Perception of Optical Flow and Geometric Field of View

Charles Adetiloye, Qiong Wu and Ronald R. Mourant
Virtual Environments Laboratory, MIE Department
Northeastern University
mourant@coe.neu.edu

1 Introduction

Gibson [1979] demonstrated a pattern of optical flow as an observer moves through an environment. The rate of this optical flow increases with offset from straight ahead and decreases with distance in front of the observer. The point of no optical flow has been called the "focus of expansion" and specifies the direction of travel. A recent study [Tan et al. 2003] found gender-specific navigation benefits come from the presence of optical flow cues. They found that the present of optical flow cues provided a performance advantage when navigating 3D environments. We will investigate optical flow on a standard monitor which is often used as a display for driving simulators. The Geometric Field of View (GFOV) of the 3D driving environment is specified in software. The GFOV is often larger than the observer's display FOV. This results in image minification.

2 Method

Twenty subjects whose average age was 23.6 years and had 20/40 (or better) corrected or uncorrected visual acuity, were used as subjects. Four values of GFOV (25, 45, 65, and 85 degrees) for the same visual scene were studied. Subjects were tested on 32 paired comparisons delivered in two trials of 16 randomly ordered pairs. The 16 pairs consisted of the 12 permutations of the four values of GFOV taken two at a time, and 4 pairs when the first and second value of a pair was the same.

The method of paired comparisons was used. For each pair of GFOVs, the scene was presented using the first value of the pair, followed by the second value. Then the subject was asked if the speed of the cars in the second presentation was slower, faster, or the same as the speed of the cars in the first presentation. In all presentations the velocity of the autonomous vehicles was the same, 30 mph. Figure 1 is a screen shot of the 3D virtual environment.

Figure 1: The 3D Virtual Environment

3 Results

When subjects reported on the comparison of equal GFOVs, they were fairly accurate. For the GFOV pairs of 25,25 45,45 65,65 and 85,85, the percentages judged to be the same were 82, 70, 66 and 85 respectively. Judgments when the presentation included at least one 85 degree GFOV are shown in Figure 2.

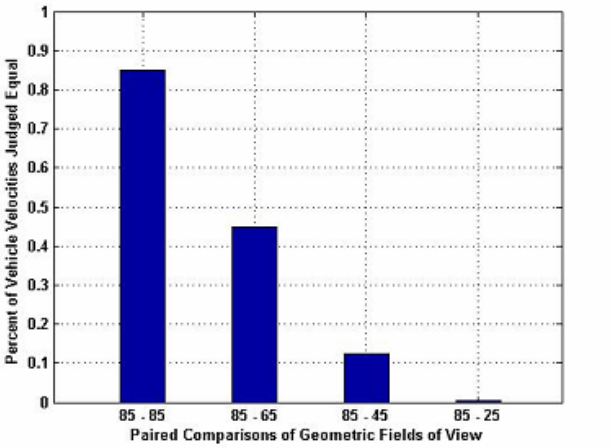

Figure 2: Paired Comparisons with a 85 degree GFOV.

Figure 2 reveals that the GFOV had a strong effect on subjects' perception of vehicle velocity. Subjects perceived velocity as being faster when viewing large GFOVs.

4 Discussion and Future Directions

The finding that the perception of velocity depends on the GFOV has consequences for driving simulators and other displays. Since the perception of optical flow in displays with large GFOVs is fast, user responses may not be the same as when using a small GFOV. Possible extensions to this study are 1) having a condition where the display FOV is the same as the GFOV, and 2) doing velocity production studies both in the lab and real world.

5 References

Gibson, J.J. 1979. The Ecological Approach to Visual Perception. Houghton Mifflin: Boston, MA.

Tan, D.S., Czerwinski, M., Robertson, G.G. 2003. Women Go With the (Optical) Flow. In Proceedings *CHI 2003 Conference on Human Factors in Computing Systems*, 209-215.