



Developing a virtual reality rehabilitation system with hand tracking

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Abstract

This study investigates the application of hand-based exercises in VR to occupational therapy upper-limb rehabilitation. Hand tracking on the Oculus Quest 2 is used to support realistic interactions without controllers or gloves.

VR Rehabilitation



VR can increase rehabilitation effectiveness



Gamification benefits motivation, intensity, and engagement



Exercises in VR translate to real-world improvements



Allows for customised exercises, difficulty, and metrics per user

Methods

A VR hand-tracking-based interaction system was developed that supports various hand interactions including grasping, pinching, and gesturing to complete virtual activities. This system has been created to facilitate future development of patient and theme-specific VR games for hand rehabilitation.

User Testing

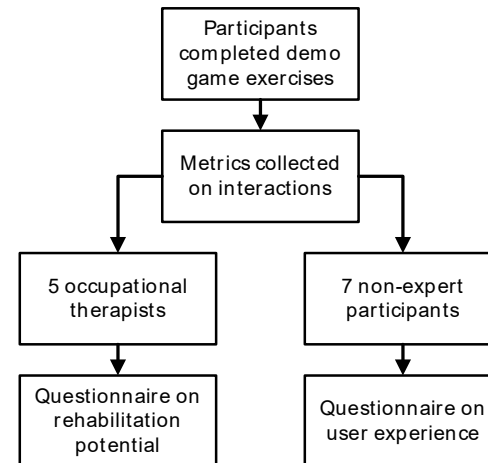
A proof-of-concept rehabilitation game was tested with non-expert (n=7) and expert occupational therapy (n=5) participants. Metrics were collected and participants filled out a short-response and Likert-scale questionnaire.

Instructions were delivered through an in-game screen. Participants completed tasks including:

- Picking up and placing objects of various shapes and sizes.
- Pinching bubbles between fingertips.
- Opening doors with handles.
- Tracing paths with shoulder movement.
- Making complex hand gestures.
- Pressing buttons.



Environment Interactions



Game Environment

Results

- **100%** of expert participants agreed the system had **potential for rehabilitation**.
- A System Usability Scale of 74.5 (Expert) and 88.92 (Non-Expert) indicates **very high usability**.
- **Recommended patient populations include stroke, burns, hand therapy, chronic pain, and orthopedic**.
- **30% of interactions failed** due to user error or tracking limitations.
- **Lack of physical feedback** and **tracking error** were identified as primary limitations.
- **100%** of participants found the system **engaging**.

Discussion

- Visual hand representation, audio-visual interaction cues, and 3d object design were vital to improving interaction quality and reducing confusion.
- Tracking error varies per user and can lead to frustration. Software filtering can mitigate this.
- In future works, this system will be tested with target patient populations in a functional environment.

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