Analysis of Virtual Reality Therapy Game Prototype for Persons Living with Dementia in the Philippines

Veeda Michelle M. Anlacan[1,2,3,*][a], Roland Dominic G. Jamora[1,2,*][b], Angelo Cedric F. Panganiban[1,4,*][c], Isabel Teresa O. Salido[1][d], Romuel Aloizeus Z. Apuya[1][e], Bryan Andrei C. Galecio[1][f], Michael L. Tee[1,5][g], Maria Eliza R. Aguila[1,6][h], Cherica A. Tee[1,7][i] and Jaime D. L. Caro[1,4][j]

[1]*Augmented Experience Ehealth Laboratory, University of the Philippines Manila, Manila, Philippines*

[2]*Department of Neurosciences, College of Medicine - Philippine General Hospital, University of the Philippines Manila, Manila, Philippines*

[3]*Center for Memory and Cognition, Philippine General Hospital, University of the Philippines Manila, Manila, Philippines*

[4]*Department of Computer Science, College of Engineering, University of the Philippines Diliman, Quezon City, Philippines*

[5]*Department of Physiology, College of Medicine, University of the Philippines Manila, Manila, Philippines*

[6]*Department of Physical Therapy, College of Allied Medical Professions, University of the Philippines Manila, Manila, Philippines*

[7]*Department of Pediatrics, College of Medicine, University of the Philippines Manila, Manila, Philippines*

Keywords: Virtual Reality (VR), Persons Living with Dementia (PLWDs), Behavioral and Psychological Symptoms of Dementia (BPSD), Gamification, Personalization, Virtual Environment Design.

Abstract: Immersive technologies such as virtual reality (VR) had rapidly gained interest as part of the technological revolution in healthcare. Because of its inspirational affectation, VR had been considered a potential intervention for individuals with impaired memory such as dementia. This paper had two goals that were achieved in collaboration with healthcare professionals and scientists from the Philippines: (a) to create an improved VR therapy game for persons with behavioral and psychological symptoms of dementia (BPSD), and (b) to acquire professional insights and recommendations about the game. With this, a VR game prototype was developed and tested among five health and four game design professionals. A focus group discussion (FGD) was then held to discuss the participants' experience with the game. The results of the FGD provided an in-depth analysis regarding the game's architecture and overall design for the use of persons with BPSD in the Philippines. Critical points discussed in this paper may be adopted in future VR studies for general healthcare applications personalized for a specific demographic.

1 INTRODUCTION

As of 2015, Alzheimer's Disease International has documented an estimated 900 million senior citizens around the globe, and with no upper limit in sight, global life expectancy continues to increase (Prince et al., 2015). With rising life expectancy, there is an increased prevalence of chronic and progressive diseases like dementia (World-Health-Organization, 2022; Prince et al., 2015). Dementia is a disorder characterized by an unusual progressive decline in cognitive function (World-Health-Organization, 2022). Persons living with dementia (PLWDs) of-

[a] https://orcid.org/0000-0002-1241-8805
[b] https://orcid.org/0000-0001-5317-7369
[c] https://orcid.org/0000-0001-9327-3339
[d] https://orcid.org/0000-0002-9314-0891
[e] https://orcid.org/0000-0001-8777-4356
[f] https://orcid.org/0000-0003-4943-3504
[g] https://orcid.org/0000-0003-0113-8290
[h] https://orcid.org/0000-0002-4034-4655
[i] https://orcid.org/0000-0002-0766-0189
[j] https://orcid.org/0000-0003-1447-594X
*These authors contributed equally to this work

Anlacan, V., Jamora, R., Panganiban, A., Salido, I., Apuya, R., Galecio, B., Tee, M., Aguila, M., Tee, C. and Caro, J.
Analysis of Virtual Reality Therapy Game Prototype for Persons Living with Dementia in the Philippines.
DOI: 10.5220/0011686900003414
In *Proceedings of the 16th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2023) - Volume 5: HEALTHINF*, pages 144-154
ISBN: 978-989-758-631-6; ISSN: 2184-4305

ten experience changes in mood, behavior, emotional control or motivation that are collectively called behavioral and psychological symptoms of dementia (BPSD). BPSD tends to worsen and fluctuate as dementia progresses, and these symptoms are also costly to manage (World-Health-Organization, 2022). While pharmacological interventions are available, the effects of these medications are modest and are limited by side effects. Furthermore, inadequate management may cause poor health outcomes for both the patient and their caregivers (Kales et al., 2015). Thus, it is necessary to develop alternative, non-pharmacological strategies for managing BPSD (Appel et al., 2021).

In recent years, Immersive technologies have rapidly gained interest as one of the tools aiding the technological revolution in healthcare (Andringa et al., 2019). Virtual reality (VR) in particular has been studied as an intervention for clinical conditions such as pain and anxiety (Eijlers et al., 2019; Pourmand et al., 2018; Wittkopf et al., 2020), burns (Czech et al., 2022), phobias (Wechsler et al., 2019), and neurocognitive diseases (Moreno et al., 2019). Moreover, the inspirational affectation brought about by VR (Huntsman, 2014) has led researchers to consider it for use among individuals with impaired memory such as PLWDs. VR can be used for cognitive and motor stimulation (Garcia et al., 2012); for early detection and diagnosis of dementia (Elvey, 2016); or for recreating the experience of dementia for carers to better understand the detrimental effects of the disorder on the lives of PLWDs (Griffiths, 2016).

This research is part of an ongoing program to develop an immersive technology system for managing BPSD among PLWDs. The researchers collaborated with Philippine healthcare professionals and scientists representing the fields of neurology, internal medicine, physiatry, nursing, anthropology, graphic design, game design, and software engineering to achieve the following goals: (a) to create an improved VR therapy game specific for persons with BPSD residing in the Philippines; and (b) to acquire valuable insights and recommendations on the architecture and overall design of the developed VR game prototype for the target population.

This paper will discuss different studies that have influenced the architecture and overall design of the developed VR game prototype for the target population; the clinical setup and the components of the game prototype. The results and discussion of the focus group discussion about the participants' experience using the prototype will be presented, followed by the summary.

2 REVIEW OF RELATED LITERATURE

Several early attempts had been made to utilize VR for dementia care. A study (Flynn et al., 2003) showed that using virtual environments (VEs) was feasible among patients with dementia. They noted that during the VR sessions, patients had little difficulty in navigating and performing simple life activities in a VE, had no significant increase in simulator sickness-related symptoms, and had no experiences that negatively affected their psychological and physical well-being. To some extent, patients felt present in the VE, perceived that objects appeared realistic and moved naturally, and generally felt in control of the interaction.

A study (Panganiban et al., 2023) on the feasibility of detecting mild cognitive impairment (MCI) through long-term cognitive monitoring or repeated assessment also noted several considerations from the literature for the design of such applications. These considerations included (a) the physical and cognitive limitations of the target users; (b) the cultural aspect of the virtual environment; (c) the cognitive assessment aspect; (d) the utilization of the three-dimensional aspect of VR; and (e) the repeatability aspect of the VR application. Designing an application with these considerations in mind might allow a VR application to be personalized and gamified for a specific demographic for healthcare, particularly for cognitive monitoring.

Previous research had attempted to create tools to aid in the design of VEs based on real-world locations. One such tool was the BENOGO Place Probe (Benyon et al., 2006), which aims to capture the sense of place from a specific location in a form that is useful for VE designers. The Place Probe elicits information on three areas of insight: general impressions, key features, and the feelings of presence while being in a particular place. Results from (Benyon et al., 2006) suggested that similar experiences between the actual and simulated environments were achieved with the help of the Place Probe. The Place Probe was able to identify features common to both virtual and real-world environments, and the features in the VE that deviated from the experience of its real-world counterpart. This made the Place Probe a useful method of exploring virtual and actual environments that may contribute insights into designing VEs.

A review study (Martinho et al., 2020) tackling the current state of gamification and related techniques observed that applications designed for elderly populations utilized similar gamification techniques and game design elements. Combining the elements of

feedback, progression, time constraints, and score game design provided an effective and real-time indicator of performance. This was common among applications designed for training purposes to motivate and encourage a user to participate. Alternatively, the combination of feedback, progression, reward, and social interaction was used by applications designed to enhance relaxed gameplay. Rather than using time constraints or a score track that might encourage competitiveness, entertaining features using the latter combination are used to improve both individual and collective gameplay.

Considerations relevant to the Philippine setting were noted in a previous study (Anlacan et al., 2023) on a VR prototype application to address BPSD in Filipino patients with dementia. The prototype revolved around a user's experience of visiting a familiar place and engaging in recreational activities while being accompanied and guided by a virtual companion throughout the experience. Its gameplay followed a smooth progression with well-structured storytelling. The results of this study suggested that it is feasible and that there is potential for the use of VR therapy for elderly patients with BPSD in the Philippines. The authors pointed out design considerations that should be incorporated into the application's overall design for future VR studies, such as easy-to-use instruments, a user-friendly interface, and captivating gameplay with respect to the target population's familiarity, comfort, and safety while in the simulated environment.

3 METHODOLOGY

This section discusses the architecture and overall design of the developed VR game and its game flow and setup for application testing.

3.1 Participants and Focus Group Discussion

A sample (n = 9) of healthcare workers with experience with PLWD, game designers, and game developers were recruited to experience the VR game prototype (see Table 1). The participants had a mean age of 35.11 (16.96) years, and most were female (66.7%) and were licensed healthcare professionals (55.56%).

Each participant experienced the VR prototype at least once. A focus group discussion (FGD) was then conducted following the prototype testing. The goals of the FGD were (a) to describe the participants' experience using the VR prototype, (b) to discuss how the application may help PLWDs, and (c) to make recommendations to improve the virtual experience.

Table 1: Participant characteristics during the application testing session (n = 9).

Variable	**n = 9 (%)**
Age (in years), M (SD)	35.11 (16.96%)
Sex	
Male	3 (33.33%)
Female	6 (66.67%)
Field	
Healthcare or rehabilitation	5 (55.56%)
Computer science or game development	4 (44.44%)

3.2 VR Therapy Game

The VR game prototype described in this paper contained improvements from the VR game developed and discussed in a previous publication (Anlacan et al., 2023). The target population of this application are the older persons with mild to moderate dementia. The experience in this improved prototype still revolved around visiting a familiar or historical place to relax and to invoke pleasant memories about the simulated environment and activities.

3.2.1 Features

Virtual Companion and Observation/Control Module. The virtual companion was designed with the appearance/form of a child, and was piloted and voiced in real time by a trained therapist. The companion guided the participant throughout the experience by communicating directions, making spontaneous conversations, and moving in a predefined animation by pointing and cheering) through the observation/control module. These features were intended to give the companion a more human-like interaction to make the experience more natural and sociable. Other features on the observation module included the guide for the flow of the session, a companion animation wheel, a timer, a view of the participant in real time, and the participant's view of the VE. The interface of the Observation/Control Module as viewed by the therapist is shown in figure 1.

Initiator. An area called the "Initiator" was designed to familiarize the participants with the virtual world and its interface. It functioned as an introduction to the VR user interface. And served as a tutorial: a venue to practice hand gestures and object interaction before the actual VR game. The initiator had minimal visual and auditory triggers in its structural design to help the participants adapt to the VE. A

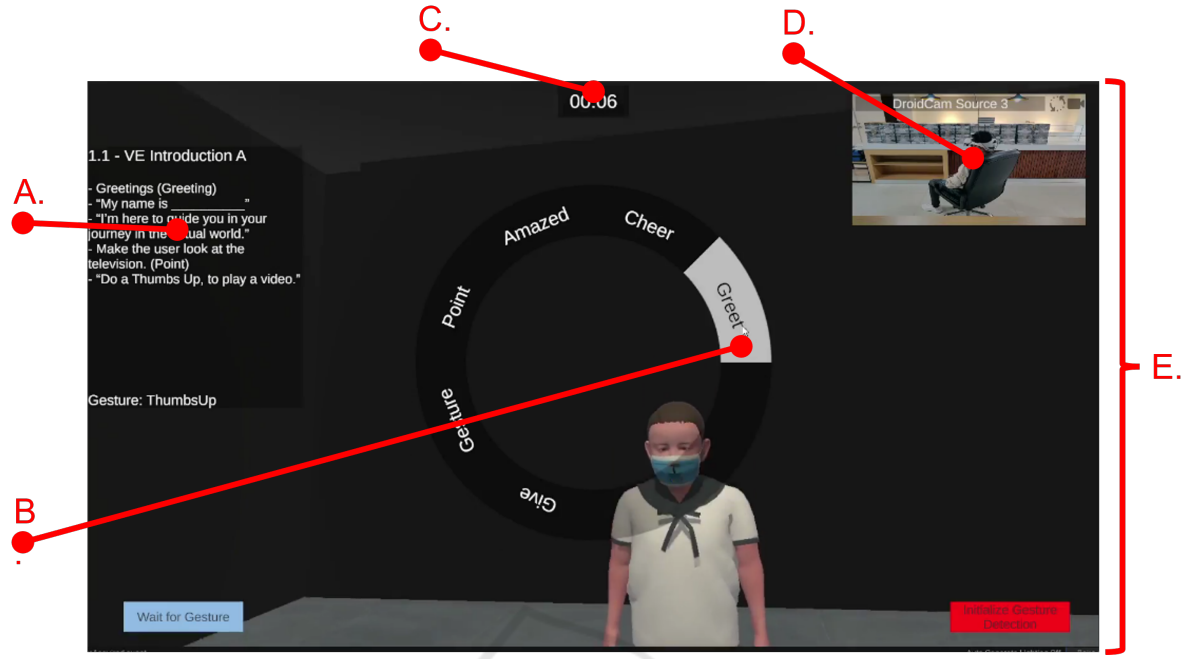

Figure 1: Observation Module (as viewed by the therapist). (A) Guide for the flow of the session, (B) companion animation wheel, (C) timer, (D) view of the participant in real-time, (E) participant's view of the VE without the module interface A to D, and (F) the boy in white is the virtual companion.

demonstration of the design and activities in the Initiator is shown in figure 2.

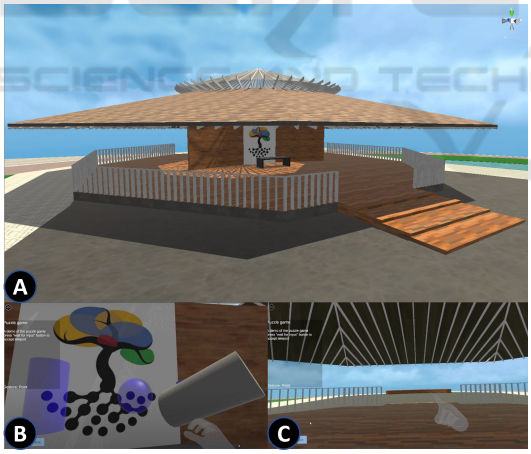

Figure 2: (A) The location of the initiator. (B) Participant matching objects at the initiator. (C) Teleportation tutorial at the initiator.

Hand Tracking and Gestures. Utilizing the Oculus Quest 2 features, the game adopted hand tracking, which is the real-time tracking of a user's hand and projecting its movements to the virtual world. Hand tracking enabled the participants to interact with objects using their physical hands. This feature freed the participant's hands from contraptions/ trackers which PLWD might perceive as cumbersome or uncomfortable. Moreover, hand tracking also enabled the use of hand gestures to prompt the system or trigger an event. Through hand gestures, the user might move from one place to another by pointing their index finger, and trigger events using a thumb-up hand gesture. These gestures were taught to the participant in the initiator and were utilized throughout the experience. A demonstration of hand tracking is shown in figure 3.

3.2.2 Places in the Virtual Environment

Waiting Room. The waiting room was where the participants were teleported after the initiator. It was depicted as an enclosed space with black walls and a floating television screen in front of the participants. The virtual companion was introduced in this room, and an introductory video about the VE was shown on the floating screen. Once the video finishes playing, the surrounding black walls dissolve, revealing the Rizal Park VE. The participants returned to this room after completing all the activities in the VE, signified by the build-up of the black walls. A demonstration of the design and activity in the Waiting Room is shown in figure 4.

Rizal Park VE. The Rizal Park VE was the main setting where the participants could move around to explore or perform recreational activities. It utilized a 360° image of Rizal Park as the background while

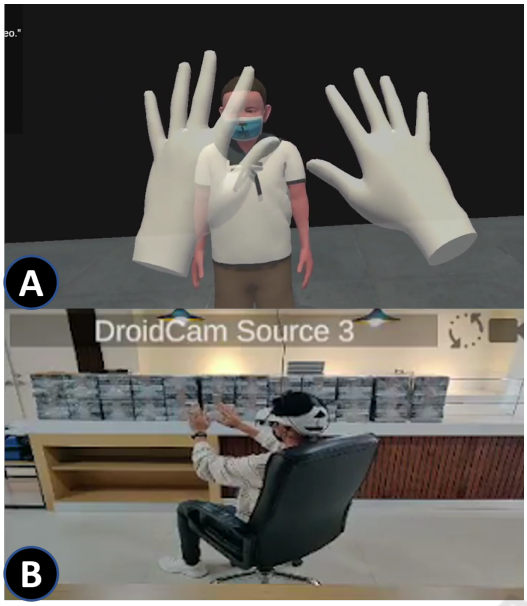

Figure 3: (A) (A) Participant's virtual hand as viewed by the participant in the virtual environment. (B) Participant in the real life as viewed by the therapist in the Observation/Control Module.

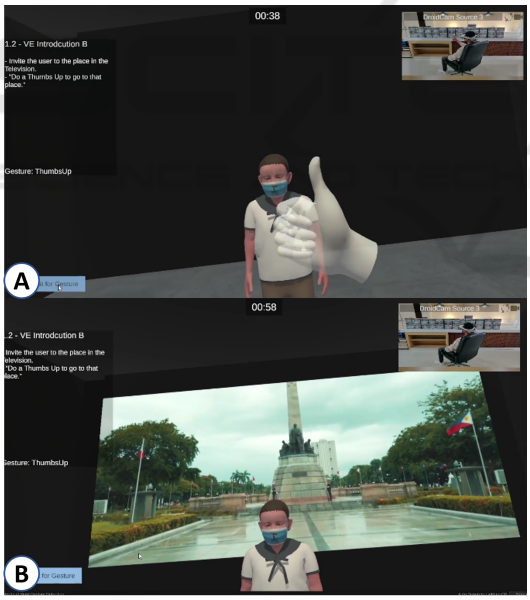

Figure 4: (A) The virtual companion in the Waiting Room. (B) Introductory Video in the waiting room.

some of the landmarks and structures were added as generated virtual objects. The Place Probe (Benyon et al., 2006) was utilized to capture the essence of the park and create a more convincing VE. The resulting VE was depicted as an open space with visual and auditory triggers consistent with the ambiance of its real-world counterpart in Manila, Philippines. A demonstration of the design of the Rizal Park VE and its real-world counterpart is shown in figure 5.

This location was chosen due to its significance and popularity among Filipinos. The park was named after the Philippine national hero, Dr. José Rizal, who was executed in the exact location. His execution fanned the flames of national independence from Spain.

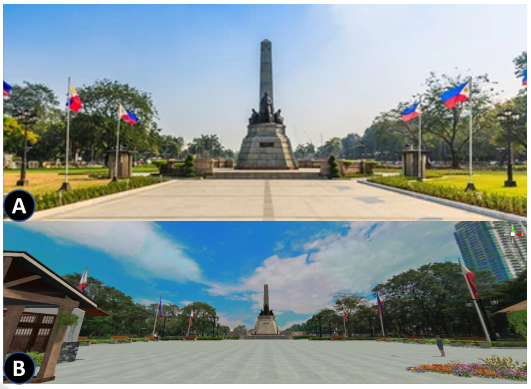

Figure 5: (A) Rizal Park at Manila, Phillipines. (B) Rizal Park Virtual Environment.

Avatar Room. The avatar room was the first of three booths depicted in the Rizal Park VE. This was where the participants selected what their avatar wore throughout the experience. The room was an enclosed structure with Filipino-inspired architectural design. This provided security and comfort for the participant while performing the sensitive activity. The clothes selection was also inspired by traditional Filipino dresses and accessories. A demonstration of the design and activity in the Avatar Room is shown in figure 6.

*Painting Booth.*The painting booth was the second of three booths depicted in the Rizal Park VE, and the first booth that offered a recreational activity. In this booth, the participants engaged in a painting activity where they were tasked to add color to the white flowers presented in the middle of the room using a virtual paintbrush. The vase containing the flowers could be rotated by tapping one of its four handles. This booth was designed as a roofed open space with Filipino-inspired architectural design surrounded by a garden of flowers and flying butterflies. A demonstration of the design and activity in the Painting Booth is shown in figure 7.

Puzzle Booth. The puzzle booth was the last booth depicted in the Rizal Park VE, and the second booth that offered a recreational activity. Participants were tasked to assemble a car by grabbing a car part and matching the piece to its correct placement on the car, a task analogous with assembling a puzzle. The booth

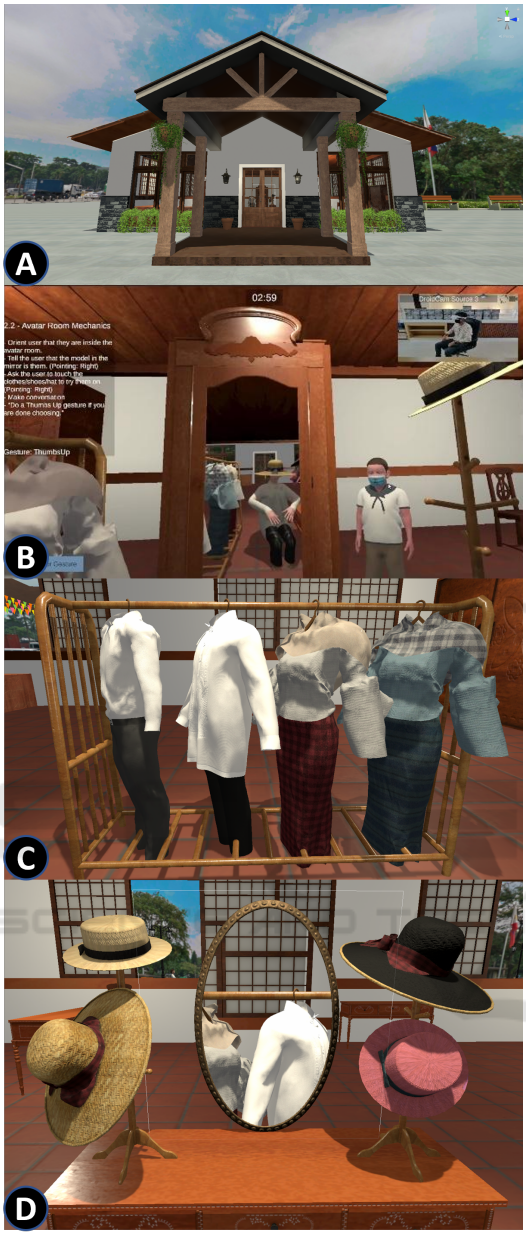

Figure 6: (A) Exterior design of the Avatar Room. (B) User changing clothes inside the Avatar Room. (C) Outfit selection (left of the participant) and (D) hat selection (right of the participant).

was also designed to be a roofed open space, depicting car parts and tools similar to a typical auto repair shop in the Philippines. A demonstration of the design and activity in the Puzzle Booth is shown in figure 8.

Figure 7: Painting Booth in the Rizal Park VE.

Figure 8: Puzzle Booth in the Rizal Park VE.

3.3 VR Testing Setup and Flow

A small testing setup was built at the University of the Philippines Manila - College of Allied Medical Professions (UPM-CAMP) and at the University of the Philippines Diliman - Alumni Engineers Centennial Hall. This setup consisted of a $9m^2$ ($3m \times 3m$) "play area" for the participant and a workstation for a therapist who was trained to administer the VR experience and a researcher who observed the testing

sessions. The therapist supervised the session using a laptop computer with an observation/control module. Through this module, the therapist managed the application parameters, oversaw the therapy from the participant's point of view, and guided the participant throughout the experience. Figure 9 shows an overview of the clinic setup.

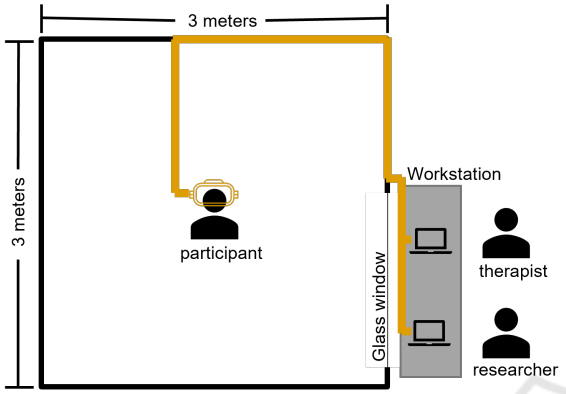

Figure 9: Application Testing Clinic Setup.

The VR head-mounted display (VR HMD) (Oculus Quest 2, 128 GB storage), which was tethered to a laptop (Nitro AN515-45, AMD Ryzen 7 5800H, 16GB RAM, Windows 11 g4-bit) was used by the participant to view and interact with the VE. Before the experiment, researchers orientated the participants on the VR HMD and the proper use and handling of the device. The participant was then seated on a stable swivel chair and was asked to remain seated throughout the experiment. The experiment started after the user successfully put on the VR HMD and earphones with the assistance of the researchers, and ended upon the participant's completion of all activities and the removal of the HMD. An overview of the flow of activities in the VR Game prototype is shown in figure 10.

4 RESULTS AND DISCUSSION

This section discusses the insights and recommendations of health and game design professionals during the FGD regarding the architecture and overall design of the developed VR game prototype for the target population.

4.1 User Interface

A common feature that the participants appreciated was the use of hand gestures instead of handheld controllers to interact with the VE. A participant explained that patients with dementia may have difficulty in using handheld controllers, especially if they are not familiar with the technology. Another participant appreciated that, instead of all the instructions being given before the session, instructions on the hand gestures were simultaneously given throughout the experience at the Initiator. Despite these positive comments, the hand gestures still required improvement. Participants still encountered difficulties in accurately using it for teleporting and interacting with objects within the VE. This was a hardware limitation and gesture flaw that will be improved in future VR HMDs.

Another characteristic that the participants appreciated was the light weight of the headset. Only one participant expressed discomfort while wearing the headset, but noted that it was the only source of discomfort throughout the VR experience.

Lastly, the participant who served as the therapist administering the VR experience praised the observation/control module for its user-friendly interface, stating that it was easy to learn regardless of one's level of familiarity with technology. However, they hoped that more interactions between the virtual companion and the patient could be added.

Aside from the negative experiences noted above, a participant also raised a concern on the use of earphones for elderly patients. They mentioned that one of their elderly relatives was averse to using earphones and that other elderly patients may react similarly.

4.2 User Experience

The participants had positive experiences with one or more components of the VE. Overall, the painting activity was the most favored activity by the participants, especially with respect to its use as a therapy activity for patients with PLWD. Notable quotes from the participants are displayed in table 2.

4.2.1 Initiator

The participants positively reacted to the addition of a tutorial before the VR experience since it helped in self-orientation within the VE. The activity was simple, structured, and had definite correct answers, which would be helpful for PLWD. The initiator also encouraged (upper body) movement, which one of the participants appreciated.

4.2.2 Waiting Room

Two participants selected the waiting room as their favorite part of the VR experience because it helped prepare them for the main environment. They felt excited

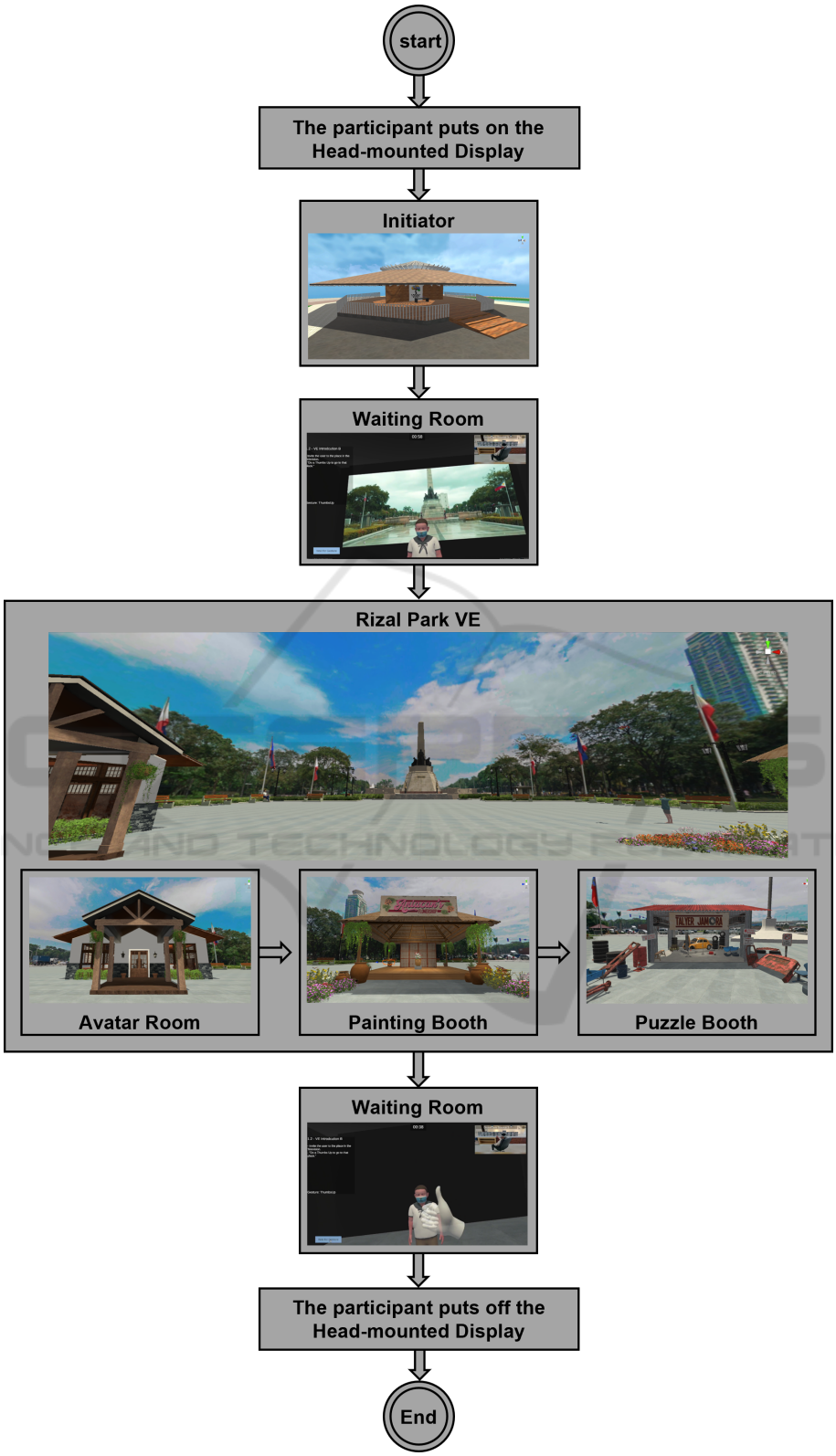

Figure 10: Flow of the activities in the VR Game prototype.

and nostalgic after watching the introductory video. One participant likened the waiting room to feeling like sitting in a movie theater or in a car traveling to a destination because it was comfortable and relaxing.

4.2.3 Rizal Park Virtual Environment

Participants appreciated the choice of setting for the main environment where the activities took place. As one participant noted, it was a good choice if the goal was reminiscence or cognitive stimulation; especially if the patients were familiar with the place. Seeing a familiar place may help make it easier to feel secure in a virtual setting, especially for first-time users.

4.2.4 Avatar Room

Participants mainly had good experiences with the dress-up activity, and some also chose it as one of their favorite activities. The activity was simple and memorable. It was a pleasant experience to choose the clothes that they wanted their avatar to wear. A participant noted that being able to choose their own clothes could make patients more interested in the experience. Moreover, this could also be an opportunity for them to have conversations about their feelings and past experiences.

4.2.5 Painting Activity

Many participants enjoyed the painting activity, saying that it was fun and they felt satisfied when they completed it. The healthcare professionals in the group particularly appreciated the painting activity for the sense of accomplishment it could provide PLWD. The design of the task would enable a patient to complete the activity since it was simple, structured, and had clear instructions. Many patients with dementia find it difficult to do everyday tasks, so the easy and straightforward nature of the activity could also help with their self-esteem.

The activity was also praised for its physically stimulating elements. Throughout this activity, target patients could move their hands to reach for certain objects. These movements could challenge balance and would require extra physical effort to perform. Aside from physical stimulation, target patients could also be mentally stimulated by the activity. The activity might provide a sense of independence by giving them opportunities to make choices, such as deciding what colors to use or what colors to put next to each other. This activity might also give the opportunity for therapists to engage patients in natural conversations.

Participants felt that the painting activity was similar to current non-pharmacological therapy activities for PLWD. They felt that the virtual activity was able to synchronize with coloring book activities that they often do with patients.

Minor difficulties were encountered when the participants performed the activity. For one participant, the grip on the paintbrush felt unnatural since it was not similar to how a paintbrush would be held in real life. Many participants also found it challenging to turn the vase, stating that patients may also feel frustrated. They suggested a more user-friendly interface for moving the vase in future iterations.

4.2.6 Puzzle Activity

The participants viewed the puzzle activity as an activity that could be particularly engaging for patients with interest in cars. Although some participants appreciated the activity, many felt that it still had room for improvement, particularly in making the activity feel familiar to patients without experience with or interest in cars. One participant attributed their low preference for the activity to technical aspects of the experience, such as the interaction with the virtual objects and the lack of key sound effects.

4.3 Sensory Elements

4.3.1 Visual Elements

The majority of the visual elements identified were from the main Rizal Park environment: the overall design, the background characters/objects, and the landmarks depicted.

The participants appreciated the overall design of the environment. The structures and objects appeared Filipino and old-fashioned, such as the choice of car model for the car (puzzle) activity and the architecture of the flower shop (painting booth). For the flower shop, a participant said: “It had the same feeling for me as visiting an ancestral home.” For the participants, these design choices were cohesive for the entire environment and added an element of familiarity.

Participants also liked the addition of background characters in the environment, such as the child flying a kite in the environment of the park. They felt that this character added a human element to the environment and made it feel less lonely. One participant, in particular, felt nostalgic and recalled their childhood upon seeing the character. The majority of the participants suggested the inclusion of more characters, each with a different personality.

Landmarks, background objects (e.g., flags, traffic), and even the lighting of the environment was also noted by the participants. These elements made the

Table 2: Notable quotes from participants for each location/activity in the VE.

Location/Activity	Quote
Initiator	Participant 8: "It's one thing for someone to talk to you and to orient you (about the VR game), but it's another thing to actually experience it (while instructing you)."
Rizal Park VE	Participant 5: "It serves as your first impression of the virtual environment. Even though it's new because it's your first time to enter a virtual environment, the fact that it is Luneta Park would make it feel familiar and, at the same time, I assume it would make it easier to feel secure in the new environment."
Avatar Room	Participant 1: "If we want it to be like reminiscence therapy, it could be a venue for them to share their experiences and talk about their feelings. I think that the ability to change how they look like, the designs of the clothes, and the things that they wear could be really good conversation starter for them."
Painting Activity	Participant 7: "There's an element of easy winnability to the activity. It's a feature that I sometimes use for some of my patients to raise their self-esteem. A lot of activities of daily living, chores and other activities are already difficult for them, so it would be good for them to have a task that is winnable."
Puzzle Activity	Participant 3: "The car activity feels like it does the same job as the painting of the flowers. But I think the car activity does not feel as good as the flower activity because the latter is a better way of moving your hands around during an activity."

environment appear more realistic and recognizable as Rizal Park.

4.3.2 Auditory Elements

The most common auditory element that the participants described was the therapist's voice. The therapist's involvement as an instructor and guide would also be helpful to patients. According to the participants, the therapist's voice could make the experience familiar, stimulating, and engaging. The real-time delivery of scripted instructions would allow the therapist to adjust instructions or their approach to accommodate a patient's level of understanding and cognition.

Participants had mostly positive comments on the sound effects of the VE, particularly for the sound effects associated with the painting activity. However, one participant reported that the ending sound effect of the painting activity shocked them. They suggested that the effect could be turned down. In contrast, they noted that the puzzle activity could be improved by adding more key sound effects.

4.4 Safety

A few positive comments were made regarding patient safety during the VR experience. One participant appreciated that patients would be seated while interacting with the VE since it minimize the risk of falling. Another participant, who declared easily having motion sickness, commented that they did not experience any dizziness or nausea despite freely turning their head during the 15-20 minute VR session.

5 CONCLUSION

This study developed a personalized VR game prototype and provided an in-depth analysis regarding its architecture and overall design for the use of PLWD in the Philippines. The researchers acquired valuable insights and recommendations regarding the user interface, user experience, sensory elements, and safety of the game for future development and possible implementation. Critical points discussed in this paper might be used or adopted for personalized VR applications in future studies for healthcare, particularly for persons with chronic and progressive diseases like dementia.

ACKNOWLEDGEMENTS

The authors of this paper would like to give acknowledgement to the Republic of the Philippines Department of Science and Technology (DOST) Philippine Council for Health Research and Development (PCHRD) for funding this research.

REFERENCES

Andringa, G., Nuijten, P., Macville, M., Mertens, E., Kaptein, J., Bauer, A., van den Doel, L., and Roos, A. (2019). Feasibility of virtual reality in elderly with dementia. In *Dementia Lab Conference*, pages 146–149. Springer.

Anlacan, V. M. M., Jamora, R. D. G., Pangilinan, A. C. F., Salido, I. T. O., Jacinto, M. E. V., Tee, M. L., Aguila, M. E. R., Tee, C. A., and Caro, J. D. (2023). Application design for a virtual reality therapy game for patients with behavioral and psychological symptoms of dementia. In *Novel & Intelligent Digital Systems Conferences*, pages 149–160. Springer.

Appel, L., Kisonas, E., Appel, E., Klein, J., Bartlett, D., Rosenberg, J., Smith, C. N., et al. (2021). Administering virtual reality therapy to manage behavioral and psychological symptoms in patients with dementia admitted to an acute care hospital: results of a pilot study. *JMIR formative research*, 5(2):e22406.

Benyon, D., Smyth, M., O'Neill, S., McCall, R., and Carroll, F. (2006). The place probe: Exploring a sense of place in real and virtual environments.

Czech, O., Wrzeciono, A., Bat'alík, B., Szczepańska-Gieracha, S.-G., Malicka, I., and Rutkowski, S. (2022). Virtual reality intervention as a support method during wound care and rehabilitation after burns: A systematic review and meta-analysis. *Complementary Therapies in Medicine*, page 102837.

Eijlers, R., Utens, E. M., Staals, L. M., de Nijs, P. F., Berghmans, J. M., Wijnen, R. M., Hillegers, M. H., Dierckx, B., and Legerstee, J. S. (2019). Meta-analysis: systematic review and meta-analysis of virtual reality in pediatrics: effects on pain and anxiety. *Anesthesia and analgesia*, 129(5):1344.

Elvey, S. (2016). Scientists using virtual reality for early diagnosis of parkinson's, alzheimer's and ms. EXPRESS.CO.UK https://tinyurl.com/4b9729rr.

Flynn, D., Van Schaik, P., Blackman, T., Femcott, C., Hobbs, B., and Calderon, C. (2003). Developing a virtual reality–based methodology for people with dementia: a feasibility study. *CyberPsychology & Behavior*, 6(6):591–611.

Garcia, L., Kartolo, A., and Méthot-Curtis, E. (2012). A discussion of the use of virtual reality in dementia. *Virtual reality in psychological, medical and pedagogical applications*, pages 123–136.

Griffiths, S. (2016). Terrifying 'dementia tour' reveals what it's like to suffer from the condition: Experience uses gloves and glasses to rob people of their senses and recreate fear patients feel. dailymail.co.uk https://tinyurl.com/4pv6vwvf.

Huntsman, M. (2014). How a virtual reality forest helps alzheimer's patients. Alzheimers.net https://tinyurl.com/5xxtykpv.

Kales, H. C., Gitlin, L. N., and Lyketsos, C. G. (2015). Assessment and management of behavioral and psychological symptoms of dementia. *Bmj*, 350.

Martinho, D., Carneiro, J., Corchado, J. M., and Marreiros, G. (2020). A systematic review of gamification techniques applied to elderly care. *Artificial Intelligence Review*, 53(7):4863–4901.

Moreno, A., Wall, K. J., Thangavelu, K., Craven, L., Ward, E., and Dissanayaka, N. N. (2019). A systematic review of the use of virtual reality and its effects on cognition in individuals with neurocognitive disorders. *Alzheimer's & Dementia: Translational Research & Clinical Interventions*, 5:834–850.

Panganiban, A. C. F., Caro, J. D., Juayong, R. A. B., and Anlacan, V. M. M. (2023). Design strategies on virtual reality for cognitive monitoring of older persons. In *Novel & Intelligent Digital Systems Conferences*, pages 232–241. Springer.

Pourmand, A., Davis, S., Marchak, A., Whiteside, T., and Sikka, N. (2018). Virtual reality as a clinical tool for pain management. *Current pain and headache reports*, 22(8):1–6.

Prince, M. J., Wimo, A., Guerchet, M. M., Ali, G. C., Wu, Y.-T., and Prina, M. (2015). World alzheimer report 2015-the global impact of dementia: An analysis of prevalence, incidence, cost and trends.

Wechsler, T. F., Kümpers, F., and Mühlberger, A. (2019). Inferiority or even superiority of virtual reality exposure therapy in phobias?—a systematic review and quantitative meta-analysis on randomized controlled trials specifically comparing the efficacy of virtual reality exposure to gold standard in vivo exposure in agoraphobia, specific phobia, and social phobia. *Frontiers in psychology*, page 1758.

Wittkopf, P. G., Lloyd, D. M., Coe, O., Yacoobali, S., and Billington, J. (2020). The effect of interactive virtual reality on pain perception: a systematic review of clinical studies. *Disability and rehabilitation*, 42(26):3722–3733.

World-Health-Organization (2022). Dementia. who.int https://www.who.int/news-room/fact-sheets/detail/dementia.