gløshaugen will be used. In this room, the prototype will be set up and tested. The OptiTrack tracking system will be used to capture motions and positions of the participants. This data is processed in the software Motive, and then streamed to an AR application developed with the game development platform Unity. The user runs the application on a Windows Surface tablet.

In the prototype, the participant will follow a trail that is divided into five areas. In each area, a story is told about a troll, or about some aspect that is related to the troll world. This is done in a multimodal may. The output given to the user will depend on where the user points the device, as well as the user's position.

30 people will participate in individual testing. The participants' evaluations will be measured by subjective means, with a non-digital survey based on standardized questionnaires. The participants will do this survey after the experiment. The participants will be split into three groups with 10 people in each group. The experiment will test the hypotheses by having one setup which is driven by instructions, and one which is driven by narrative. The groups will participate in the following way:

Group 1

The participants will do a setup with an overarching narrative, that binds the stories together. If instructions are given, they will be formulated in a way so that they fit the narrative.

Group 2

For this group, the overarching narrative is removed. Instead, the participant is given instructions regarding where to walk and what to do, without these instructions being related to the individual stories.

Group 3

This group will do both setups, both the one with the narrative, and the one with the instructions.

5. Results

The results will be gathered by using an adjusted questionnaire. Since the emphasis is on the experience people are left with after following the trail, a post questionnaire is suitable.

The results will be analyzed by comparing the arithmetic means for each question over the participants. This can be done with t-distributions. If there are significant differences in the responses, then the hypothesis can be proved.

The results will be presented as bar charts.

6. Priority and Timetable

29.04: Start gathering participants

10.05: Finished with gathering participants

13.05: Start testing

28.05: Finished with testing

04.06: Analysis of results is ready

26.06: Deadline for delivering thesis

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Running plan

One person will be responsible for conducting the experiment. After a participant enters the room, the responsible person greets the test subject and tells him or her to sit down. If the participant is doing the narrative experiment, the Unity editor on the laptop should be running at this point, so that sounds are played over the loudspeakers. The participant is then handed the introduction. After he or she is finished reading this the consent form and demographic questionnaire are handed over, as well as a pen to sign them with.

After this is done, the responsible person will repeat the main points from the introduction sheet: that the participant will follow a trail with pictures, and that the participant will look at the pictures through the device's camera. The responsible person shows how to hold the device (the device should be held so that it is standing,) and explains that it is only possible to detect one picture at a time with the camera. Lastly, the participant is told that the responsible person will sit at the end of the trail during the experiment, and that the participant can ask for help if needed. The participant will then start the trail, which begins with reading a text on a sheet, which is placed next to the device.

The responsible person goes to the end of the trail and sits down. As explained earlier, the Unity editor is already running, and sounds are being played already at this point if the participant is doing the narrative experiment. If the participant does the instruction experiment, the responsible person must start the Play Mode in Unity editor when the participant enters the trail area. During the experiment, the responsible person overlooks the Motive software which tracks the test subject's position. Motive runs at the stationary computer at the end of the trail. The tester will also watch over the Unity Editor on the laptop which Motive is streaming to. The reason for this is to make sure that the tracking is performing correctly during the experiment. The responsible person will also be available if the participant has questions and may interrupt the participant if he or she seems lost and needs guidance. When the participant reaches the trail end, he or she will be met by the responsible person who tells him or her that this part of the experiment is over. If the instruction experiment was done, the Unity editor is stopped at this point. If the narrative experiment was done, Unity can keep running.

The participant is led back to the starting area. There, he or she will be handed the survey, which can be filled out while sitting by the same table as in the beginning. After this is done, the participant will be thanked for his or her participation. He or she will get the cinema voucher before being led out of the room. The responsible person must then make sure that both sheets of the survey are marked with the participant's name, and mark each sheet with an I letter if the instruction experiment was done, or an N letter if the narrative experiment was done.

Experimenter: Øyvind Sørdal Klungre, tel.no.: 90 76 64 08

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Evaluation of narrative's impact on QoE

Dear participant,

Thank you very much for your participation in this experiment. This study will last approx. 30 min and will be rewarded with a cinema voucher at the end.

During this experiment you will use a Surface Go tablet. On the tablet runs an application that uses the device's camera. You will walk along a trail while using the device's camera to look around. To the device is attached a tracker. This is used by the OptiTrack equipment to track your position during the experiment, so that it can be used to trigger events. The purpose of this experiment is an evaluation of the system's Quality of Experience (QoE). QoE is defined as follows:

Quality of Experience (QoE) is the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and / or enjoyment of the application or service in the light of the user's personality and current state.

The experiment is divided into three main parts:

1) After signing the consent form, you will fill in a demographic questionnaire that captures statistical data.
2) During the experiment, you will follow a trail that has a starting point and an end point. During the trail you will encounter several events. Some of these you can experience without the device, while others are only available by using the tablet.
3) After finishing the trail, you will evaluate your experience with a questionnaire.

Please note, **not you are getting tested**, but **you are testing the experience of the system**!

All the data that you provide and we are recording during this experiment will be pseudomized.

During the experiment you always have the chance to leave the study without the need to provide any reason. In case you have questions during the experiment at any point please feel free to ask the experimenter.

And now: Have fun during the experiment!

Experimenter: Øyvind Sørdal Klungre, tel.no.: 90 76 64 08

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Consent form

I have read the information for the study *Evaluation of narrative's impact on QoE*. I will participate in this study. I was informed that the following data will be obtained today during this study from me: Demographic questionnaire, Survey. I approve that all recorded data will be saved and will be used pseudomized (e.g. identification data will be stored separately from recorded data and only be accessible to a small circle of authorized personnel) for research analysis. All data I give will be handled confidentially. All information will be used for research purposes only. Personal data will not be given to any third party.

I am aware that participating in this study is voluntary and I can withdraw anytime without giving any reason. Doing so I will not suffer in any disadvantage.

Additionally, I am aware that I will handle everything confidentially, I hear and see today, and I will not give any information to other people.

Name: _____

Date: _____

Signature: _____

Experimenter: Øyvind Sørdal Klungre, tel.no.: 90 76 64 08

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Demographic questionnaire

Please fill out the following:

What is your gender?

☐ Male

☐ Female

How old are you?

☐ Under 18

☐ 18-24

☐ 25-34

☐ 35-49

☐ 50-64

☐ 65+

Experimenter: Øyvind Sørdal Klungre, tel.no.: 90 76 64 08

Survey

Name:

1. Did the experience seem more like looking at the events/people on a movie screen or more like looking at the events/people through a window?

(Like a movie screen - Like a window [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

2. To what extent did you feel mentally immersed in the experience or distant from it?

(Distant - Immersed [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

3. To what extent did you feel a part of the experience?

(Uninvolved – Involved [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

4. How exciting was the experience?

(Boring - Exciting [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

5. Was it emotionally engaging?

(Unemotional - Emotional [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

6. Would you evaluate the experience as dead or lively?

(Dead - Lively [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

7. How annoying or enjoyable was the experience?

(Annoying – Enjoyable [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

8. Did you find the experience surprising or predictable?

(Predictable – Surprising [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

9. Did the directions you got along the trail seem obstructive or supportive?

(Obstructive – Supportive [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

10. Did the experience feel complicated or easy?

(Complicated – Easy [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

11. Was the experience motivating or demotivating?

(Demotivating – Motivating [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

12. Did you find the experience clear or confusing?

(Confusing –Clear [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

13. Did the trail you followed seem organized or cluttered?

(Cluttered – Organized [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

14. Did you feel that you could explore things?

(Could not explore – Could explore [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

15. How was the experience in essence?

(Poor – Rich [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

16. How imaginative did you feel along the trail?

(Unimaginative – Imaginative [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

17. Did you feel free or pressured during the experience?

(Pressured – Free [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

18. Did you feel exhausted or relaxed after the experience?

(Exhausted – Relaxed [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

19. What was your sense of achievement?

(Meaningless – Purposeful [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

20. How did you feel during the experience?

(Bad – Good [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

21. How easy was it to get back to reality after the experience?

(Hard – Easy [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

22. How gratifying was with the experience for you?

(Irritating – Satisfying [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

23. How effected were you by the experience?
(Unengaged – Engaged [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

24. How much did you feel like yourself in this experience?

(Participant – Explorer [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

25. What was memorable from the experience?
(Sights & Sounds – Characters [7 points])

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

Do you have suggestions for improvements? Explain here:

Appendix B

Drawings

This chapter contains drawings of the final setup with measurements.

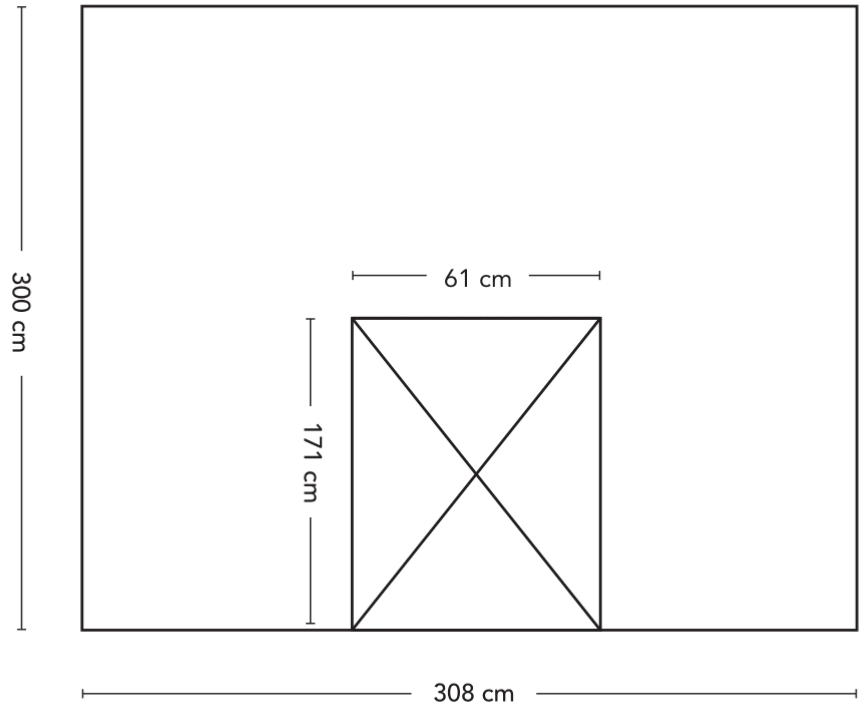


Figure B.1: Drawing of floor area.

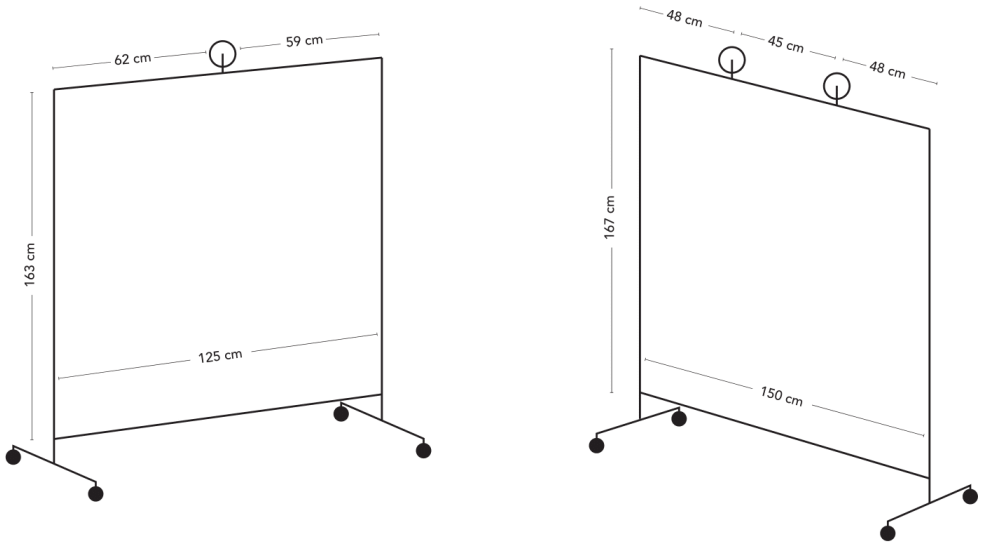


Figure B.2: Drawing of racks with wooden plates.

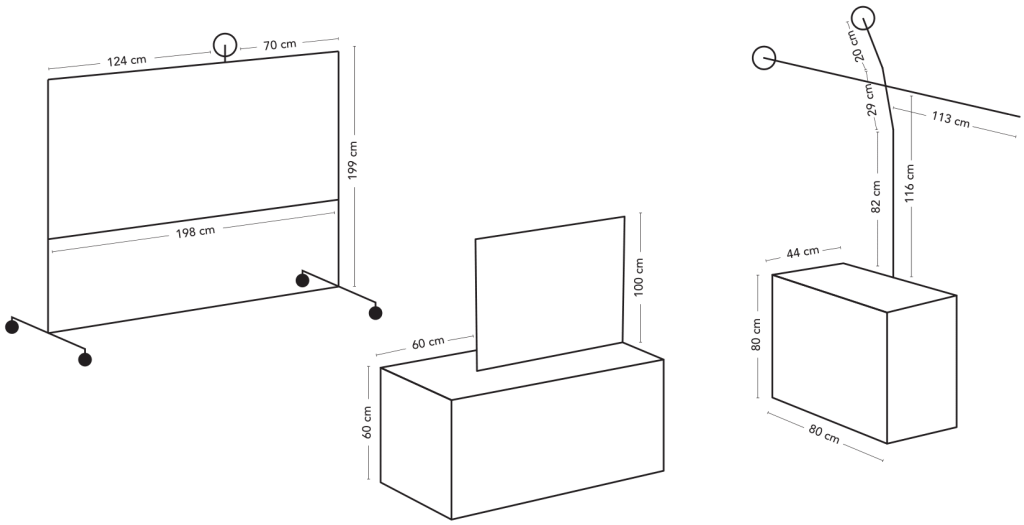
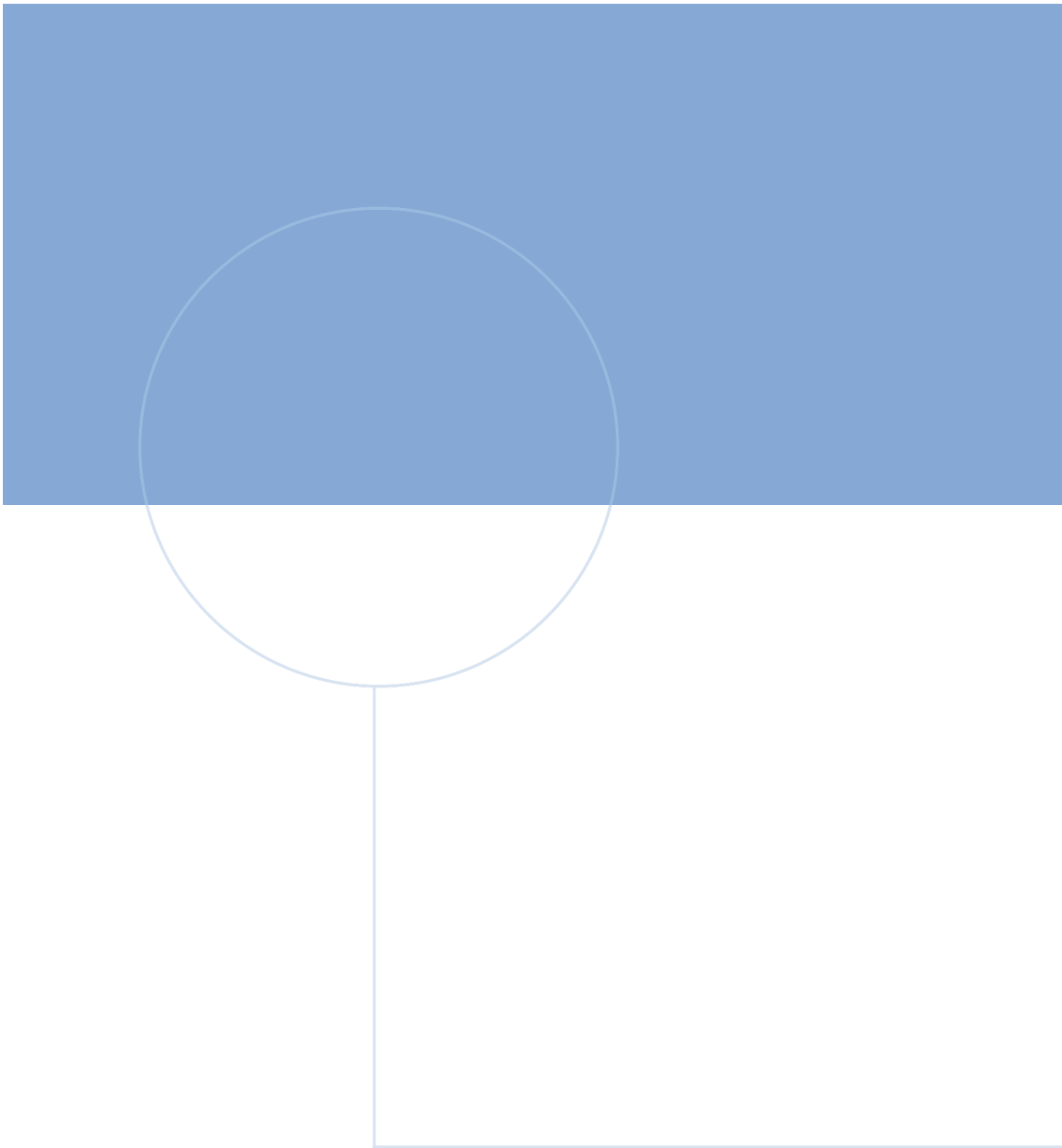


Figure B.3: Drawing of whiteboard, wooden island and rack.



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