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Developing a Game in Virtual Reality for Rehabilitation of Vestibular Hypofunction

The vestibular system includes parts of the inner ear and brain, and helps control balance and eye movements. Vestibular disorders, commonly caused by disease, aging, or injury, can severely impact the quality of life in those afflicted. Symptoms of this disorder typically include dizziness, vertigo, and vision disturbances, prompting affected individuals to seek physical therapy. Rehabilitation programs are vital for improving a person's quality of life and meeting certain goals like enhancing gaze stability, reducing vertigo, and increasing ease in performing daily activities. We created a virtual reality game to simulate the exercises that physical therapists use for this type of rehabilitation. Using virtual reality as a tool for therapy is an area that has been used to treat severe phobias, PTSD, etc., but has not been used as much for physical rehabilitation.

We used the Unity Game Engine and programmed the game using C#. The virtual reality hardware used was the HTC Vive. The game was based off exercises already used in therapy. The exercise we focused on is a gaze stabilization exercise in which users either raise their thumb and focus on it or focus on an "X" on the wall while turning their head from side to side. We simulated this exercise in virtual reality to provide users with a more interactive environment, and to give the physical therapist error-free results. Rather than the thumb, users focus on a cube that floats in front of them while turning their head 25 degrees side to side. If users raise or lower their head past a 15 degree limit, the game does not let the user continue and prompts them to adjust their head. After users are finished with the exercise, they are asked to rate their level of dizziness. If they rate their dizziness between 0-3 on a scale of 0-10, they may progress to the next level. However, if they rate their dizziness as anywhere between 4-10, they cannot progress and the therapist will decide further action.

There are three levels in this game. Each level increases in the number of distractions, making the game more difficult as it progresses. The first level requires the user to sit down and perform the gaze stabilization exercise in a distraction-free room. The second level has the user perform the exercise standing up and introduces disorienting, flickering lights. The third level features a checkerboard wall, which further distracts the user amidst even harsher lighting. In addition to the built-in features of the virtual environment, the physical therapist can input the amount of reps they would like the patient to perform for each level.

There is yet to be a test subject for the system; however, a questionnaire has been created for when subjects are approved and available for testing. The game is currently in a beta stage, where minor improvements are being made to add to the user's overall experience.

There has been an increase in the popularity of applying technology to various types of physical therapy. Most of this work has been done with Kinect for Xbox or the Nintendo Wii system. However, because the HTC Vive is placed directly on the person's field of view, it is more engaging than simply looking at a television. The game saves the patient's data, so therapists can review the data and evaluate a patient's progression. Additionally, the program provides a much more accurate measurement of head movements that a therapist would not be able to gauge simply by observing the patient. The program also makes the process of getting therapy much more appealing under the guise of being a highly interactive game.