VR-based exergames for physical rehabilitation of back pain

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Keywords:

VR, Exergames, physical rehabilitation, back pain, serious games, AR

Introduction

Physical rehabilitation with the use of serious games is a well-known topic with many years of research. Likewise, the topic of using Virtual Reality (VR) for physical rehabilitation is also attracted some attention from researchers in the last few decades (Keshner, 2004). More recently Augmented Reality (AR) has also been a technology used for physical rehabilitation (Jin et al., 2019). However, the majority of works that employ VR or AR for physical rehabilitation are being carried out for upper limb physical rehabilitation or stroke patients (Aung and Al-Jumaily, 2012, Vieira et al., 2021, Phelan et al., 2021). Therefore, applications of VR and AR for lower limb and back pain require more work (Nagpal et al., 2022).

Exergames are a category of serious games for exercises during the physical rehabilitation process (Abd-Alrazaq et al., 2022). They can increase the motivation of patients and keep them engaged in the rehabilitation process (Adeel et al., 2022). As VR and AR technologies can be used for the physical rehabilitation of patients (Trombetta et al., 2017), they can be used in exergames for physical rehabilitation in larger settings.

In this work, we explore how VR-based exergames can be used for the physical rehabilitation of patients suffering from back pain. The application of VR technologies allows motivating patients to do these exercises at home and at their own pace. The record of their performance in doing these exercises would be available to physiotherapists and rheumatologists who can monitor the progress of the patients in their rehabilitation process.

Methodology

Exergames can employ AR, VR, or Extended Reality (XR) technologies. In the case of exergames aimed to help patients with back pain, rehabilitation requires exercises focused on that part of the body that might be different from exercises to deal with everything else. For example, some exercises that are related to back pain require the person to lay down or move their face and body in different directions, which is only possible by VR as it reduces the need to be screen-bounded. The most important factor of this study is to keep the patient engaged in the exergame so that they get an escape from their pain and their focus will be on playing the game and therefore doing their

exercises. Therefore, VR HMD (Head Mounted Display) gives us the option to captivate all the attention of the person and keep them engaged.

Another aspect of the exergame is to allow medical experts to monitor the patient's progress and give them feedback. Therefore, the game needs to capture the movement of the player's body. For that, motion capture from the camera-based device is used to track the progress of the patient. Figure 1 briefly show us the method which will be carried out in this research.

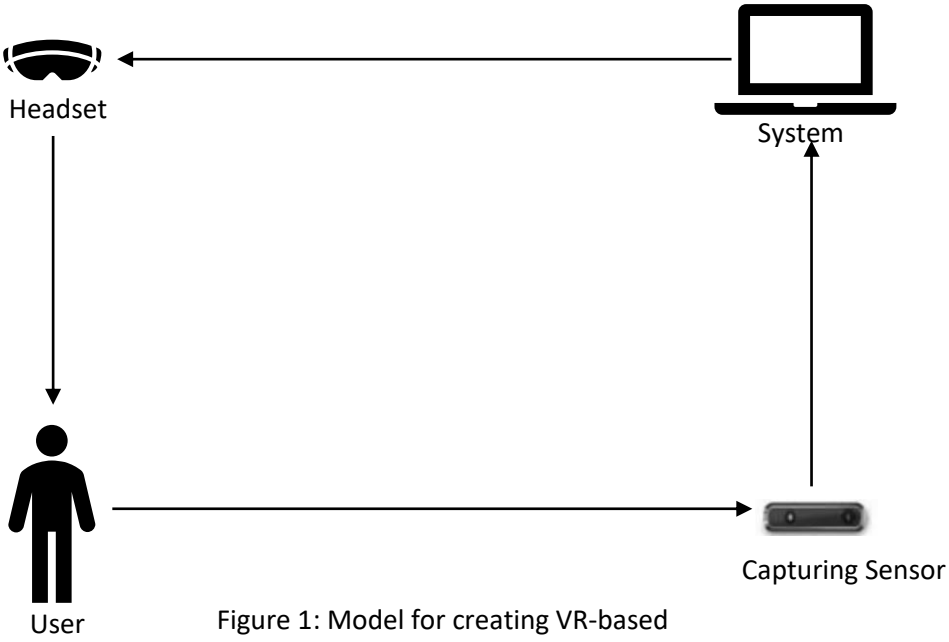

Figure 1: Model for creating VR-based exergame for back pain

In our experiments, we are using Azure Kinect for motion capture and a variety of VR headsets, such as VIVE, Oculus Rift, or Oculus Quest, with their controllers to augment or replace camera-based motion capture. The research involves testing various input techniques on our target group to find out whether the choice of headset is important in the process.

Our initial test shows that Oculus Quest allows for tracking hands data, and while it can be used for motion tracking, it is not useful for our research where tracking of the back of the patient is essential. Quest 2 controller allows for full body tracking, but our initial tests show the limited scope of using it for tracking the progress with exercises. Similar can be said about controllers for Oculus Rift and HTC VIVE. On the other hand, experiments on Azure Kinect show that, for many exercises, it is the best available option for motion capture, but even then, augmentation with the data from controllers is beneficial.

Conclusion

This work explores applications of VR for rehabilitation purposes in line with the prior works in this area. We have found that VR is beneficial for the physical rehabilitation of patients who have back pain. It provides escapism to patients from their pain as well as they will be doing their

exercises unconsciously. The exergame can motivate them to play it on daily basis. The only thing that is needed is a better way to capture the movement of the body. In that respect at this stage VR can also be merged with camera tracking can be used. In the future when better movement trackers are available then only VR will be back again solely.

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