Experimental Investigations into the Feasibility of Using Augmented Walking to Facilitate the Intuitive Exploration of Large Scale Immersive Virtual Environments

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Through the use of Immersive Virtual Environments (IVE) technology, we seek to enable participants to experience a computer-represented environment in the same way as they would if it were actually real. Although the state of the technology is not sufficient, at present, to mimic the experience of reality with such fidelity as to raise ambiguity in peoples' minds about whether the environment that they are immersed in is real or virtual, there are many indications that IVEs in their present state can be successfully used as a substitute for real environments for many purposes, including job training, psychotherapy and social psychology. Much recent and historical research in the field of virtual reality (VR) has focused on the question of how much and what type of fidelity (visual, auditory, haptic, proprioceptive, etc.) we need to maintain between a virtual and real experience in order to enable participants to achieve similar results from their VR experience as they would in reality.

The broad objective of our own recent research has been to determine how to most effectively harness the potential of IVE technology to enhance architectural design and education – in particular, we have sought insight into how to enable designers and students to effectively use IVE technology to interactively experience architectural structures and their environments at true scale and from an egocentric point of view. Much of our research has focused on questions of how to enable people to achieve a spatial understanding of an experienced virtual environment that is as similar as possible to the spatial understanding that they would have achieved if they had experienced the real place, in light of the common finding that people tend to behave in IVEs as if they perceive egocentric distances to be significantly compressed. Our most recent work has addressed the problem of how to enable people to achieve an optimal spatial understanding of an IVE that is up to several times larger than the physically available directly navigable space.

It has been previously shown that participants report a higher sense of presence in a virtual environment when they are enabled to virtually explore that environment by actually walking through it than when they must use an indirect metaphor to change their position in the virtual environment: either using walking-like gestures or by pressing a button on a hand-held wand [3]. Unfortunately, when the IVE spans a larger open area than exists in the space housing the tracking equipment, allowing people to explore the VE by simply walking is no longer feasible.

As an alternative, we have been exploring the potential merits of enabling people to move through an oversized IVE by means of *augmented walking* using virtual Seven League Boots [1], a locomotion metaphor in which each step that a person takes in the real world moves him or her forward by a small multiple of

that distance in the virtual environment. The implementation is such that one's movement is exaggerated only in the intended direction of travel and not in the side-to-side or up-and-down directions. Although the proprioceptive sensation is similar to what one experiences with real walking, the visual experience is quite different, and we have been conducting a series of qualitative and quantitative studies to investigate the extent to which the augmented walking metaphor maintains the benefits previously associated [3] with real walking.

In a preference study conducted with 8 participants [1], we found that people overwhelmingly preferred the sensation of augmented walking with Seven League Boots to augmented walking via uniformly scaled translational gain. Furthermore, we found that people rated the experience of exploring a simple virtual environment using Seven League Boots, in terms of criteria such as naturalness and ease of use, no worse than exploring it using real walking interrupted with turns or virtually flying, at a normal walking rate, using a hand-held wand.

In a subsequent performance study conducted with 10 participants [2], we found that people appeared to maintain a more accurate sense of place in a complicated IVE when they were enabled to travel through it by directly walking using Seven League Boots than by virtually flying at a similar rate using a hand-held wand. Participants were asked to follow lighted paths through a virtual city environment and to point through walls to the locations of previously-seen targets. Both boots and wand travel required participants to orient their bodies in the current direction of travel; thus visual feedback about distances traveled was equivalent for both methods, but proprioceptive feedback was different. Our results are consistent with results found in a related study by Williams *et al*. [4]. In future work we plan to assess the limitations of the seven league boots metaphor by exploring how its usability breaks down as the augmentation increases.

CR Categories and Subject Descriptors: I.3.6 [Computer Graphics]: Methodology and Techniques.

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References

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