Title: Immersive Physical Therapy Experience in Virtual Reality

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Introduction: This project involved the creation of an immersive physical therapy experience in virtual reality (VR) using 3D image reconstruction methods. This approach is relevant because COVID-19 has restricted access to in-person healthcare services and among those affected are patients requiring physical therapy.

Methods: The reconstruction of the static background used photogrammetry software to build spatial point clouds. The human model and exercise animations were reconstructed with a depth sensor, skeletal tracking software, and a rigging process in which the skeletal movements were applied to the physical therapist model.

Results: These background and exercise components were combined to form the VR experience in a headset, where the patient can successfully walk around and see the trainer in 3D, use functions such as play/pause and slow down, and see real-time annotations giving instructions for each exercise. Feedback was also incorporated into the program. Using an algorithm known as dynamic time warping, the program compares the trainer and patient's exercise performance regardless of the time difference. It outputs a mathematically calculated accuracy score between 0-100% based on the patient's form, technique, and speed.

Conclusions: The four features of the VR program: 3D space, real-time annotations, user interface, and feedback - make VR an effective approach to facilitate remote physical therapy sessions as it eliminates COVID-19 transmission risk, reduces chances of injury, and provides individualized experiences for patients. In the future, this project could be advanced by creating a real-time VR experience, where the input data is processed and feedback is available almost immediately for a more realistic and efficient patient and trainer interaction.

Keywords: Virtual Reality, immersive experience, physical therapy, dynamic time warping, photogrammetry, image reconstruction, skeletal tracking, real-time

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