A Virtual Environment for Accessible Desktop Navigation

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Virtual reality is an emergent technology with the potential to offer valuable contributions to ambient assisted living. For example, it can be utilised to enhance equality of access to, and ease of use of technology. This paper introduces virtual reality technology, and presents a prototype system for intuitive file navigation and manipulation. Through a discussion and end user evaluation of system use cases, we offer commentary on the system's potential for increasing computing confidence and competency in non-computer literate populations. Findings indicate virtual reality constitutes a viable tool for aiding users with reduced computer literacy and confidence in relation to everyday computing tasks, and therefore could be deployed as an assistive technology within such populations.

Virtual reality, Virtual desktop navigation, Assistive Technology, HCI

1. INTRODUCTION

The Oxford Dictionary defines virtual reality (VR) as a computer generated simulation of a three dimensional (3D) image that can be interacted with via the use of a spacialised headset (Oxford University Press, 2016). VR is on the cusp of becoming main stream, with projections indicating that 6.31 million head sets will be sold in 2017 alone (Statista, 2017). Yoon (2011) suggests individuals characterised by reduced computer-confidence and competency may find 3D interfaces, such as those provided by VR, easier to navigate than their 2D counterparts. Furthermore, Bowman (2001) proposes that VR can alleviate common usability and learnability problems found in 2D environments- the provision of system interaction methods similar to that of everyday tasks carried out by the user can reduce barriers to use.

This paper presents a headset-delivered, 3D virtual environment for file navigation, which aims to assist users typified by reduced computing competency or confidence. System use cases are presented, and navigation considerations are identified via end user evaluations. An overview of related literature is provided in Section 2. The proposed system is presented in Section 3. Our experimental overview and results are offered in Sections 4 and 5, respectively, and conclusions are offered in Section 6.

2. RELATED LITERATURE

Although the application of VR within areas such as gamification and physical rehabilitation has been widely researched (Lin, 2017; Laver et al., 2011), the potential benefits of such technology for aiding non computer-literate users, to enhance user confidence and capability, remains less explored. Ausburn and Ausburn, (2008) evaluate desktop VR's effect on learner performance and confidence. Using a quasi-experimental design to compare desktop VR and still colour imagery, they propose that VR desktop environments can enhance user performance and confidence when compared to traditional desktop environments. Conversely, Santos et al., (2008), evaluate user performance of common tasks within VR desktops and propose that, although VR constitutes a more intuitive and natural environment, most users perform better using a standard desktop set up. Despite conflicting results, intuitive use is consistently identified as a key design consideration (Seo et al., 2016). Yoon, (2011) propose that when using VR, the efficiency of completing a task is not necessarily a key factor when deciding if the interface is usable, instead it is how intuitive the next step in the task is.

Intuitive use depends on selection of appropriate user input mechanisms. For VR, input mechanisms include hand tracking, hardware controllers, and gaze recognition (Stedmon et al., 2011; Atienza et al., 2016). Doisy et al., (2017) identify hand tracking as both reliable and efficient. Guna et al., (2014) found that hand tracking via the leap motion (an infrared hand tracking and visualisation tool) was accurate enough to consistently track with an error margin of < 0.5 mm when the hand is between 20 and 30 centimeters away. Lu et al., (2016) found that hand tracking via leap motion had an overall accuracy of 95% for gesture recognition.

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Within existing literature, it is acknowledged that VR desktops can impact performance when completing tasks. However, there remains disagreement as to whether 2D environments are consistently more or less usable than VR. Studies have focused on user groups of mixed computing ability and age- the potential benefits of designing usable VR systems to increase competency in less confident computer users remains relatively unexplored. Given the high accuracy of approaches such as gesture recognition, we propose that a VR system incorporating intuitive gestures and simple task progression has the potential to increase usability and user confidence.

3. PROPOSED SYSTEM

Our system offers users access to file directories through a virtual library environment. A library metaphor is used instead of the standard file and folders metaphor. Within this environment, use cases include but are not limited to:

1. ‘As a user I want to be able to select and open a text file so that I can view its contents’
2. ‘As a user I want to be able to edit and save a text file’
3. ‘As a user I want to be able to select and open music file so that I can listen to its contents’ and
4. ‘As a user I want to navigate through the file system so that I can find a file I want to open’.

As suggested by research conducted by Seo et al., (2016) low emphasis has been placed on graphics and game variety. Models utilised were minimalistic and open source. The environment, illustrated in Figure 1, was designed to simulate a virtual library where a user must perform hand gestures to search, open, and navigate books instead of files. The objective behind development of a virtual library was to draw closer similarities between the virtual and real world, replicating everyday tasks that users would feel confident performing.

To provide appropriate and progressive guidance when performing system tasks, audio feedback is offered within task sequences. Audio feedback, coupled with visible task progression, should ensure system interactions remain clear and consistent (Kabassi and Maravelakis, 2015). Our system was developed in Unity, using the second generation Oculus VR development kit, with input via leap motion. The application runs on a 16GB RAM, Intel core i7 with NVIDIA GeForce GTX 970m.

Figure 1: Virtual library

4. EXPERIMENTAL OVERVIEW

Performance data was collected from participants (n = 5), with the overall objective of understanding if VR technology can allow intuitive task completion across a series of prescribed tasks. It has been previously demonstrated that 5 participants can effectively identify 85% of common usability problems (Nielsen and Landauer, 1993). The participants in this study where all aged over 65, and had a range of literacy skills. All participants use computers less than once a week and stated when interviewed that they found computing tasks difficult. No participants had experience using VR.

Users were asked to carry out tasks corresponding to system use cases. Specifically, users were asked to perform the 8 tasks identified in Figure 2. System usage was recorded using Flashback Express screen recording software, and task error/success rates were subsequently calculated. In addition to analysis of task completion and error rates, post hoc satisfaction data was collected via a questionnaire, where users were asked to: rate the ease of task completion; and offer suggestions for system improvement. Questionnaire data was utilised to estimate participants perceived system usability and gather recommendations regarding system enhancements.

5. RESULTS & DISCUSSION

5.1 Participant Perceptions of Usability

Post hoc satisfaction data indicates that users generally found the system easy to use. Specifically, 60% of users reported the system as highly usable when opening books, image and music, and 100% of participants found tasks 1, 2, 3, 6, 7 and 8 easy to complete. However, 70% of participants reported difficulty when using the keyboard to edit and save text documents completed in tasks 4 and 5.

Recommendations for system improvements were in the majority input related. 3 out of 5 participants recommended that the keyboard layout be changed to QWERTY, as opposed to alphabetical arrangement. Users also recommended that the keyboard size be made larger, to avoid pressing more than one key at a time. It should be noted that one of the participants mentioned they understood QWERTY keyboards from typewriters, stating this as the reason they would prefer a QWERTY keyboard.

1.	Open the book called Videos on the lectern in the VR environment
2.	Find and play the file called Small.ogv
3.	Open the documents book and open the text file called Text Files (3).txt
4.	Edit the text file called Test File (3).txt adding the word "library" to the end of the text file
5.	Save the edited text file Test File (3).txt
6.	Open the documents book and find the image called Leap Motion Hands.PNG
7.	Open the Music book and play the music file called Music2.Wav
8.	Pause the current playing song and navigate back to the image book

Figure 2. System Evaluation Task Summary

5.2 Participant Error / Success Rates

Across all tasks, mean user success was 92.5%, although 60% of users failed to complete task 4. Success rates were based on whether a user successfully completed the tasks in Figure 2. Error rates per task are summarised in Figure 3. Task success rates were 100% for tasks 1 – 3, and most errors were associated with task number 4. Example user errors include mistakes on the keyboard, opening the wrong book, and accidently playing music. Task 4 related to editing a text file adding the word library to the end.

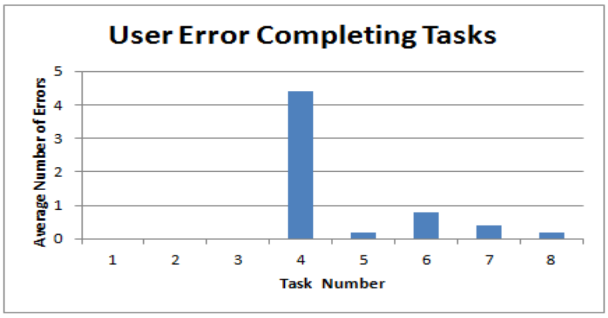

Figure 3: User Error Completing Tasks

Task 4 success was 40%. All participants thought that they had completed this task effectively. Users failed due to pressing more than one letter at a time while typing, and not checking if they had typed the word correctly. Across the prescribed usability tests, editing text files was the least usable part of the system. This system component requires further consideration and design to fix this usability problem.

6. CONCLUSIONS AND FUTURE WORK

This study introduces a prototype immersive environment for performing file navigation and editing tasks. The system was developed with usability in mind, and drew upon recommendations from existing literature to enable simple task completion.

As the first step in investigating whether VR is an appropriate assistive technology for less confident / proficient computer users, we evaluate the prototype in relation to task success and system usability perceptions. Findings indicate that VR offers an alternative approach to desktop navigation which users find simple and intuitive. Most tasks were completed successfully. However, usability issues arose when performing file edit tasks via a virtual keyboard.

The prototype incorporates a library metaphor with hand tracking to perform everyday tasks that simulate real world non-computing tasks (e.g. open a book). Participants felt comfortable with this metaphor. It is clear the library metaphor resonated with the non-confident users included within our evaluations, but we acknowledge the metaphor chosen may have a negative impact with certain user groups, for example those with literacy issues. Decoupling the complex interrelationship between metaphor-based and VR-based interactions has not been fully explored within this study, and one cannot comment with confidence on the relative impact of each for developing intuitive systems. Future evaluations should explore this concept more fully.

As stated previously it was decided that only 5 participants would be used due to research done by Nielsen and Landauer, (1993) Although this research is dated and widely contested this method has become industry standard and is still used today (Verkuyl et al., 2016). However later studies question this approach. Faulkner, (2003) propose that only when approaching 20 users can the practitioner approach increasing levels of certainty and therefore future research could accommodate this.

Although it is clear more research is required, it is felt that this software offers great insight in to the potential for increasing computing confidence and competency in non-computer literate populations through the use of VR, and forms a foundation from which future research can build.

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