Unity Experiment Assignment

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Introduction (Professor Rob Aspin)

Determining the distance travelled in virtual environments and 3D games can be extremely challenging for most users. The combination of a reduced field of view, determined by the display system, and the rate of travel, which is often exaggerated to make the environment feel more exciting, remove the normal references we use in the everyday way we travel through the real world. While this is often exciting for entertainment purposes and, within the context of the environment, is plausible, through a suspension of belief, it means that virtual environments can sometime be difficult to navigate in. The aim of this research is to identify simple approaches that aid the user in gauging the distance they have travelled in the virtual work.

As virtual environments are becoming more common in everyday use there are situations where the users' ability to relate distance travelled in the virtual world to their experiences of navigation in the real world are becoming more important. This is particularly true of environments which offer replication of real-world ideas and entities, such as for engineering design review, training environments or environments created for the treatment of phobias. Our hypothesis is that adding additional decoration to a scene aids the user by providing points of reference for better determining the distance travelled.

Our research applies an experimental approach to testing out hypothesis. In this we create two variants of the same virtual environment in which the user follows the same simple path through the scene. In the first variant the scene is constructed of basic geometry, sufficient to define the path, without decoration. In the second variant the first environment is modified to include additional decoration in the form of additional geometric models, materials and textures to enrich the scene. Users are asked to follow the same path in both scenes. A guided discussion, based on 3 objective questions is used to determine the impact of the decoration over the undecorated scene. Our objectives for completing this research are:

- Identify the current research context in which this problem fits
- Design, implement and test the two variants of the virtual environment
- Evaluate the effectiveness of the decorated virtual environment in aiding distance estimation through user trial and discussion
- Discuss the relevance of our findings in relation to the aim of the research and report our conclusions.

State of the Art

Technology is moving very fast. As mentioned in the video of Thong Ngyuen's talk, virtual reality or VR can be used in a variety of fields. Some people are not aware of this fact and only associate the use of this technology with gaming and entertainment. However, VR can be used in numerous fields such as to decrease stress in Alzheimer's disease[1] or to design cars[2].

"Distance estimation of visually simulated self-motion is difficult, because one has to know or make assumptions about scene layout to judge ego speed."[3]. Research has been conducted on estimating travel distance from leaky path integration in virtual and real environments by Lappe and Frenz. "When humans use vision to gauge the travel distance of an extended forward movement, they often underestimate the movement's extent. This underestimation can be explained by leaky path integration, an integration of the movement to obtain distance."[4] Misperception of egocentric distances in virtual environments has also been discussed. "Most studies show that observers immersed in virtual environments (VE) perceive virtual space as compressed relative to the real world, resulting in systematic underestimations of egocentric distance." In this experiment, VR simulation of driving was tested.[5] In the present experiment, the user's perception of distance is analysed by presenting them with two paths which are identical but differ in whether they have decorations or not.

Design

The three-dimensional scenes were created using the Unity software, 2019.4.32f1 version using a template that was provided during the lesson. For both scenes, an identical corridor was used. The corridor had a simple L-shape and when the user reached the ending point which was marked by a red circle, the starting point could not be seen. For the second environment, the same corridor was utilised. However, the second corridor had decorations added to test the hypothesis which was mentioned in the introduction section. The corridors were therefore differentiated by having decorations or lacking them.

The first corridor did not contain any extra objects other than the circle marking the end of the path and it simply consisted of walls and a white plane to walk on. The second corridor had a wallpaper texture added to the walls and colour added to the floors. Some items were also added from the Unity asset store, including apartment doors (with doormats), a chair, some shelves with small plants and two paintings on the walls. A script was added which enabled the user to move using the keyboard keys and to look around the scene using the mouse.

The user was asked to view the different environments, "travelling" through each one. After they had looked at the scene some questions were asked to evaluate how they perceived distance. The questions were not leading questions. For example, the questions were not suggesting that adding decorations affects the perception of distance in any way. The general answers of the user during the guided discussion were then used to test the hypothesis.

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[1] Kim, Oksoo, Yanghee Pang, and Jung-Hee Kim. "The effectiveness of virtual reality for people with mild cognitive impairment or dementia: a meta-analysis." *BMC psychiatry* 19.1 (2019): 1-10.)

[2] Ford & Gravity Sketch 3D Virtual Reality Car Design (https://www.youtube.com/watch?v=ZiVGH_ARyzQ)

[3] Frenz, Harald, et al. "Estimation of travel distance from visual motion in virtual environments." ACM Transactions on Applied Perception (TAP) 4.1 (2007): 3-es.

[4] Lappe, Markus, et al. "Keeping track of the distance from home by leaky integration along veering paths." Experimental brain research 212.1 (2011): 81-89.

[5] Rousset, Thomas, et al. "Misperception of egocentric distances in virtual environments: More a question of training than a technological issue?" Displays 52 (2018): 8-20.

Implementation

Initially the scenes were created differently including moving objects such as cones and spheres. After that, the scene was changed to include furniture pieces and doors. This was a major deviation from the design, but it might be useful to test this kind of design to see how the user judges distance if objects such as a shelf or a chair are used. Another two scenes should be created with objects added but in one scene, the objects have no texture and in the other one, the objects such as cones and spheres have a texture. The user could then be asked to explain their thoughts on distance evaluation in each of these virtual environments.

Evaluation

The research questions that were asked, a short description of them and the answers provided by the user have been listed below.

- **Did you feel any differences in your perception of the distance travelled through the environments?**
- This question is non-leading and is confirming if the user felt a difference in their perception of the distance travelled through the environments.
- The answer to this question was positive. The user felt a clear difference in their perception of the distance travelled.

- **What features, in either environment, best enabled you to gauge how far you had moved?**
- In this question, the user is expected to refer to some of the objects in scene two.
- The user felt that the portraits helped them to know that they were near the end of the scene as there were no more portraits close to the red circle.

- **Do you remember two of the objects that you saw and did these objects change your perception of movement through the corridor?**
- The two items that the user states are the most important thing that they remembered and noticed in the scene. The user will then confirm whether they felt that these objects influenced their perception of movement through the corridor.
- The user remembered that there were doors, but they remembered two doors while there were in fact three doors. They also remembered that there were shelves present in the scene. They felt that there was a difference in their perception of movement while they were travelling through scene number two.

Discussion

The hypothesis was that "adding additional decoration to a scene aids the user by providing points of reference for better determining the distance travelled". The answers provided to the research questions demonstrate this as the user noticed that their perception of the distance travelled was different in the scene that contained the decorations. The user also remembered some of the objects in the scene and felt that the portraits helped them to determine that they were near the end of the corridor. Therefore, the evaluation supported the hypothesis.

The project went well. The corridor that was created was quite short and it did not take a long time to travel through it, so the user travelled quite fast. If the experiment was to be repeated, the length of
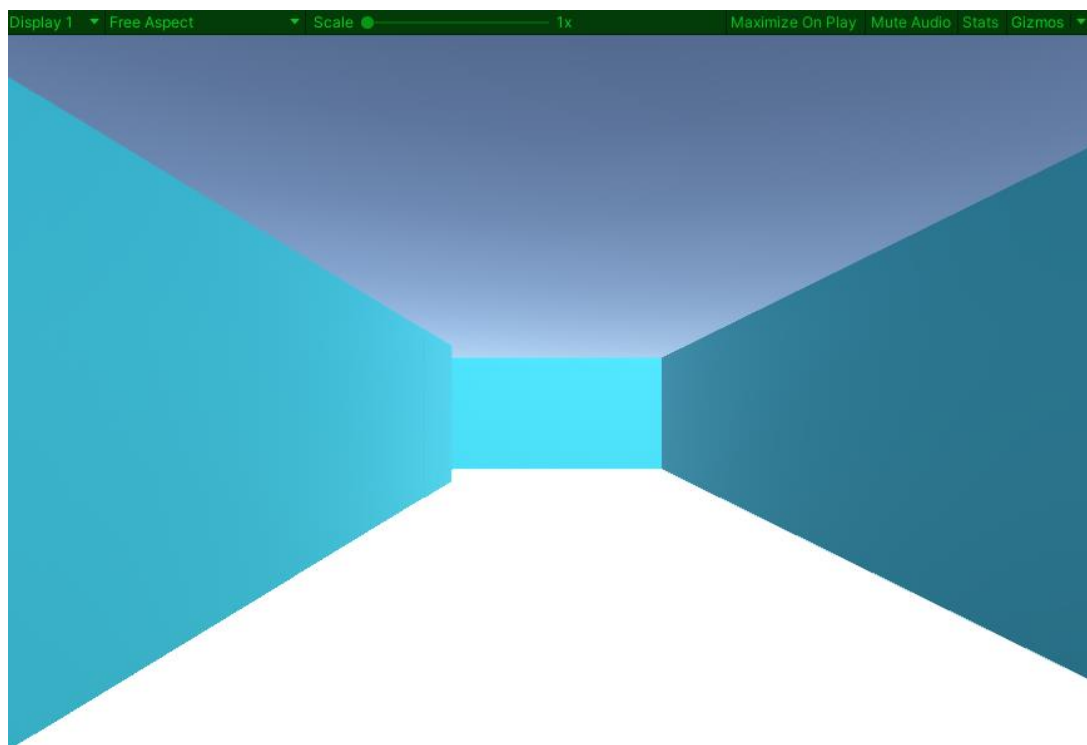
the corridor could be increased, and the shape could be adjusted so it is more complex. If the user has more time to travel through the scene, their answers to the questions may be more accurate compared to when they are travelling through a shorter scene. There were a few problems with the shadows in the scene. For example, the paintings and walls were creating a shadow on the floor. These problems should be fixed next time, so the scene is more accurate and realistic. In addition, there were only two scenes and different scenes should be created which contain varying objects and all of the scenes could be compared. There was only one person viewing the scene and answering questions but if we have more people who answer the results will be more accurate.

Conclusion

In conclusion, all of the objectives have generally been met as the research context was generally discussed, the variants of the virtual environment were designed, implemented and tested. The user was then asked to evaluate the two scenes and provide answers to the questions. According to this experiment, the hypothesis was proven. Further work can be carried out such as creating more complex scenes with longer paths. The sample size can also be increased, and other scenes can be created with varying objects to test the hypothesis.

Appendix

Screenshots

Links

The link to the file on Google drive:

https://drive.google.com/file/d/1O6YzU1-zqJTHP7YdFKLTNFJFjf8MCKKu/view?usp=sharing

A short video of the two scenes on YouTube:

https://www.youtube.com/watch?v=Hwo0rfc2DRM