Augmented Reality for Physical Rehabilitation

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Abstract

Past research has shown that in-home physical therapy contributes to prescribed patients not being able to properly execute effective actions due to no reassurance by a physical therapist, which tends to lead to increased pain or injury due to incorrect execution. As technological advances change the way rehabilitation is approached, the potential for Virtual Reality (VR) as a live physical therapy substitute has researchers focusing on measurable motor improvements, motivational and analgesic effects. Although, there has been little to no research done in regard to implementing Augmented Reality (AR) and Virtual Reality (VR) in a common marketplace for the general population to explore more in-home remedies. As a result, I designed an Augmented Reality (AR) environment that explores the potential for adopting Augmented Reality (AR) and Virtual Reality (VR) in a home setting for rehabilitation of the application's users. Moreover, I found that there was a knowledge and motivational barrier that initially stopped users from doing more in-home exercises, but while using the application users tended to enjoy the experience overall because they felt knowledgeable in terms of how to execute the desired movement. Ultimately, the conclusions drawn from the experiment support the case for Augmented Reality and Virtual Reality being a viable option going forward in rehabilitation services.

Keywords
Augmented Reality, Virtual Reality, Physical Rehabilitation, Home Rehabilitation, User Perspectives

I. Introduction

To master movements crucial to physical activities repetition is key. Executing these movements correctly and efficiently can take endless amounts of time and practice to successfully become proficient in that specific matter. It also tends to require guidance from an expert in the subject matter [1].

Although, given all of the technological advancements over the past 20 years, the internet has given many people access to abundant amounts of information that can be used to learn various concepts and skills. However, this information cannot provide real-time feedback and that is where applications using Augmented Reality (AR) and/or Virtual Reality (VR) can step in and bridge that discrepancy. Hardware such as the Microsoft Kinect allows for tracking of physical elements such as a person's heart rate, facial expression, the position and orientation of 25 individual joints, the weight put on each limb, speed of player movements, and track gestures, which can be used in conjunction with software to provide a supplement real-time feedback solution.

II. Approach

The project approach was to produce an environment that allowed for users to receive in real-time feedback on how they were executing assigned physical exercises, while being able to see a mirrored image of themselves. Also, I wanted to compare the differences in gamified versus non-gamified platforms in relation to how it affects the user's motivation to use the application. From this query, I formed two variations of the system to compare user feedback overtime.

III. Experiment

a. Methods

I began by gathering all the application requirements as well as the user needs to determine the scope of the application and the target audience. I formulated a demo script as well as a user script for all my testing. Participants were asked to fill out a survey sharing their experiences with physical or occupational therapy and their adherence unsupervised in-home exercise regimens. Participants were then offered a lab visit where they could experience augmented reality with and without gamification meant for in-home development of balance

and coordination. I also did not instruct users that they had a score limit or time limit to complete the pilot. Instead, I let them play freely to determine if there was a correlation with how long users played given the type of system they were using, gamified or non-gamified. They were not expected to explain the circumstances or specifics of their previous experiences with physical or occupational therapy. A post-survey was then issued to the participant to share their perspectives on this experience. The scene I constructed used vectors which is key when calculating velocity and acceleration of a moving object and the forces acting on it (as shown in Figure 1). Using integrations for Microsoft Kinect 2 and HoloLens, I developed an application in the Unity3D game engine which transform the Kinect body tracking data into first-person space on the HoloLens (as shown in Figure 2).

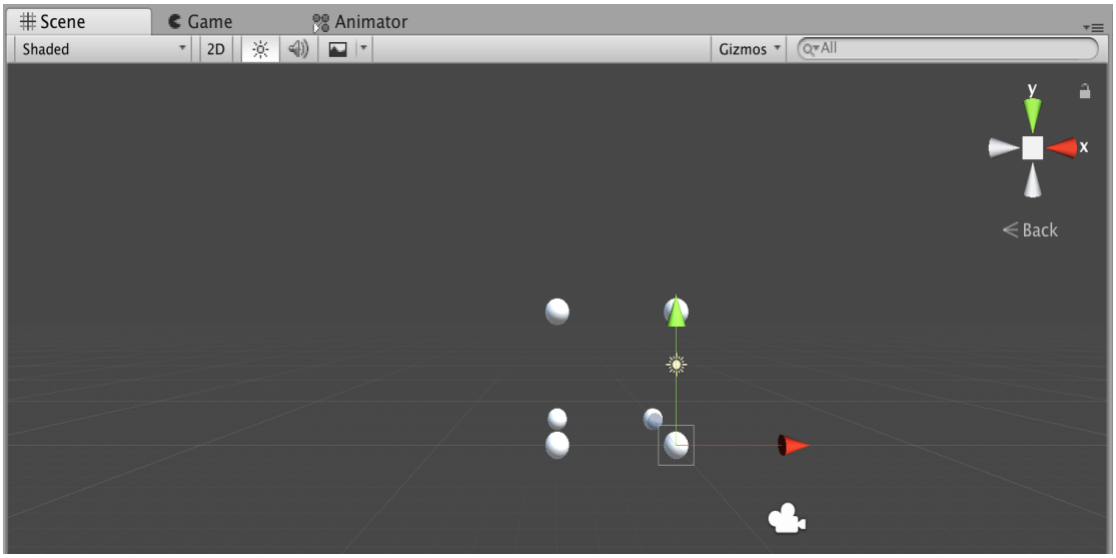

Figure 1: Spherical vectors replicating joints on a human body for tracking.

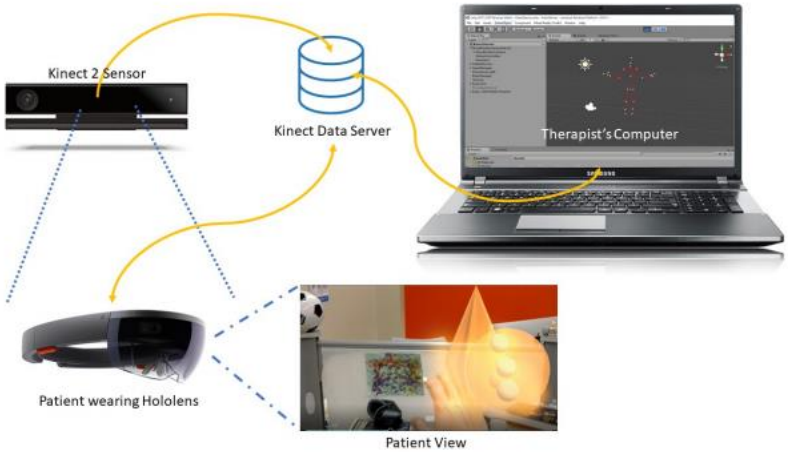

Figure 2: System diagram shows how the postural information from the Kinect is interpreted by the host machine and relayed to the HoloLens which communicates posture and limb targets to the participant.

b. Results

From the pilot, I gathered results that showed users liked the idea of having a system that should them how to correctly execute proper exercises. Moreover, I also discovered that the use of the gamified version of the system had no long-term affect on how long the users used the system, which confirms research done by scientist in the past in regard to motivation [2]. Most participants stated they would use the system in a home setting if available and often described the experience as "unique," "exciting," and "fun." Although, users did have initial technical disruptions and problems while using the HoloLens, which included not being able to use the built in Kinect and HoloLens navigation queues, properly fixating the HoloLens to their head, or not being able to see all in game elements properly.

IV. Analysis and Conclusion

In conclusion, most of the concerns I have in regard to Augmented Reality (AR) for physical rehabilitation comes from the limitations of the current hardware available, the large price gap for mainstream access, and moderately supported updates and features of the hardware for ease of use with other devices with lower specifications. Although, I believe the concept is good and as technology advances and more affordable options come to market it will make the concept more viable in everyday society.

References

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