Comparison of Multi-Wall Displays for Navigation in a Virtual Store

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Abstract

Many major retail companies use one-wall projections of virtual stores to test new marketing ideas on consumers. These companies are concerned with improving navigation in virtual environments while avoiding unnecessary costs. We investigated whether a multiple-wall display in an immersive room enhances navigation by minimizing the amount of time it took a user to find consumer products in the virtual store. To help retail companies determine if multiple walls are worth investing in, we compared the amount of time it took a participant to find products in a one-wall display versus a five-wall environment.

1. Introduction

Virtual stores allow retail companies to test marketing strategies without spending the resources to physically implement new stores, displays, products etc. Within these virtual environments it is important to represent shopping experiences as realistically as possible. If these virtual experiences are accurate of real world shopping, then companies can reliably use the virtual environments to survey participants about consumer preferences. The virtual environments used by major retail companies simulate a shopping experience by immersing the user in a three dimensional graphic and auditory environment. For the purpose of our research we used the C6 located at the Virtual Reality Applications Center in Iowa State University. The C6 is a 10 x 10 x 10 ft. room that has four walls, a ceiling, and a floor giving us six walls on which to project an image. Our study compared a one-wall display in the C6 with a five-wall environment consisting of four walls and the floor.

Procter & Gamble (P&G™), for example, currently use one-wall displays for virtual environments [4]. Major companies such as P&G™ are concerned with how they can successfully survey consumers and reduce unnecessary expenditures at the same time. This concern was addressed by testing whether multiple walls enhanced a consumer's ability to navigate a virtual store. Navigation is "the process of determining a path to be traveled by any object through an environment" [1]. For our experiment, navigation involved the user controlling their virtual movement in order to find products on a grocery list. Our objective was to compare navigation time within these immersive virtual environments. The results were valuable to retail companies because if the one-wall display yielded minimal navigation time, companies could avoid the additional costs of running multiple walls.

The research question we developed was: Do multiple walls minimize the amount of time it takes a user to find products in a virtual store? We hypothesized that the five-wall display in the C6 would yield significantly shorter navigation times on average.

2. Literature Review

Numerous studies have compared user performance in immersive displays. Pausch et al. conducted one such study comparing user performance when searching for letters (i.e. 'A') in desktop and head-mounted virtual reality (VR) displays. They found that VR users were able to identify when there was no target letter present substantially faster than desktop users [8].

Kasik et al. later concluded that certain display types do not yield significantly shorter search times when locating an item. Their study tested airplane engineer participants to explore navigation using different sized displays. Kasik et al. couldn't determine whether a larger, more immersive display improved a user's ability to find airplane parts in VR [6]. Swindels et al. followed up on Kasik's study and compared CAVE (Cave Automatic Virtual Environment), single wall, and desktop displays on navigation time for finding airplane parts. Their results also suggested that display type does not significantly reduce the time it takes to find objects in a complex 3D model [10].

Our objective was similar to Swindels' hypothesis that, "Immersive environments should be significantly faster and more accurate compared to desktop displays". Our study differed from Swindels' because we used a virtual store rather than an industrial environment, and we introduced a shopping cart device to simulate motion in VR. We were interested in studying whether the differences between our study and Swindels' would produce significantly shorter navigation times for one of the two display types we tested.

Gabbard et al. determined that past user input devices for virtual environments were not designed with the user in mind [3]. We designed our shopping cart device for the inexperienced VR user such that the controls were minimal and could be taught in the brief demo time before the actual experiment. We hoped that the device would augment a sense of reality in the virtual store by creating a connection between the experience in VR and real world shopping experiences.

3. Methods

At the start of the one-hour experiment, participants were asked to complete a brief survey about their background. The questionnaire asked participants about their education level, shopping experiences and familiarity with computer technology. Following the survey, they were introduced to the C6 and given a brief demo on how to use the user input device to control motion in a virtual environment.

Figure 1. Virtual grocery store.

Participants were randomly assigned to one of two evenly numbered groups. One group viewed the virtual store (see Figure 1) on one wall of the C6 and the second group viewed the same virtual store on a five-wall environment in the C6. Three participants from each of the two groups were arbitrarily chosen for think-aloud protocol. Think-aloud protocol was the process by which participants voluntarily articulated their cognitive and emotional processes as they accomplished the given task. As the participants looked for products in the virtual store, they voiced their thought process and we took written notes of their comments.

Participants in both groups were asked to complete the same task. They were given a shopping list of four products dispersed throughout the virtual store:

1. **Vicks® Nyquil® Cough**
2. **Mr. Clean® Magic Eraser**
3. **Kotex® Pads**
4. **Kleenex® Facial Tissues**

The participants' task was to locate the four products. When his or her position in the virtual store approached the location of the product, the product was considered collected. The two dependent variables measured were time it took participants to find all products and arc length of the path they took to complete the task.

During the task, all participants used the same shopping cart device (see Figure 2) to control movement within the virtual store. We designed a user input device that allowed the user to remain stationary in the C6 while simulating walking in the virtual environment. The device resembled a modified shopping cart, with a physical stationary base and virtual basket displayed as part of the virtual store scene. We maintained the same width and height of an average grocery store shopping cart, 24" and 40" respectively.

Figure 2. Shopping cart device with rotating base.

The device consisted of a wooden handlebar connected to a gamepad joystick and a wand was attached next to the gamepad. The gamepad controlled forward and backward motion in a straight path. Participants could push or pull on the handlebar to simulate forward or backward motion in the virtual store. A wand was secured beside the gamepad to control rotation. To change direction or look around in the virtual store, users swiveled the handlebar left or right on the rotating base. The wand signaled the virtual store to rotate around the viewer in the direction the user pointed the wand. We mounted the handlebar system on a lazy Susan to permit rotation.

For the one-wall display, we restricted handlebar rotation to turn at most, 45 degrees to the left and right of the starting position. To start turning in the virtual store, users moved the handlebar to the left or right of the center and stopped the turning by bringing the handlebar back to center. In other words, the virtual store revolved relative to the stationary viewer. In the five-wall environment, users were free to rotate the handlebar 360 degrees. Contrary to the one-wall display, the virtual store remained stationary while the user physically turned the shopping cart device to the desired direction. Thus, the multiple-wall environment was more accurate of real world shopping movements.

The device allowed users to simulate movement without physically walking around in the C6. We hoped it would increase the level of immersive feeling by making a connection between standard shopping experiences and the virtual experience.

Upon completion of the task, participants were asked to complete a short exit survey summarizing their experiences during the shopping task. The survey questioned participants about their level of stress, comfort and how convincing of reality they felt the shopping experience was. We used excel to analyze whether multiple- or single-wall displays produced shorter navigation times. We looked for any correlations between the pre-survey background information and the user's navigation time. We also investigated if the two display types impacted the user experiences as stated in the exit survey and think aloud protocol.

4. Expected Results

We expect to confirm our hypothesis that the five-wall environment will yield significantly shorter navigation times on average. Therefore, it would be a worthwhile investment for retail companies to use multiple-wall displays when testing consumer preferences in virtual stores.

5. Future Work

An extension of this study could investigate the optimal navigation time for different display types and level of immersion. It is also unclear how the ceiling and floor walls influence a user's ability to find products. Potential future work could investigate other user input devices for virtual shopping experiences. Future experiments using VR to study marketing strategies could test if the layout of the store or different types of signage plays a factor in reducing navigation time.

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