Virtual reality and input devices: The habit of gaming

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Abstract

With the huge rise in popularity for Virtual Reality headsets, the market has become a bit of a wild-west situation where the technology is being explored for strengths, weaknesses and possible uses. Though, VR headsets have also opened up the possibility to explore and use alternate input and output devices to give a more realistic feeling.

The boom has also opened up the doors for the use of Virtual Reality within education. The purpose of this paper is to investigate whether there is a difference between people that play video games and people who don’t when using Virtual Reality.

This thesis was tested in a five minute experience using Unreal Engine 4. As hardware, the HTC Vive and Leap Motion were used.

Sammanfattning

Med den stora ökningen i popularitet för Virtual Reality headsets har marknaden blivit lite av en vilda västern situation där teknologin utforskas för att hitta styrkor, svagheter och användningsområden. VR headsets har också öppnat upp för möjligheten att utforska och använda alternativa gränssnitt för att ge en mer realistisk känsla.

Ökningen har också öppnat dör rar för att använda Virtual Reality inom utbildning. Målet med denna uppsats är att utreda om det finns en skillnad mellan folk som spelar datorspel och folk som inte gör det när Virtual Reality används.
Denna undersökning gjordes i en fem minuters lång upplevelse skapad med hjälp av Unreal Engine 4. Som hårdvara användes HTC Vive och Leap Motion.
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Chapter 1

Introduction

Virtual Reality has been around for a long time, though gone in waves. The previous wave occurred in the 1990’s and spawned Nintendo’s Virtual Boy[12]. The latest wave was created by the overwhelming success of the Oculus Rift Kickstarter[13] which made this topic popular once again.

Though the Oculus was first and foremost marketed towards playing games, there are many other uses for Virtual Reality than purely entertainment. A paper written in 2006 from the Emory University School of Medicine tells about their success with treating the fear of flying with the use of Virtual Reality, and even stated that it was as effective as exposure therapy[14].

This shows that Virtual Reality can create experiences so real that it can influence the user and make the user bring something out of the experience when they leave it. This also shows that Virtual Reality has many other uses besides entertainment and could in the future be a great source of education.

1.1 Background

Two companies in town (Data Ductus[4] and Autotech[5]) wanted to work together to create an interactive Virtual Reality experience that could be used as a demonstration at the games festival Nordsken[6].

Their ambition was to later use this experience as a prototype for a military training tool, where the user would learn how to handle a situation where they are stuck behind enemy lines and need to call for extraction by helicopter.
There were several students working on this project except myself. Autotech had three Computer Graphics students (Dan Karlsson, David Törnkvist and Johnny Wallinder) and Data Ductus had three Game Development students (Daniel Lundberg, Emil Bond and myself).

1.2 Goals and purpose

The goal with the project was to make a Virtual Reality experience that could serve as a prototype to show the military the possibilities with this kind of technology.

The idea was to integrate multiple input devices into the same simulation to create an experience where the user interaction felt natural and intuitive. The HTC Vive[1] and Leap Motion[2] were used as input devices. The HTC Vive was used to track the orientation and position of the user’s head, while the Leap Motion was used to track the user’s hands.

The point of using Virtual Reality is to make the user more aware of their surroundings and make the user’s choices more reflectable to the real world, so that the user could be more prepared if a similar situation would happen to them in real life.

This made input integration a key part of the project. The thesis was that if you could mirror the user’s movement and motions as close as possible, it should not matter whether you have the habit of playing video games or not.

The goal was therefore to answer the following questions:

1. Is there a difference between someone who plays video games and someone who doesn’t when using Virtual Reality?

2. Do users find it intuitive and natural to interact with the virtual world using their hands?

1.3 Limitations

The Leap Motion added some limitations. The device driver requires that the Leap Motion is mounted at the front of the Virtual Reality headset, which was achieved by using double sided tape. The issue with the Leap Motion comes from the fact that, while it has an impressive 150° field of view[7], it is far too narrow to give real, functioning hand tracking for VR.
For the Leap Motion, a recently released driver branch called Orion[3] was used, which was made with VR in mind. This driver lacked a few features present in the original driver, such as displaying the “Data confidence” of the tracking. The “Data confidence” feature would make it possible for the driver to present how reliable the input data is, something the Orion driver sadly doesn’t include.

Another issue with the Leap Motion was the difference in arm length of the users. The Leap hands that were used in-game were attached to a skeleton with the root being located in between the two hands (see Figure 1.1). Because the hands were connected to the character in such a way, it created a problem where users with long arms could sometimes reach outside the virtual hand’s reach. This was most noticeable when picking up objects from the ground, since the user’s hand would often hit the floor before the in-game hand reached the object.

![Figure 1.1: The hands skeletons and connecting bones](image)

Figure 1.1: The hands skeletons and connecting bones
1.4 Social, Ethical and Environmental Considerations

When using Virtual Reality for educational purposes, it could in the future lead to less social interaction during education since people might be within their own world. However, when looking at ethical and environmental considerations for this project, it’s positive.

Using Virtual Reality for military education would heavily reduce the chance of injuries or death from training accidents. It would also heavily reduce the cost of practicing certain scenarios, especially if you have to practice it several times. Lastly, it would also be positive for the environment when considering that this approach in regards to military training does have a substantially smaller carbon footprint than doing it in our reality.
Chapter 2

Design and Implementation

When the project started there already was a designed outline for the experience that was going to be created. It would be a short experience that would take the user around five minutes to play through. Unreal Engine 4[8] was used to create the experience because of its out-of-the-box Virtual Reality support.

2.1 The Experience

The experience would take place in a parking lot somewhere in northern Sweden, where the user was supposed to hide while waiting for a helicopter. When the helicopter arrived, the user would have to interact with the objects in the area to signal it and make it land.

There were three different objects that the user could interact with during the experience. The first one was a radio (see Figure 2.1 a). It was used to give the user instructions and hints of what’s happening and what they should do next. The second one was a flashlight (see Figure 2.1 b). It was used as a way to signal the helicopter, but also to add a common object to the scene that everyone could understand how to use. The third and last object was an emergency flare (see Figure 2.1 c) that could also be used to signal the helicopter.
There were three ways the game could end:

- Being detected by patrolling vehicles.
- Not signaling the helicopter.
- Signaling the helicopter to make it land.

The experience also had a short intro where the scenario was explained to the user. In this scene there was a button placed a short distance from
the user that had to be pressed to progress. This made sure that every user that tried the experience had to understand that they would have to move around the room and use their hands for interaction to progress.

2.2 Positional tracking

One of the big strengths of the HTC Vive is its ability to do full room positional tracking, which is something that was used for the created experience. While most Virtual Reality solutions use a single IR camera mounted in front of the player, the HTC Vive instead use two base stations\[9\] that are mounted close to the ceiling in opposing corners of the playable area. This made sure that the user could easily move around in the room and could crouch or even lie down on the floor without having issues with the headset loosing positional tracking.

Some built in SteamVR\[10\] features were used, such as the Chaperone. The Chaperone is a light blue wall that fades in when the user approaches the edge of the playable area. This safeguard exists to help users avoid walking into walls or other objects.

2.3 Leap Motion Hand Tracking

The Leap Motion was used to track the user’s hands. It was mounted at the front of the Head Mounted Display (HMD) to keep track in front of the user’s face.

With the help of the finger tracking, the user was able to pick up objects in the virtual world by doing grab motions with the hand. The Leap Motion tries to determine each hands “Grab Strength”, which it defines as how much the hand resembles a fist.

It was determined that different objects require different levels of Grab Strength to pick up if you compare it to the real world. For example, a pencil requires a much tighter fist shape than a bottle, even if you hold them in the same pose. Therefore, it was made possible to define per-object at what Grab Strength it should be picked up by a hand.

It was also made possible to define at what Grab Strength an object should be released from the hand. This, in combination with the minimum Grab Strength for pickup, made it possible to tweak quite a lot at a case by
case basis to make the objects feel natural when picked up.

2.4 Interaction with objects

To create interaction with our objects, sphere shaped triggers were created that could be placed on objects to make certain areas interactable. With this approach, it was possible for the user to interact with objects by just approaching the area they wanted to interact with.
Chapter 3

Methodology

The majority of the project was focused on polishing the interaction methods, since the entire experience was dependant on good interaction. Since the gameplay was just a few minutes, the game’s logic was quickly implemented and not something that required a lot of time. It was decided that the interaction should be as simple as possible. This decision was made to make the success-rate as high as possible, with success being defined as rescued by the helicopter.

The user tests were performed at the game festival Nordsken over the course of day two and three. The users got to try the experience once. Afterwards, the users were asked to fill out a document with questions (see Appendix A for the original document, Appendix B for the same document translated into English).

It should be noted that Nordsken had a whole section of the festival dedicated to Virtual Reality experiences, so many had tried VR before. Though, no other experience present at the festival used the Leap Motion as input device.

Every participant was asked if they had tried this VR experience before. This was to done to see who the user’s result should be compared against.

Since the purpose of this study was to see if there is a difference between people with the habit of playing games and people without it in regards to interaction, it heavily affected which people were asked to participate in the study. Nordsken is a game festival, so most people there tend to have the habit of playing games. With this in mind, one could make the assumption that whatever demographic you ask, the majority will have a gaming habit. Because of this, only people that were perceived as older than 13 were asked
to participate.

This decision was made because of generational gaps. In this day and age, most children play games on their computers, phones or consoles. Because of the assumption that most people at Nordsken will have the habit of playing games, one could also make the assumption that older people, like the children’s parents, are more likely to have a lesser or lack of habit of playing video games.

Every participant in the study got to see an instruction paper at the entrance to the room where the tools featured in the scenario were presented and explained. Everyone that participated also had the chance to watch someone else play the scenario before they tried it. This creates a big margin of error when checking how many people managed to reach the end of the experience.
Chapter 4

Results

4.1 The Experience

The virtual reality experience ended up having simple gameplay mechanics that would be easy to understand for both people who play regularly and those who don’t. The time for each playthrough was between three to five minutes.

![Screenshot](image1.png)  ![Screenshot](image2.png)

(a) The Intro  (b) The Scenario

Figure 4.1: Screenshots from the experience played at Nordsken.

The experience started out with a short intro (see Figure 4.1 a) where the scenario was explained. The user got to know where they were located,
that they are waiting for a helicopter to save them and that they need to
avoid being discovered by search vehicles. The user could progress to the
main experience by pressing a button with their hand.

The scenario was split up into three phases, the first phase being there for
information, the second phase where the user has to avoid the search vehicle
and the third phase where the player has to user the helicopter.

When the scenario started, so did the first phase. The user was located in
a parking lot surrounded by boxes and a concrete pillar, which were placed
there to logically limit the their movement. The concrete pillar is slightly
visible at the lower part of Figure 4.1 b. After a short time, the radio started
making sounds to try to make the user pick it up. Picking it up would make
the experience jump straight to phase two. If the user did not pick up the
radio, it would still progress to phase two after some time.

The second phase contained the search vehicle. The search vehicle would
pass the parking lot two times, first going right-to-left and then left-to-right.
During the second phase, the user was not allowed to use any of the flares or
use their flashlight to light at the vehicle, which would force an instant game
over.

The second phase begun with hearing the search vehicle coming. The
search vehicle made a distinct sound because they played quite loud music
in the vehicle. It started to light up the parking lot, forcing the user into
hiding behind the concrete pillar. If the user was discovered, the vehicle
would stop and exclaim that they saw something, but simply stating that it
was probably just a squirrel. They would then continue their patrol. After
the first vehicle pass-by, the vehicle would do a second patrol. This time, if
the user was discovered, it gave the user a game over.

The third phase begun with the user hearing the helicopter. The radio
would signal that the helicopter was approaching the pickup point. The user
then had to wait for the helicopter to come in and start hovering above the
pickup point, which was located around 10 meters in front of the user’s start
position. When the helicopter started to hover, the user could use the flare
to signal it or point the flashlight towards it. If the helicopter received the
signal, it would land and the user got rescued. If the user failed to signal the
helicopter, it would wait around for about a minute, then leave, triggering a
game over state.
4.2 The study

As previously stated, the study was performed over the course of two days at the game festival Nordsken.

The study had 79 participants with mixed age and habit of playing video games (see Figure 4.2). A bit more than a third of the participants had tried VR before (see Figure 4.3).

None of the people participating in this study had tried the experience before Nordsken.

![Figure 4.2: Hours playing video game per week]

As previously stated, there was a monitor that showed the participants gameplay so that the people waiting in line could see a simplified representation of what the user saw. The people watching would not get any sound though. This is important to know when looking at how well the participants did, since it could affect the result.

Before every play session the user was told about the Chaperone and it’s purpose, as well as what tracks their hands. The user was also asked to look at their hands at all times to create less tracking issues.
Figure 4.3: Tried Virtual Reality before

Figure 4.4: How the game ended for each group
Figure 4.4 represents the different defined groups of video gaming habit and how well they performed in the experience. A majority of the testers completed the experience by being rescued by the helicopter. About a quarter ended with the tester being detected by the search vehicle, and less than 5% of the testers managed to reach the point where they should signal the helicopter, but failed to do so.

Figure 4.5 shows how the different groups of video game habit responded to the question regarding how intuitive and natural they felt the interaction was. This shows that an absolute majority of the participants thought that it was intuitive and natural to interact with the world in the manner that the experience required.

Every participant was also asked how difficult they thought the interaction was. Their answers are depicted in Figure 4.6. In Table 4.1, all the answers are calculated as averages for each group to more easily see correlations between their answers in Figure 4.4 and Figure 4.5.
Figure 4.6: Each answer on how difficult the tester found the experience separated into groups based on playtime per week, where 10 is easiest.

<table>
<thead>
<tr>
<th>h/week</th>
<th>How difficult (Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7,455</td>
</tr>
<tr>
<td>1-5</td>
<td>6,409</td>
</tr>
<tr>
<td>6-10</td>
<td>7,444</td>
</tr>
<tr>
<td>11-15</td>
<td>6</td>
</tr>
<tr>
<td>16-20</td>
<td>5,833</td>
</tr>
<tr>
<td>&gt;20</td>
<td>6,6267</td>
</tr>
</tbody>
</table>

Table 4.1: Average in difficulty scale for each group
Chapter 5

Discussion and conclusions

5.1 The experience

This experience was developed in a very short timespan of only five weeks. This made it so that there wasn’t a lot of spare time for polishing features. This mostly included Leap Motion related features.

The Leap Motion is a pretty unique piece of technology, but it has a lot of flaws and can be pretty hard to use, especially without prior experience. Most of our testers would pick things up with one of their hands, and then lower that hand and look around, only to find that they had accidentally dropped the object they were holding.

The issues with the Leap Motion went so far that a feature, where you were supposed to turn on and off the flashlight by pressing a button with your thumb, was cut. This proved to not work as well as expected and added a lot of frustration to an object that often is the first to be picked up. So the feature was removed, creating the on-when-grabbed system present in the finished version.

Another issue with the Leap Motion is that sometimes it would lose track of the user’s hands. This created a lot of confusion and frustration, especially for people who have never used a Leap Motion before. It was discovered that you could easily regain tracking by moving a hand toward the Leap Motion and covering it, which made it find the user’s hands once it could see them again.
5.2 The result

The result was interesting in many regards. First off, by using Figure 4.2 it is possible to see the spread in video game habits between the people participating in the study. As expected, the group of people who don’t play video games would be a minority at such an event as Nordsken. Most people who tried this experience were young children, which was a group that wasn’t asked to participate in this study for generational reasons. Thankfully, many children had their parents with them who were included in the group of people who don’t play video games regularly.

Another interesting thing shown in this study was how many people have tried virtual reality before, as seen in Figure 4.3. Though, many of these people might have tried VR just a moment earlier, this still shows that there is an increase in availability for this technology that have made it possible for more people to try it out, which is always fun to see.

Though, the most interesting data shown in this study is when comparing Figure 4.4, Figure 4.5 and Figure 4.6, as well as Table 4.1. What can be seen in Figure 4.4 is how many people from each group got what ending. Here it is shown that every group had a majority who completed by being saved, except the group who don’t play video games, where the majority was either detected or failed to signal the helicopter. This shows that the habit of playing video games could have an impact on the performance of the player, even if the controls are very different from regular video games.

When looking at Figure 4.5, it is shown what the people from each group answered on the question about the controls being intuitive and natural. It shows that only people from the two highest groups thought that it didn’t feel natural to interact with the world in the manner that the experience required. Though, no assumption can be made on this since only three out of 79 answered that they didn’t find it intuitive, something that could just be random occurrences.

What is also interesting is when looking at Figure 4.6 and Table 4.1. It shows that in every group, most people gave the experience a score above average, with many landing at the number seven. In Table 4.1, which is a more easily readable presentation of the data from Figure 4.6, it tells that the group that don’t play video games was the group that thought it was most easy, though not by a large margin.

By looking at all of this together, it shows that the testers that don’t play video games at all thought that the controls seemed natural and intuitive
and gave the highest average score of how easy it was, but still performed the worst by a large margin. While every other group had a high success rate, the people that don’t play video games just didn’t keep up.

This could be for various reasons. One plausible reason is that the people that don’t play video games go into the experience thinking that it’s going to be hard because they are not very good at video games, and are then surprised by how easy it was. This would also mean that the people that play more go into the experience thinking that it’s going to be easy because they play video games regularly, while later realizing that it’s harder than they thought.

What could also be a reason is that the zero hours-per-week group might have harder picking up on visual cues that are prominent in video games, such as glowing outlines. Since a glowing outline to the caps of the flare was added, some people found it easier to find that you could screw them off while others had the same issue as without the highlight.

5.3 Improvements

Most of the improvements that could be made to this would be to solve the hand tracking issue. The Leap Motion is too unreliable to work as an input device in a simulation like this. It not only creates frustration but also increases the learning curve of how to use the learning tool, something that’s not good when working with educational software.

Right now there is no good way to replace the Leap Motion without using some sort of traditional controller, like the HTC Vive controllers. These controllers have the same sort of room wide tracking as the HTC Vive uses for the headset, which would fix one of the biggest issues that the Leap Motion has.

Thankfully, there is new technology coming. A company called Manus VR are developing a sort of Virtual Reality Glove[11]. It’s a glove that connects to the HTC Vive controller to give hand and finger tracking while also using the HTC Vive base stations to position the hands in the room. This would remove the need of looking at your hands while interacting with objects, which would increase the user-friendliness of the experience and make it a better educational tool.
5.4 Conclusion

In this study, a comparison between groups who play different amount of hours of video games have been made to try to determine whether Virtual Reality works as well for all groups regardless of their previous experiences with playing video games when using Leap Motion as input device.

While making the experience was the biggest part of the project, a two day study was made at the games festival Nordsken to see how well people performed and their own perception of how natural the controls felt.

The two questions this thesis wanted to answer was:

1. Is there a difference between someone who plays video games and someone who doesn’t when using Virtual Reality?

Virtual Reality does bring many advantages, such as increased realism and presence, while also increasing the availability of the experience to people who don’t play video games. Still though, participants without the habit of playing video games performed noticeably worse than every other group.

This could be for various reasons but could for example be due to not picking up on visual and audial cues used within video games to signal to the user what to do.

2. Do users find it intuitive and natural to interact with the virtual world using their hands?

This is the question that is most easily answered. Out of the 79 participants this study had, 76 of them answered that they found the controls natural and intuitive.

Even though the difficulty score they gave could be seen as them saying it was difficult, the absolute majority still stated that it was natural and intuitive. This could mean that most people thought it was fairly obvious what they should be able to do, but thought it was sometimes hard to do that.

A final conclusion could be Virtual Reality does open up for the people that don’t play video games, though they won’t perform as well as the people who play video games regularly. They will find controls natural and intuitive when their motions are correctly reflected within the experience, removing the learning curve.
References

Appendix A

Undersökning angående spelvana och interaktion

Hur gammal är du?

Hur många timmar per vecka spelar du Dator- och TV-spel?
0 1-5 6-10 11-15 16-20 Mer än 20

Har du provat VR (Virtual Reality) förut?
Ja Nej

Har du provat denna VR (Virtual Reality) upplevelse förut?
Ja Nej

Tycker du att interaktionen med världen kändes intuitiv och självklar?
Ja Nej

På en skala 1-10, hur enkelt upplevde du interaktionen (Hur enkelt var det att röra på sig, använda sina händer som kontroller)?
Svårt Enkelt
1 2 3 4 5 6 7 8 9 10

Hur tog spelet slut?
Upptäckt Signalerade ej Räddad av helikopter

Övriga anteckningar:
Appendix B

Study of videogame habits and interaction

How old are you?

How many hours a week do you play videogames?
0  1-5  6-10  11-15  16-20  Mer än 20

Have you tried VR (Virtual Reality) before?
Ja  Nej

Have you tried this VR (Virtual Reality) experience before?
Ja  Nej

Do you think the interaction with the world felt intuitive and natural?
Ja  Nej

On a scale of 1-10, how easy did you think the interaction was (How easy was it to move, use your hands as controllers)?

Hard  Easy
1  2  3  4  5  6  7  8  9  10

How did the game end?
Discovered  Did not signal  Saved by helicopter

Other notes: