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Size Constancy in Virtual Reality

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Abstract

This project studies human perception of size within a controlled virtual reality environment. When we open our eyes and glance at the surrounding, we see stable scenes that appear absolute. However, many argue that this is a pure illusion as nothing in our visual pathway is stable. Thus, our perceived size of an object may not reflect accurately the extent of the projection onto our retina. We do experience such false perception when we see celestial objects near the horizon. But are such misjudgments ubiquitous in our daily lives?

With this in mind, the virtual reality scene has been created with a manipulated environment to provide a false sense of depth perception to the viewer. We want to test if this setting can cause the viewer to see familiar objects inaccurately in both size and distance. More specifically, we want to test if objects in one scene can look both closer and larger than the same objects in the other scene. If we can create such false perception, then we can conclude that misjudgment of angular size is ubiquitous. To bring this set up to life, the gaming software Unity is used to develop the scene, an HTC-Vive is used as the virtual reality goggles, and a computer running Windows 10 and equipped with an Intel Xeon CPU, 64GB RAM, and a GeForce GPU is used as the host. Subjects to participate in this experiment will be 18 or older and will be recruited around Susquehanna University. They will be asked to judge both size and distance of the objects in the virtual scene.

Objectives

Soccer Balls vs Pyramids: The Pyramids' less familiar appearance will allow the viewer to recognize them as different sizes instead of distances. The familiarity of the soccer balls will cause viewer to perceive them as different distances.

Two Cubes vs Five Cubes: For the two cubes more people will be able to perceive differences since there are only two objects. For the five cubes, the viewer will be comparing more, and more likely to miss differences.

Pedestrian Signs: The signs are the exact same distance and size. Side 2 is manipulated to hopefully make the viewer perceive it as closer and bigger.

Roger Shepard's Tables: The rectangular tables are the exact same size, except one table is rotated 90 degrees. In 2D, viewers perceive them as different sizes, in 3D will they as well?

Experimental

First, Unity, Google Sketch Up, and Adobe Photoshop were downloaded to create the scene. From Unity's assets store, the VRTK package and Steam VR package were imported to be able to move around within the scene with the HTC Vive. The scene contains 6 different layouts for participants to compare, each specifically designed with hopes that people will be misguided to believe they see a layout that is not really there. For both the soccer balls and the pyramids, they are floating 4 meters in the air and 5 meters away from the viewer, with the one soccer ball/pyramid as twice the size of the other (Figure 3). The next set of objects are groups of cubes, 2 light blue and 5 red (Figure 4). Both are laid out similarly, with one cube higher and farther back to account for the viewers visual angle (Figure 5). For the Pedestrian signs layout, the signs are the exact same size and distance from the viewer. However, the objects on Side 2 are manipulated with hopes that the viewer will perceive the sign as larger and closer. The wall is four times as large, the trees are not only more spaced out than Side 1, but also getting farther apart in a trapezoid shape as they get closer to the wall, the grass is also less dense, and tilted to be parallel with the trees (Figure 6). The final scene is the Roger Shepard's tables. There are two tables that are the exact same dimensions, but one is rotated 90 degrees.



HTC Vive Goggles, Controllers and Room Set Up.



Computer running Windows 10 and equipped with an Intel Xeon CPU, 64GB RAM, and a GeForce GPU is used as the host



Figure 3



Figure 4

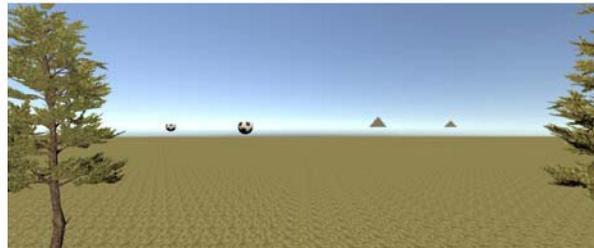


Figure 5

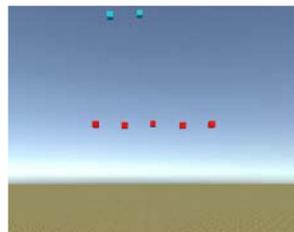


Figure 6



Figure 7



Figure 8

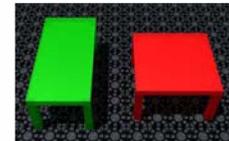
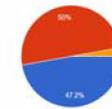


Figure 9

Results

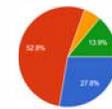
Gender

(30 responses)



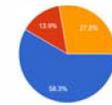
Age Group

(30 responses)



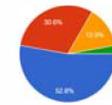
Soccer Balls

(30 responses)



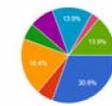
Pyramid

(30 responses)



Two Light Blue Cubes

(30 responses)



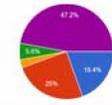
Five Cubes

(30 responses)



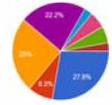
Pedestrian Sign

(30 responses)



Tables

(30 responses)



Conclusion

Based on this experiment, it is a lot harder to create a manipulated scene to get the results desired. For both the soccer ball and the pyramids, most of the participants bought into the illusion. However, more participants were able to recognize the correct answer for the familiar object the soccer ball than the less familiar object the pyramids. The two cubes experiment was rather successful in achieving the desired results of having the Right Cube to be perceived as smaller. Unfortunately, the results for the Five Cubes did not have a solid trend to make a solid conclusion. For the future, questioning will be more specific to focus the results more. This will allow for a stronger comparison with the two cubes in the future to see if the objective was met. While most were fooled by the scene with the Pedestrian Sign, there was interesting trend where about half the male participants were able to see past the deception and realize it was the same size and distance. For the tables, many were familiar with this illusion which skewed the data. However, a majority perceived the tables to be different sizes similarly to the 2D drawing of Roger Shepard's Tables.

References

- https://www.google.com/search?q=roger+shepard+tables&rlz=1C1GGRV_enU5751U5751&source=lnms&tbm=isch&sa=X&ved=0ahUKEw7g5ye05rVhXfD4KHdEUBCOQ_AUICgC&biw=1396&bih=690#imgcr=RTzESLlRqJ-3M
- https://www.google.com/search?q=htc+vive&rlz=1C1GGRV_enU5751U5751&source=lnms&tbm=isch&sa=X&ved=0ahUKEwll7X0J1VAHVv4KHeKRB0Q_AUIdSg&biw=1396&bih=690#imgcr=RTzESLlRqJ-3M
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Acknowledgments

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