USER PERCEPTION OF DISTANCE

INTRODUCTION TO MAJOR THEMES : XR

esiea

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1 - INTRODUCTION

This project is part of an introduction course to virtual reality taught by Mr. Rob ASPIN during my 3rd year of studies at ESIEA Paris.
The goal of the experiment is to setup a virtual environment to determine how a user can estimate distances. In other words, the experiment will help determine if a user can better estimate distances in a visually richer environment.

Virtual reality is often used to represent the actual world, or a copy of it. We could take as an example the applications created to preserve natural or historical landmarks such as the Grottes de Lascaux. This kind of application need to be as accurate as possible but most importantly, it must feel as accurate as possible.

We will setup a small experiment that will consist in creating a raw virtual environment on Unity.A user will be invited to test the environment by walking through a corridor and interact with a bunch of items. At the end of the experiment, he will be asked about how he felt about the environment and how long he thinks he travelled. In a second time he will be asked to travel the same environment but with added elements to give a visually more comfortable feeling. Then he will be asked the same questions. His answers should help us answer the question “Can a user better estimate distances in a visually richer scene?”. To get accurate results we will obviously repeat the experiment on at least 2 persons.

2 - STATE OF THE ART

This experiment has obviously been performed many times before, and so for the reasons given in the introduction but also many more. Architecture needs to give precise measures; medical applications need to be precise to help patients and so on…

An article, written by Fatima El Jamiry and Ronald Marsh, from the North Dakota University, explains that a similar experiment was made by Waller and Richardson and had interesting results. In this experiment, subjects had to interact with an immersive virtual environment, and then assess distances in the physical world. The result was surprising: most of the subjects overestimated distances in the real world, because interacting with the VE had effects on their perceptual system. The main reason conveyed by this article is that behind the underestimation of distances is the fact of seeing the world through Virtual Reality HMD.

Another article, by Ilja Feldstein from the Harvard Medical School, Felix Kölsch from the Technical University of Munich, and Robert Konrad from the Stanford University, talks about a new study that compares verbal distance estimates within real and virtual environments. In opposition to a lot of experiment, this one did not show a significant difference between distance estimates in the real environment and in the virtual one. However, the paper highlights the possibility that the order in which participants were exposed to the real and virtual environments may have affected the outcome of the experiment.

3 - DESIGN

Our purpose was to meet the following design heuristics. Our environments should be sensory, cognitive, and physically and digitally safe.
Regarding the path, it should be simple but sufficiently complex, so the end point is not visible from the starting position, any kind of path with at least one turn would be enough.
Given people tend to underestimate distances in VR, all in the design should help the user evaluate distances as accurately as possible. Ground, scale, and perspective are also important if we want the user to evaluate distances.
As in our physical reality, the ground to horizon plays a huge role in the balance of our inner ear and orientation. No ground could make the user feel dizzy and it would be impossible for him to evaluate the distance so its presence in our environment is crucial.
It is besides easier to estimate a distance when one has a scale and a perspective. To help the user, we can use lifelike items such as lamps with .

Although virtual reality has proven its usefulness to a great extent and while being highly appreciated, the side effects and risks it entails should not be overlooked. As a matter of fact, because it is so realistic, virtual reality has both physical (nausea, headaches…) and psychological (“post-VR sadness”, game transfer phenomena…) effects on human beings.it is important to build places that look close to the real world and that could be explored by anyone. For instance, the places should be wide enough not to disturb claustrophobic people.

4 - IMPLEMENTATION

The environment designed is a large corridor with four turns designed so that the user cannot see its end. The corridor is closed by a flat roof but lots of lights were added, and the walls and corners are rounded to create as much volume as possible. Pretty much like in the subway you can see the beginning of the next straight line before you take the turn, this is to reduce as much as possible the risks of panic attacks for claustrophobic users. The user will have to interact with 3 clickable items before reaching the end.

For the raw environment, the light is white and emitted at regular intervals. No textures are used and no familiar objects either. The presence of a regular pattern on the walls and floors, however, helps the user with the notion of distance.

The decorated environment integrates more colorful lights and gives a new point of comparison to the user with ceiling lamps placed at regular intervals. A few side lamps give a more warm light and rugs where added to the floor. On the side of the first corridor, the user will find a small coffee table with a few plants and candles on its top. The more he travels the more objects he will encounter. A sofa with colorful pillows and paintings on the walls. Those help to remove the pattern effect. Nesting tables with a bigger plant can also be seen in a few corners along the path and ventilation with the sound of the blades was also added near the end.

5 - EVALUATION

The evaluation of the experiment was performed on two subjects that have a different approach of VR. One was totally new to virtual environments while the other was familiar with them. I asked them four questions:

IN WHICH ENVIRONMENT DO YOU FEEL THAT YOU TRAVELED THE MOST?

1: I felt like the first one, all grey was very repetitive, it seemed very long. In the second I think I traveled a lot as well but less than in the first one.
2: Obviously the raw environment felt the longest but I'm pretty sure they where the same length after having tested them both again.

IN WHICH ENVIRONMENT DID YOU FEEL MORE COMFORTABLE?

1:The lack of colors on the first one and the repetitive shapes where unwelcoming. The second one had more pleasant stuff to offer, like the sofa.
2:The second one, with the plants and the sofa. I think the different lighting also helped.

RAW ENVIRONMENT, HOW LONG DO YOU THINK YOU TRAVELED?

1. I would say I traveled at least 30 meters.
2. Very difficult, I used the patterns to keeps track of my steps but I'm not sure. Maybe around 35-40m ?

DECORATED ENVIRONMENT, HOW LONG DO YOU THINK YOU TRAVELED?

1. It was less than the first, around 25 meters at most
2. As I said above, I feel like both environment where the same length, however the decorated environment offered more visually attractive elements that helped to forget the distance, like when you count the houses when taking the train. So I'd say around 35-40 meters but it felt at most 35 meters.

6 - DISCUSSION

As we can see, both subjects felt they traveled the most in the raw environment. This is a satisfying result as it means that the way we wanted to evaluate the hypothesis was the right one.

I Maybe we could have done this experiment on a few more subjects, It would have helped getting more precise results.

The answers also pointed out the fact that feelings play a role in this experiment. The raw environment looks like something unreal because we wanted to prove that there is a direct link between the feelings and the distance. Not being comfortable in an environment, makes people feel that the time goes slower, and, thus, that they move a longer time in this environment, which implies a longer distance.

An article from Albert Lee and Li-Jun Ji (Queen's University), says that indeed, feelings have an influence on relative time.
The fact that the path is short helps : if the question wasn't asked, maybe the two persons would have found that both environments had the same distance. This leads to another conclusion and another question : can the result be biased by the way the questions are asked ?

7 - CONCLUSION

Based on the experiments and its results, to the hypothesis “users of virtual environments can better estimate distance in a more visually enriched scene”, the answer is a big yes. The observations can however provide a few more hypothesis :
-“Feelings have an influence on relative time”
-“Results of a survey can be biased, depending on the way questions are being asked.”

These two hypotheses could make the objects of another work, which would improve the accuracy of the results of this experiment.

Even though I’m quite satisfied with the work done in a few amount of time, I feel that I could have done more things for this experiment. First, as mentioned in the Discussion section, I could have changed my methodology just once and see if the results were the same. I would also have appreciated to have more participants to my experiment, in order to have a bigger sample, on which I could apply normal statistics (Hypothesis testing). Also, I should have tried more things in my assets, such as adding more textures, lights, and sounds, better controls for people with disabilities.

This experiment was made for PC users. But we could extend it to VR HMDs, or even Smartphones.

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