Epic Team 2 - Project Report

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# Introduction

The field of virtual reality has garnered a massive amount of interest over the past few years, with a growing number of companies making plays in the space. Companies like Oculus pioneered the technology in the commercial market, and have quickly amassed massive valuations and highly notable acquisitions. However, no company has created the perfect implementation of a virtual reality system. Recent entrants into the space (such as the Vive headset created in collaboration between HTC and Valve) have tried to solve some of the challenges related to virtual reality, such as the concept of user-controlled motion and the visual-vestibular mismatch between the world of the game and the physical space the user occupies.

We are tasked with figuring out how to provide the best virtual reality experience for gamers, focusing on the variable of amount of control. To provide the “best” virtual reality experience, we must be able to fully immerse a user in our virtual world and convince them that this is the experience in which they exist. As such, we need to make sure there are no points of friction between their experience in our virtual reality and the physical space they currently occupy. Prior studies have proven that the control of motion within the experience does have a significant effect on the level of immersion, and we aim to further this research by providing our own evidence of this phenomenon.

# Experiment

## Goals and Design

The goal of this research is to determine if user controlled motion provides a quantifiably better experience to the user than having no control over the virtual environment. The independent variable in this study is the control over motion in virtual reality with two levels: user controlled and passively experienced motion.

If neural matches exist between what is being felt by the body and what is expected and if compelling and/or repeated mismatches are found, these cue conflicts cause illness in users, manifesting itself in one of three general forms: nausea and vomiting; oculomotor disturbances (eyestrain); and disorientation, ataxia (postural instability), and vertigo. Several factors have been identified as contributing to cybersickness, including gender, experience in virtual environments, and field independence.

In the user-controlled ”active” trials, the user will have some degree of the visual motion they are subjected to, i.e. control of their in-game character. In the passive trials, the user will not have control over all the motion they experience, which makes the experience more akin to a movie than a game. To accomplish this, we will study participants’ individual interactions with the game and evaluate his/her experience with a questionnaire.

### Questions

The questions we have asked our participants are as follows:

* Before interacting with VR:
  + How many times have you used VR before?
* After completion of each task (active and user-controlled motion):
  + Game Engagement Questionnaire (No, Sort Of, Yes): [7]

1. I lose track of time
2. Things seem to happen automatically
3. I feel different
4. I feel scared
5. The game feels real
6. If someone talks to me, I don’t hear them
7. I get wound up
8. Time seems to kind of stand still or stop
9. I feel spaced out
10. I don’t answer when someone talks to me
11. I can’t tell that I’m getting tired
12. Playing seems automatic
13. My thoughts go fast
14. I lose track of where I am
15. I play without thinking about how to play
16. Playing makes me feel calm
17. I play longer than I meant to
18. I really get into the game
19. I feel like I just can’t stop playing

## Hypotheses

We believe that when the user has control of any kind, they will feel more engaged in their virtual reality experience. The depth of control given to the user (e.g. one vs multiple degrees of motion) will directly correlate to the level of engagement. Research indicates that giving users a level of control over their movement within a virtual world also highly mitigates the risk of cybersickness, with additional benefit if the user is allowed to take breaks during the adjustment process (much like a pilot/copilot relationship in an airplane). We believe that these benefits will come together to make the virtual reality experience more enjoyable overall.

There are 3 ways to get adapted to VR:

1. Repeated exposure (Passive control)
2. Active control
3. Coupled control (Active-Passive condition)

Researches suggest that the active control condition reduce the severity of the symptoms experienced by the passive group, but not as completely as the active-passive condition. It is generally accepted that greater kinematics engender greater potential for sickness symptoms. Thus, to get a better idea about how active vs passive controls induce motion sickness in player under varying degree of control, we planned for two tasks: one allowing more physical control, and the other game allowing more “in-game” control.

## Methods

### Participants

We had 10 participants in the age group of 22-26, comprised of 4 males and 6 females. Each of these participants has a basic knowledge of VR and a limited exposure to it in the past.

We also conducted two pilots to get a better idea about how to finalize on the tasks in the experiment. It was conducted on the team itself, Dr. Ben Watson and two other participants.

### Apparatus and Stimuli

1. PC with GPU
2. Games available for Oculus DK2 (Luge and Asteroid Racer).
3. Tracked VR Helmet provided by Epic Games
4. Location for experiments: Visual Experience lab (EB2)
5. Google forms to log the measures

### Procedure

Participant arrives in the visual experience lab, gives us basic information (e.g. name and number of times they have experienced virtual reality), and then proceeds through the experiment. The entire experiment is divided into two tasks, which are further divided into active and passive versions in an effort to ensure accurate results across multiple levels of engagement. The participant will perform each task below in an order randomly selected by the proctor, to ensure the order of experience does not bias the experiment results. After each of the four tasks, participant is asked to rate their experience.

1. Game: Luge Version: Passive

Participant is passively sitting in a sledge moving down a mountain while the proctor steers the sled. Participant has no control of the movements whatsoever.

2. Game: Luge Version: Active

Participant is actively controlling the direction of the sledge that is travelling down the mountain.

3. Game: Asteroid Racer Version: Passive

Participant will dodge the asteroids coming their way, but will not have the control over their speed. This is passive, in the sense that the player can not slow down if the asteroids start coming too fast to dodge and ends up hitting them too often.

4. Game: Asteroid Racer Version: Active

Here, participant will have full control over their speed as well as the physical movements required to dodge the asteroids.

## Results

To develop meaningful results from such a small dataset, questions from the Game Engagement Questionnaire were placed into four categories. These categories - absorption, flow, presence, and immersion - are based on previous work in the subject and can be seen in Figure 1 below. [7] Absorption explains how much user get involved with the game while playing. More positive response in this section indicated higher level of involvement with the game. Presence indicates if user is more involved with the game then he loses track of surrounding things and his mind gets involved into the game totally. Immersion also means involvement of user with the game. Responses of “No” were given the value of negative one (-1), “Sort of” the value zero (0), and “Yes” the value one (1). These values were evaluated with respect to both the game the participant was playing and the style of user control.

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| --- | --- | --- | --- | --- | --- |
|  |  | **Absorption** | **Flow** | **Presence** | **Immersion** |
| **Asteroid Racer** | **Active** | **0.40** | **-0.70** | **0.70** | **0.80** |
|  | **Passive** | **0.27** | **-0.27** | **1.27** | **0.73** |
| **Luge** | **Active** | **-0.60** | **-2.30** | **-0.90** | **0.20** |
|  | **Passive** | **-1.30** | **-1.70** | **-0.20** | **0.10** |

## Discussion

Unfortunately, the results do not support the conclusion that active user control is more engaging than passive control in Virtual Reality gaming. Possible reasons for this lack of interaction include the fact that study participants are unfamiliar with the games that were selected as well as, on average, having little experience with Virtual Reality in general. This could explain why participants appear more engaged with less control. That is to say, as new users are becoming familiar with a game and Virtual Reality in general, having less control may be more engaging than the alternative.

### **Limitations**

This being a class assignment, very few participants are well aware of the study purpose. The participants are too few for reliability and possibly confounded by bias from awareness. Thus, these results can only be treated as preliminary.

Another limitation is dependency on games provided by Oculus Rift. One game had a better graphics and control than the other. Such factors are very subjective and it is difficult to determine how they may affect individual experience.

### Possible Alternatives

As this experiment was performed for class only, there was an artificial age restriction on the participants selected for our trial. Performing the experiment on groups of varying ages and prior exposure to VR could lead to more reliable results. Considering the length of the tasks, experiments could be conducted in separate batches with a predetermined break time between trials to allow participants to recover from one virtual reality experience before diving into the next one. This practice would also help ensure appropriate results.

# Conclusion

Our experiment was designed to discover the degree to which user control affects the overall experience of virtual reality, and our data partially confirms our hypothesis. The scores from our game engagement questionnaire showed that users are indeed more absorbed and immersed in the game when they have control, but have a greater sense of flow and presence when they do not have direct input into their motion. We did observe users experiencing slight nausea and general discombobulation when they were not in control of their own motion, though these effects did not materialize into any major problems since we allowed our participants to take the helmet off if they started feeling these symptoms.

Though our experiment has proved our hypothesis for some aspects of user engagement, we would like to go into greater depth in future versions of this experiment. For example, the games showcasing the different types of control were entirely different games with different user mechanics. We believe that testing different degrees/variations of control within the same game will provide more reliable results, and will show us in greater detail exactly how much control is optimal - possibly reinforcing studies that show hybrid control (pilot-copilot) is preferable for most users.

It still has yet to be seen if users can be completely immersed in an alternate reality for an extended period of time, and whether or not the experience as a whole will be improved if users can take breaks during their gameplay. Due to the time constraints within the course, we were unable to fully test this aspect of user control, though we are happy to have accomplished our current findings with the help of our fellow UX scholars.

# References

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