An Experimental Investigation of Distance Perception in Real vs. Immersive Virtual Environments via Direct Blind Walking in a High-Fidelity Model of the Same Room

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Abstract

Numerous studies have reported evidence of a compression of egocentric distance perception in immersive virtual environments (IVEs). Motivated by the long-term goal of exploring the potential of IVEs for facilitating the process of conceptual design in architecture, we set out to investigate possible methods for facilitating a more accurate perception of egocentric distance in these environments. In this poster we describe the results of our recent experiment comparing distance perception, as indicated by direct blind walking, in a real environment vs. a high fidelity virtual model of the same environment, presented in an nVisor SX head-mounted display (1280x1024 resolution; 60° diagonal monocular field of view; 100% stereo overlap) tracked at 500Hz over a 24'x24' area. The two most important elements in our present experiment were: to remove the possibility of cognitive dissonance associated with having the presented virtual environment be different from the real environment, and to see whether providing users with short-range haptic feedback about the presence, size, and spatial location of a real object in the virtual environment, in combination with allowing them a moderate amount of time to experience the presented virtual environment in the context of performing an engaging and reasonably enjoyable task, could together improve the users' ability to make accurate judgments of egocentric distance in the virtual environment. Using a within-subjects experimental design, we had 7 naive participants indicate their perception of three different distance intervals (10', 20' and 30', interleaved) marked by tape at various locations on the floor in our lab (figure 1a), and in a high fidelity virtual reconstruction of our lab (figure 1b), over 4 conditions: real-world (baseline), co-located virtual-environment (baseline), virtual-environment after ten minutes of experience completing a virtual modeling task on a real table also represented in the virtual world, followed by a real-world post test. Prior to testing, participants completed 5 practice walks for each interval with feedback in a basement hallway.

Figure 1: A participant in our experiment; screen shot of the IVE.

Our hypotheses were that we would, in our first and second conditions, replicate earlier findings of accurate blind walking in the real world [Rieser *et al*. 1990], but 'walking short' in the virtual world [Thompson *et al*. 03]. We expected that in the third and fourth conditions we would find evidence of adaptation to the compressed representation, followed by an after-effect (overshooting) in the real-world. However, our results (figure 3) did not exactly conform to these expectations. Specifically, we found a far more minor amount of distance compression in our baseline VE condition than has been found in previous studies and, consequent to this 'ceiling effect', we found only weak evidence of trends in the expected directions. We also found that people walked more slowly in the IVE. The main difference between our VE conditions and the VE conditions used in previous studies is that in our case the virtual environment was rendered in full 3D using photorealistic textures, and was co-located with the real world environment. Our training procedure was also different.

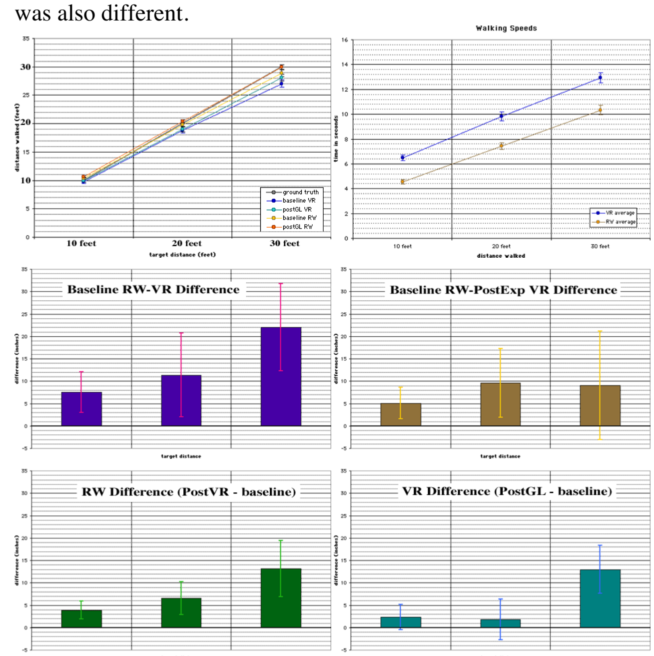

Figure 3: Our results. Error bars show 95% confidence interval.

There are several possible explanations for our results. They may suggest a greater tendency to 'walk normally' in an immersive virtual environment when it is clearly understood to be a faithful representation of an actual, co-located, real environment. They may also reflect an effect of the greater availability in our IVE, relative to the IVEs used in previous studies, of rich optical flow cues in a stimulus that faithfully represents the spectrum of image spatial frequencies existant in the real world. It is also possible that our results show some effects from the training, Further studies are planned to explore each of these possibilities.