Panoramic Imagery of Physical Locations inside Immersive Environments

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Figure 1. This project aims to create an immersive virtual environment using real-world Google Street View panoramic images and will investigate the effects of changing display modalities on user immersion, spatial awareness, and workload.

ABSTRACT

Immersive environments hold great promise in allowing people to physically engage with virtual objects and surroundings in a natural and intuitive manner. In this project, we will develop immersive virtual environments using panoramic imagery of real-world physical locations, and explore the effects of presenting real-world panoramic imagery in immersive environments compared with traditional displays on user spatial awareness, presence, and mental workload.

INTRODUCTION

CAVE and CAVE-like virtual environments are becoming increasingly popular due to their unique ability to afford immersive, three-dimensional interactions with virtual objects. Such novel technology has already been used as a means of improving group collaborative visualizations [1] and as a way to visualize complex data, such as multi-dimensional atmospheric information [5] and molecular structures [6], at a level of clarity and definition that would otherwise be infeasible.

By combining six degrees of visual freedom, full field of view, and user head tracking, CAVEs hold the potential for users to fully be present in their virtual environments. Such increased immersion might impact how users think about and interact with virtual settings compared with traditional displays by improving intuitive understanding and awareness of the virtual environment and decreasing mental workload during interaction tasks. Research has already shown that immersive display technology can lead to improved planning when compared to planning done on traditional displays [3]. Other studies have shown benefits in utilizing highly immersive virtual environments for complex 3D data [7]. However, both of these studies deal with environments that are not meant to resemble the natural world. In this study, we seek to examine the impact of rendering real-world location images in a three-dimensional immersive virtual environment. Specifically, we seek to combine a conventional mobile map interface with an immersive, three-dimensional Google Street View rendered in a CAVE.

APPROACH

For this research, we will utilize the Google Street View Image API to construct a database of real-world images that will be used to develop three-dimensional panoramas for use in a CAVE environment. Our system will enable participants to utilize a mobile device to view a standard, top-down area map. When the user selects a location on their mobile device, a panorama corresponding to the chosen map location is generated interactively inside of the CAVE. Our system may pull images for different eyes providing information on object depth, will utilize head tracking, and will tailor images based on user location, orientation, and measured interocular distance.

HYPOTHESIS

We have developed several hypotheses for our system based on findings in literature on immersion and awareness:

Hypothesis 1. In exploration/navigation tasks, presenting real-world panoramas in corrected 3D with head tracking will improve users' *presence* in the virtual environment compared with traditional displays.

Hypothesis 2. In exploration/navigation tasks, presenting real-world panoramas in corrected 3D with head tracking will improve users' *situational awareness* of the virtual environment compared with traditional displays.

Hypothesis 3. In exploration/navigation tasks, presenting real-world panoramas in corrected 3D with head tracking will decrease the *mental workload* placed on users compared with traditional displays.

EVALUATION

We will design and conduct a laboratory experiment to investigate the effects of presenting real-world panoramas in immersive environments on exploration and navigation task outcomes. The experiment will utilize a task which requires participants to explore and navigate a real-world city with which they have little prior familiarity. Below we describe our tentative experimental design and measurements.

Experimental Design

To test our hypothesis, we plan to conduct a 5×1 within-participants study, in which we will manipulate the type of display participants use to interact with the panoramic images. The independent variable representing the type of display interface has five levels:

1. The participant views the panorama on a single screen.
2. The participant views the panorama in 2D without head tracking. This condition will give the images the appearance of being painted on the CAVE walls.
3. The participant views the panorama in 2D with head tracking.
4. The participant views the panorama in 3D with head tracking. In this condition the display for the images is determined by the original disparity of the cameras.
5. The participant views the panorama in corrected 3D with head tracking. In this condition image disparity will be based on participant location, orientation, and measured interocular distance.

Dependent variables will include task completion performance including time and efficiency of route, as well as participants' spatial awareness regarding their surroundings, participants' sense of immersion, and participants' perceived cognitive workload while navigating.

Measurements

Several objective and subjective measurements will be taken in this experiment to check our manipulations and asses the effects of presenting real-world panoramas across various display modalities. Manipulations will be assessed using post-experiment questionnaires to confirm that participants were able to distinguish between different display conditions. Task time and route efficiency will provide objective measures of task performance. The Presence Questionnaire Item Stems (Version 2.0) [8] will measure participants' presence, or immersion, with the environment. The Situation Awareness Global Assessment Technique (SAGAT) will objectively measure participants' situational awareness, which will also be measured subjectively using the Situational Awareness Rating Technique (SART) [2]. Participant mental workload will be measured using the NASA Task Load Index [4].

CONCLUSION

Immersive environments offer a novel means of human-computer interaction whereby users are able to physically interact with virtual objects and feel present in virtual environments. This research aims to explore the effects of rendering real-world panoramas in a CAVE environment on users' subjective experiences as well as their cognitive and decision-making processes, with the goal of improving immersion, situational awareness, and mental workload.

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