On the Potential of Virtual Reality for Locomotion Rehabilitation

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Introduction: In recent years, we have witnessed a growing number of people needing locomotion rehabilitation (e.g. stroke). The inability to walk has tremendous effects on the individuals' wellbeing and quality of life, making locomotion rehabilitation a major component of physiotherapy. Virtual reality (VR) is a promising technology that has proven significant benefits in rehabilitation [1]. In this work, we built an immersive VR system, Locomotiver, aiming to support locomotion rehabilitation and fit physiotherapists' practices and patients' abilities.
Materials and Methods: Locomotiver consists in a VR environment that can be simultaneously used by both therapists and patients. The patient experiences a 360º immersive environment by using an HTC Vive headset and 4 trackers placed on both hands and feet. Through a secondary display, the physiotherapist has access to the patient's 3rd person or 1st person view, along with a graphical user interface to control the rehabilitation session. We designed a minimal representation of the virtual body, inspired by Kondo et al. [2], where the patients' head, hands, and feet are represented in the virtual world. Based on a series of formative studies, we created three exercises that can be personalized to fit the patients' abilities and session goals. First, the "Walking Forward", which require patients to walk within the bounds of a corridor without crossing its edges. Second, the "Barriers" exercise where patients have to go over a set of obstacles. Finally, the "Zigzag" exercise where patients are requested to walk around cones without touching them. Corrective feedback is given during the execution of exercises while therapists have access to a set of performance measures, which can then be leveraged to build personalize therapy plans. We conducted a usability study next to 9 physiotherapists using a think-aloud protocol, semi-structured interviews, and adoption questionnaires, aiming to understand Locomotiver's potential to be deployed in the field.
Results: All physiotherapists agreed that Locomotiver would be an innovative solution to their interventions and to increase patients' engagement. There was a consensus that Locomotiver was more suitable for patients with musculoskeletal disorders rather than neurological patients as the latter may experience proprioceptive challenges. Therapists also pointed that exercises need to allow further customization and collect additional performance data. Participants praised both the instruments and prototype, namely how fast and easy they were to set up, especially compared to other conventional systems in clinical practices. Overall, professionals highly rated their interest in adopting Locomotiver in their daily practice pointing benefits such as optimization of their methods, ease of customization, and improved diagnosis;
Discussion and Conclusions: We presented Locomotiver, an immersive VR system for locomotion rehabilitation that includes 3 customizable exercises. Results showed that professional therapists would be interested in adopting Locomotiver as a rehabilitation tool. This research contributes to highlight key challenges and opportunities when introducing immersive VR technologies in clinical rehabilitation practices.

References:
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