

The Use of Virtual Reality to Evaluate Activities of Daily Living for Psychosocial Training and Rehabilitation

¹Toh Hsiang Benny Tan, ¹Huiguo Zhang, ²Siyuan Liu

¹Joint NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY), Nanyang Technological University, Singapore

²Department of Computer Science, Swansea University, Swansea, UK

BennyTanTh@ntu.edu.sg, Hgzhang@ntu.edu.sg, siyuan.liu@swansea.ac.uk

Abstract

Psychosocially impaired elderly often suffer from functional limitations which impede independent community living. Rehabilitation is the process in which they regain the necessary skills to reintegrate back into the community and can therefore age in place. In this work, we developed a VR psychosocial rehabilitation platform that enables users to perform daily tasks in a high-fidelity virtual environment so that their gained experiences and skills can be applied back in the real-world environment, thus helping them reintegrate back into the community. A food court scenario was developed. An initial pilot study was conducted to evaluate the feasibility of VR as a rehabilitation platform. The study shows that VR is well-received for its immersion and experience of being present in the scene, while basic knowledge on operating VR headsets and controllers is needed to use the platform. It is found that prolonged use of the VR headset will induce cybersickness.

Keyword: Virtual Reality, Psychosocial Training, Rehabilitation, Elderly.

I. Introduction

Many elderly face psychological challenges as they age. Indeed, as they go through major changes in their lives such as retirement, bereavement or disability, they are considered to be psychosocially vulnerable [8]. As a result, they may lose their ability to self-care, thereby impeding their ability to

live independently. This has a negative impact not only on the elderly's quality of life, but also puts social and economic pressures on their family and society as a whole. Indeed, impaired psychosocial functioning has been shown to be strongly associated with increased hospitalization and healthcare costs, premature institutionalisation, and poor physical and health outcomes [2]. As such, it is crucial to find solutions to help the elderly recover from such a condition in order to enable them to age in place.

Psychosocial rehabilitation aims to facilitate community living ability of persons with mental health issues, by teaching them specific life skills needed to function effectively or developing appropriate community and environmental resources needed to strengthen their present levels of functioning [1]. Psychosocial rehabilitation is an important component not only in aiding the psychosocially impaired elderly overcome obstacles in their daily life, but also for helping them improve their mental and physical health required for independent living.

In this work, we develop a Virtual Reality (VR) platform for psychosocial training and rehabilitation of psychosocially impaired elderly in order to help them recover, maintain or improve their community living skills. VR offers an alternative method in simulating real world community functioning. Compared to traditional psychosocial skills training, VR tasks afford more active engagement by participants, allow better experimental control, provide some ecological validity to real-world tasks and offer greater amounts of enjoyment [3, 7]. We conducted a pilot study over young users to explore the acceptability and tolerability of VR as a training and rehabilitation tool. The results suggest that immersion and presence within the VR environment was good. However, the longstanding issues in VR such as cybersickness remain to be resolved.

II. Methodology

A. Selection of Virtual Reality Device

In a virtual reality (VR) platform, the target user would be required to use a VR headset in order to experience and carry out the necessary activities in the virtual world. The selection of an appropriate VR headset thus can have a significant impact on the platform's usability and the user's experience. In order to make an appropriate selection, headsets from major vendors, including HTC (HTC Vive, Vive Cosmos), Oculus (Oculus Rift S, Oculus Quest), Lenovo (Explorer), Samsung (Samsung Gear, HMD Odyssey) and Google (Google Cardboard), were evaluated.

After careful consideration, the Oculus Quest was selected as the VR headset of choice due to the following reasons. First and foremost, it is one of the few untethered headsets available. Being connected to a computer via numerous cables means that the risk of trips and falls would be significantly higher for users in a virtual environment. Hence, untethered headsets are safer for the elderly.

In addition, the Oculus Quest is an untethered headset which allows for 6 degrees of freedom. Some other untethered headsets such as the Samsung Gear or Google Cardboard only allowed for 3 degrees of freedom, meaning that they could only detect rotational movement, but not translational movement. Other tethered headsets, such as the HTC Vive, are also able to provide 6 degrees of freedom room-scale experiences similar to the Oculus Quest but necessitate external accessories such as base stations, significantly increasing the complexity of the setup.

And lastly, Oculus Quest provided a high level of flexibility. It provided a relatively high level of visual fidelity compared to other untethered headsets, while still allowing for visual fidelity comparable to other tethered headsets by connecting to a computer either using a cable or wirelessly via their Oculus Link technology.

B. Content Design

B.1. Flow of experience. Working with our clinician partners, training content for the platform is designed with a focus on depth and realism rather than breadth, in order to ensure proper evaluation of each task, as well as to improve the ecological validity of the evaluation results. The platform focuses on both rehabilitation and assessment. For a pilot study, a food court scenario requiring the user to purchase food is designed. As shown in Figure 1, the platform provides two different modes, a training mode and an assessment mode.

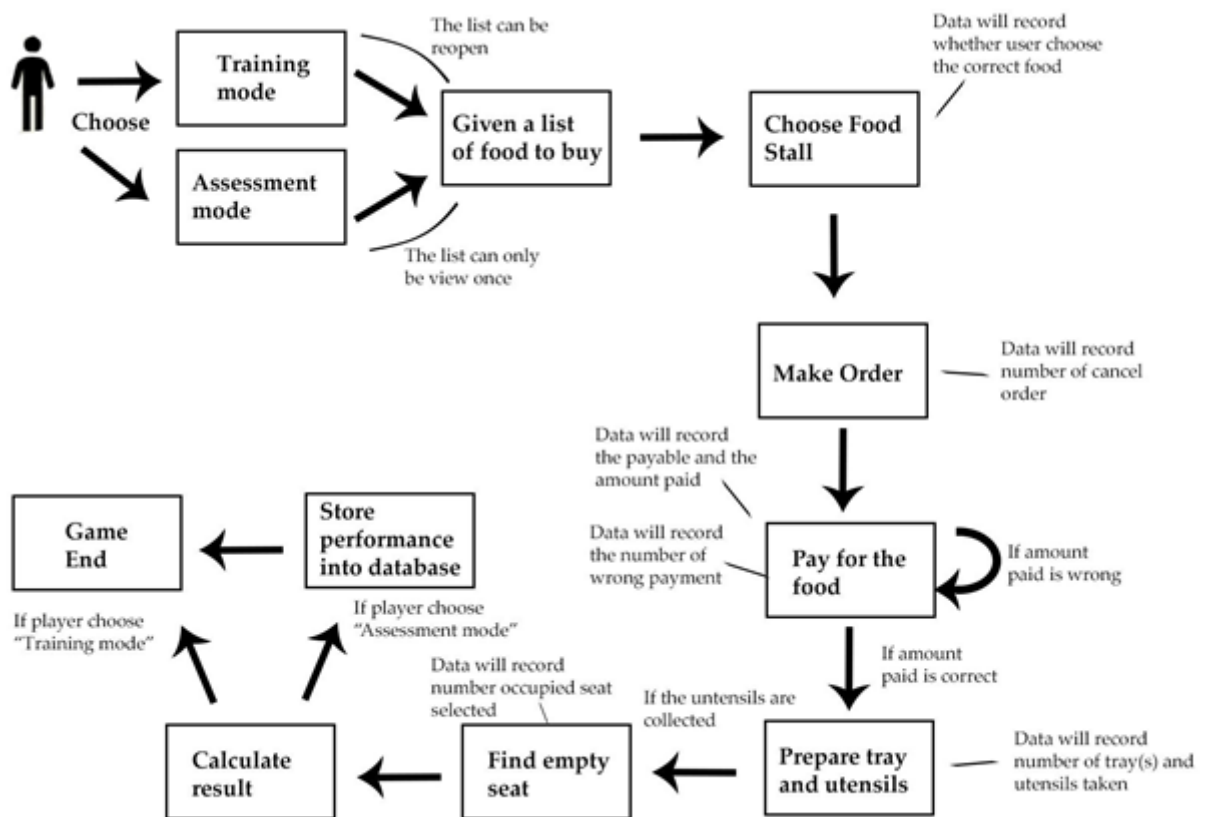


Figure 1. Flowchart of the designed scenario

In the training mode, users have access to various assistive functions such as repeated viewing of their required tasks, as well as visual hints as shown in Figure 2, to help them complete the required tasks. In assessment mode, assistive functions and hints are not available to the user, and the user's performance for each task is recorded in more detail to aid in understanding and review.



Figure 2. Glowing hint to indicate where to place coins.

B.2. The designed scenario. In the designed scenario, to help increase immersion and the ecological validity of the rehabilitation and performance assessment, effort was made to recreate the ambience of the environment. Figure 3 below shows a comparison of a reference picture used for the design of the environment, and a screenshot showing a crowded food court environment in the platform. As in the real world, non-player characters (NPC) in the virtual training environment communicated with the player only via voice (audio) or gestures. Unlike traditional games, no text or subtitles detailing what the NPCs said were available to the user.



Figure 3. Reference photo and food court populating test.

III. User Testing and Results

A pilot study involving 19 youths between the ages of 20 to 25 was carried out. Among the 19 users, 6 of the participants are female, while 13 of them are male. Ten of the 19 participants had prior experience with the use of VR equipment. The participants experienced the VR platform and provided their evaluation in four aspects: immersion, cybersickness, height calibration, and controls.

A. *Immersion*

The participants were generally accepting of the level of realism of the environment of the designed scenario. However, most participants felt that the food court environment should be better designed with more detail in terms of the props and texture. One possible reason for this is that the food court environment is very much unique to Singapore. As such, it was not possible to purchase any ready-made environmental models and props. The environment and props for the food court thus were created from scratch.

On the other hand, users found that the background noise, such as people talking, significantly contributed to the immersion of the scenario. However, some users pointed out that the quality of the voice acting when interacting with NPCs could be improved, for example “when the

player takes too long, the hawker should sound irritated, to give the player a sense of urgency”. The presence of physics operation on interactable objects also contributed to their experience of the platform, with many users taking the time to test the effects of throwing and dropping interactable objects.

B. Cybersickness

One of the main barriers reported in prior VR research which was observed in the current study as well as cybersickness. Like motion sickness, cybersickness frequently manifests itself as a feeling disorientation or nausea. The leading theory behind cybersickness is based on the idea of sensory conflict. Essentially, the information received by your eyes in VR does not always match up with what your body feels is going on in terms of balance and spatial orientation. Cybersickness thus occurs when the human perceptual systems that provide accurate information about orientation and movement are challenged in these virtual environments [6].

Of the 19 participants, 6 of them reported experiencing some form of cybersickness, with 2 of them having to take a break after 10 minutes. One of the main actions which caused them to experience motion sickness was that of transitioning between areas in the virtual environment. While the Oculus quest allowed for 6 degrees of freedom, the sizes of the scenario meant that it would not be possible to provision sufficient space for them to physically full move about the environment while physically walking. As such, two forms of movement were trialed. There is a clear sequence of steps in the scenario,, where the users in game avatar would automatically move to the required location to carry out an action. For example, if the users were to select a stall by pointing at it, the users avatar would then automatically walk over to the stall. The users felt that the automatic movement of the avatar elicited some level of cybersickness.

C. Controls

In the current platform the default oculus controllers were used as the main form of input for the system. While participants who had prior experience with VR were able to quickly pick up the controls, those who were new to VR had more trouble adapting to the controllers. Due to not being able to see the controller while in the virtual world, and unfamiliarity with the layout and buttons on the controller, new users required constant guidance to find the correct controls, as well as encouragement to carry out actions.

Problems regarding the use of the physical joysticks was also brought up. One user found the use of the controllers tiring, one felt that the use of the controllers was risky as she felt that depending on the task, users might drop or throw the controllers by mistake, and another user felt that the lack of haptic feedback when performing actions such as grabbing objects was problematic, suggesting the inclusion of at least basic haptic feedback such as vibrations to complement the actions.

III. Conclusion

Psychosocially impaired elderly often suffer from functional limitations, e.g., difficulties in concentrating, coping with multiple tasks, and interacting with others. These limitations impede independent community living. Rehabilitation is the process in which they regain the necessary skills to reintegrate back into the community and can therefore age in place. In this work, in the collaboration our clinician partners, we developed a Virtual Reality (VR) platform which enables users to perform daily tasks in a high-fidelity virtual environment so that their gained experiences and skills can be applied back in the real-world environment, thus helping them reintegrate back into the community. A food court scenario was developed.

An initial pilot study over 19 young users was conducted to evaluate the feasibility of VR as a rehabilitation platform. It was found that VR is well-received for its immersion and experience of

being present in the scene, while basic knowledge on operating VR headsets and controllers is needed to use the platform. It is also found that prolonged use of the VR headset will induce cybersickness. In the future, hand-tracking input methods and VR treadmills will be explored to substitute controllers, allowing more natural interaction. Scenario design will be improved with shorter segments, with in-between breaks.

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