Chapter 11
Visiting Tourist Landmarks in Virtual Reality Systems by Real-Walking

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ABSTRACT

In recent years virtual environments (VEs) have become more and more popular and widespread due to the requirements of numerous application areas in particular in the 3D city visualization domain. Virtual reality (VR) systems, which make use of tracking technologies and stereoscopic projections of three-dimensional synthetic worlds, support better exploration of complex datasets. However, due to the limited interaction space usually provided by the range of the tracking sensors, users can explore only a portion of the virtual environment (VE). Redirected walking allows users to walk through large-scale immersive virtual environments (IVEs) such as virtual city models, while physically remaining in a reasonably small workspace by intentionally injecting scene motion into the IVE. With redirected walking users are guided on physical paths that may differ from the paths they perceive in the virtual world. The authors have conducted experiments in order to quantify how much humans can unknowingly be redirected. In this chapter they present the results of this study and the implications for virtual locomotion user interfaces that allow users to view arbitrary real world locations, before the users actually travel there in a natural environment.

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In recent years virtual environments (VEs) have become more and more popular and widespread due to the requirements of numerous application areas in particular in the 3D city visualization domain. Two-dimensional desktop systems are often limited in cases where natural interfaces are desired, for example, when navigating within complex 3D scenes. In such cases virtual reality (VR) systems, which make use of tracking technologies and stereoscopic projections of three-dimensional synthetic worlds, support better exploration of complex datasets.

These VR systems allow users to explore virtual worlds in an intuitive and immersive manner. In virtual 3D city environments people can visit, for instance, tourist landmarks virtually. However, due to the limited interaction space usually provided by the range of the tracking sensors, users can explore only a portion of the virtual environment (VE). Redirected walking allows users to walk through large-scale immersive virtual environments (IVEs) such as virtual city models, while physically remaining in a reasonably small workspace by intentionally injecting scene motion into the IVE. With redirected walking users are guided on physical paths that may differ from the paths they perceive in the virtual world.

In this context two questions arise: First, how does redirected walking work and second, up to which degree can users be manipulated? In order to quantify how much humans can unknowingly be redirected, we have performed constant stimuli experiments. In our study, 18 subjects tested in four different experiments: Study E1 explored the difference of user response between virtual and physical rotation; study E2 investigated the difference between virtual and physical translation, and study E3 investigated the same for walking direction. In experiment E1 subjects performed rotations to which different gains have been applied, and then had to choose whether or not the visually perceived rotation was greater than the physical rotation. In experiment E2 subjects chose if they thought that the physical walk was longer than the visually perceived scaled travel distance. In experiment E3 subjects walked along a path in the IVE, which was physically bent to the left or to the right, and they estimate the direction of the curvature.

In this chapter we present the results of this study and the implications for virtual locomotion user interfaces that allow users to view arbitrary real world locations, before the users actually travel there in a natural environment.

Most of the presented results can be found in the works of Steinicke et al.

INTRODUCTION

Walking is the most basic and intuitive way of moving within the real world.

Navigating through large-scale immersive virtual environments (IVEs) can be used in interesting ways in the e-Tourism domain. Landmarks, historical areas, hotels etc. can be viewed in an IVE before going there physically.

Many domains are inherently three-dimensional and advanced visual simulations often provide a good sense of locomotion, but exclusive visual stimuli cannot address the vestibular-proprioceptive system -- which provide us the ability to know where we are in space and time.

Real walking through IVEs is often not possible (Whitton et al. 2005). However, an obvious approach is to transfer the user’s tracked head movements to changes of the virtual camera in the virtual world by means of a one-to-one mapping, i.e., a one meter movement in the real world is mapped to a one meter movement in the virtual one. This technique has the drawback that the users’ movements are restricted by a limited range of the tracking sensors and a rather small workspace in the real world. Therefore, concepts for virtual locomotion methods are needed that enable walking over large distances in the virtual world while remaining within a relatively small space in the real world. Various prototypes of
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