Designing a Naturalistic and Interactive VR Museum Environment With a Realistic Avatar as a Guide for Cognitive Treatment of the Elderly

Amir Bani Saeed
Department of Biomedical Engineering
University of Manitoba
Winnipeg, Canada
banisaea@myumanitoba.ca

Zahra Moussavi
Department of Biomedical Engineering
University of Manitoba
Winnipeg, Canada
Zahra.Moussavi@umanitoba.ca

***Abstract*—This project introduces a virtual reality (VR) museum designed to help individuals with cognitive impairments and memory-related challenges. A realistic avatar, created using Character Creator and animated with iClone's AccuLip tool, acts as a guide to engage users in interactive museum tours and memory exercises. The environment, which is modeled in Blender and integrated into Unity, offers an immersive experience. Users navigate the environment with the Oculus Rift, receive explanations about exhibits, and participate in recall challenges that strengthen cognitive function. A performance tracking system records user interactions, response accuracy, and time spent on tasks, providing insights into cognitive progress. By combining VR with interactive storytelling, this approach aims to improve cognitive function and reduce loneliness in the elderly. Future clinical trials will assess its effectiveness as a therapeutic tool.**

Keywords*— *Virtual Reality; Avatar; Cognitive impairment; Museum; loneliness.

I. INTRODUCTION

The utilization of avatars in virtual reality (VR) has emerged as a tool for addressing mental disorders, offering a unique opportunity to enhance therapeutic interventions. Previous research indicated that the usage of avatars contributed to mood change [1], self-compassion [2], and reduction in the severity of depression [3]. Despite the above advances, we still need a new generation of VR-based therapeutic methods that are automated and realistic. Recent advances in deep learning and computer vision have enabled VR systems to interactively react to humans, enhancing their realism and engagement. In this project, we focus on the development of a realistic avatar in a virtual museum to represent an individual as a guide and interact with patients. The ultimate application of this study is to utilize the naturalistic avatar of a person and a virtual museum for cognitive treatments of individuals with memory and cognitive impairments as well as depression due to loneliness.

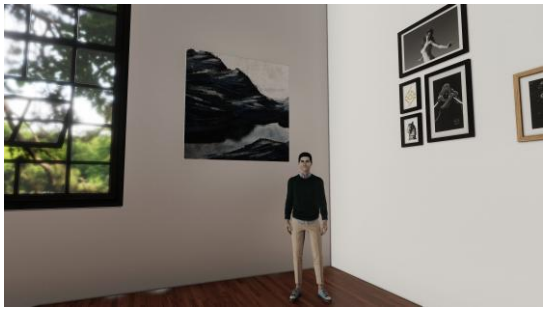

Figure 1. An avatar based on an individual's picture in the VR museum.

II. METHOD

The avatar creation process starts with capturing a high-quality headshot, which is transformed into a realistic 3D face using Character Creator software [4]. Rigging techniques are applied to facilitate natural movements, and facial expressions are synchronized with audio using iClone's AccuLip tool [5]. These animations are then integrated into Unity using Animation State Machines, avatar masks, and root motion, ensuring smooth transitions between gestures and expressions while maintaining lifelike behavior. This allows the avatar to guide users seamlessly through the museum, offering engaging and interactive experience.

The 3D museum environment is crafted using high-resolution reference images, which are imported into Blender for modeling, texturing, and lighting. The final product is a realistic museum with detailed exhibits and artifacts, ready for user interaction.

The game development process focuses on creating scenarios that engage users in exploring various exhibits, enhancing memory recall and cognitive skills. For example, in one scenario, the user enters a room filled with paintings, and the avatar provides detailed explanations of each piece, including information about the artist, era, and significance. Afterward, the user is guided to a room with sculptures, where the avatar offers similar insights. Once both rooms are explored, the avatar challenges the user to recall specific details, such as identifying which room a particular painting was in or answering questions about the painting itself. Throughout each scenario, the avatar offers step-by-step instructions and hints to ensure that users remain engaged and can effectively engage with the content.

The Oculus Rift is used to deliver immersive VR experience, allowing users to fully engage with the environment and exhibits. This VR integration enhances the effectiveness of cognitive training, enabling users to interact naturally with the exhibits and the avatar, therefore improving engagement and memory recall. To navigate in the virtual environment, users will utilize the Oculus Rift controllers, which provide intuitive control and interaction, ensuring a seamless and interactive experience.

The user's performance is carefully tracked and recorded at each step of the process, with checkpoints to log movements, time spent at each exhibit, and interactions. Detailed logs also capture the user's responses to avatar questions, accuracy in recalling information, the time taken to complete tasks, and how often hints are requested. This data helps assessing cognitive function and engagement. A scoring system will be implemented, with points awarded based on factors such as accuracy, successful task completion, time efficiency, recall ability without hints, and overall engagement with the exhibits. Penalties will be applied for errors, excessive time, or over-reliance on hints. A cumulative score reflects the user's overall performance, providing a measure of cognitive progress.

III. CONCLUSIONS

This project is currently under development, with ongoing work in both museum environment design and game development to ensure an engaging and interactive experience. It serves as the building block for a larger program aimed at utilizing VR to enhance cognitive impairment among the elderly. The next phase, which is itself a major project, will involve testing the game on people with cognitive impairments and analyzing the data in the future. This design is expected to be used in clinical trials to explore its potential for addressing cognitive impairments as well as depression due to isolation in the aging population.

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