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A Free Tool for Motor Rehabilitation: NeuroVR 1.5 with CamSpace

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Abstract. NeuroVR 1.5 is a cost-free virtual reality platform based on open-source components, allowing professionals to easily modify a virtual world, to best suit the needs of the clinical setting. The goal of the present project is to extend the functionalities of this platform by allowing users to interact with the virtual environment by using gestures detected by a webcam. To this end, we used CamSpace Beta 7, a cost-free and user-friendly computer vision technology. We describe how this integrated approach can be used to implement cognitive and motor training programs, involving partial or full-body movements.

Keywords. NeuroVR, CamSpace, open-source software, elderly, motor rehabilitation

Introduction

NeuroVR is a cost-free virtual reality platform, designed to allow non-expert users to easily modify a virtual environment (VE) and run it using an immersive or non-immersive system [1].

The updated version of this tool (NeuroVR 1.5) includes new features, such as new virtual environments, cheaper hardware components and more possibilities for personalization. The possibility to customize the VEs, by introducing video and sounds reproducing the patient's real life contexts, is intended to facilitate the transfer of learning [2].

A limitation of the current NeuroVR interface is that the use of joypad or mouse is not easy for users with motor limitations, such as elderly or brain-injured patients. Further, the current interaction modalities with NeuroVR do not allow the creation of VR-based motor rehabilitation exercises.

To address these issues, we extended the functionalities of NeuroVR by allowing users to interact with the virtual environment by using gestures. To this end, we used CamSpace Beta 7, a cost-free and user-friendly computer vision technology.

The use of human gestures (hands and full body) to control activities into the virtual environment allows the user to overcome the limitations of age and disability.

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Further, this approach permits to design specific training exercises for motor rehabilitation and balance disorders [3].

1. Video capture technology for motor rehabilitation

Several video-capture gaming platforms have been developed for motor rehabilitation. One of the major developments was the release of VividGroup's Mandala Gesture Extreme (GX) platform in 1996, together with a suite of interactive, game-type environments. The platform has been adapted for applications in rehabilitation and been used to treat elderly patients who were unstable and at high risk for falling.

Later, Sony developed its very popular EyeToy application designed to be used with the PlayStation II platform. Compared to these commercial tools, CamSpace is a totally cost-free and highly flexible tool, as it needs only a pc and a webcam to work.

2. A clinical scenario

Mark is a stroke patient suffering from a mild neglect and upper-limb motor disabilities. A rehabilitation program for the recovery of neglect and motor functions was developed using NeuroVR and CamSpace.

Mark is asked to enter the NeuroVR park, and to walk along the central pathway (Figure 1). CamSpace Beta 7 has been configured in a way that, to move into the VE and to catch objects, the use of both arms is required (Figure 2). Some objects have been placed on the right and left sides of the path; the therapist encourages Mark to pay attention to these objects and to join his hands if the same object is present on both side. Since this movement is quite difficult for him, he can stop and take the time necessary to execute the movement. In the first trial, a sound appears on the left side when as a target is approached; the intensity of the sound is gradually reduced as the patient improves. The number of distracting and target objects can be progressively increased.

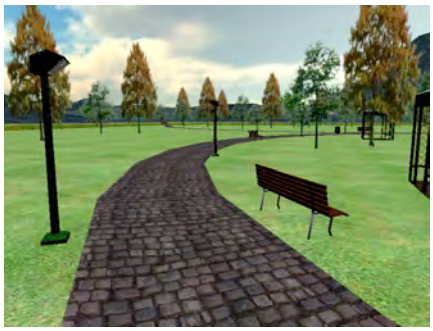

Figure 1. A screenshots of NeuroVR Park

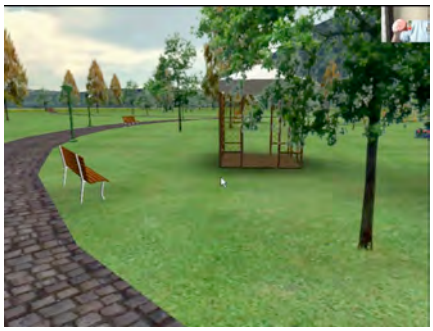

Figure 2. A screenshots of CamSpace applied to NeuroVR Park

3. Results and future work

Preliminary testing involved the following actions:

1. 360-degrees rotation;
2. Grasping an object with opponent fingers or hands;
3. Forward/backward movements.

Results of testing demonstrated the feasibility of the integration of CamSpace with NeuroVR. In particular, outcomes of evaluation indicated that actions 1-2 are fully working, while forward/backward movements require further adaptation. A demo clip of the application of CamSpace to NeuroVR is available.

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