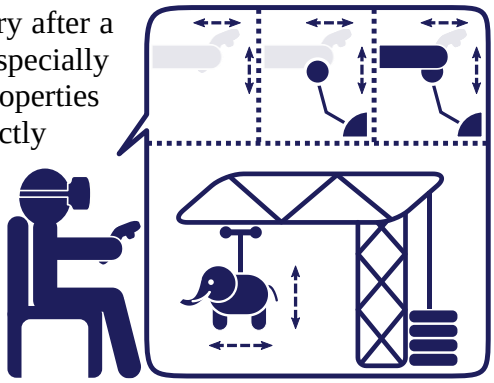
Movement visualization in immersive virtual reality for motor learning

Background:



The interest in using virtual reality (VR) for motor recovery after a brain injury has rapidly increased in the recent years, especially concerning immersive virtual reality (IVR). The inherent properties of these technologies and how each of them impacts directly (performance/learning) or indirectly (e.g., motivation) motor learning are not well defined. Especially regarding IVR offering a greater immersion away from the reality. One of this property is the movement visualization (MV).

Amongst all VR applications used for neurorehabilitation, a wide range of MV (indirect, abstract, avatar, etc.) are used, but only limited information can be extracted from theses studies. Even less is investigated regarding the impact of MV in IVR for motor learning. IVR completely occludes users' body, potentially giving more importance to the MV. On the other hand, IVR can direct users' attention to the same location of their own limb which could improve learning with specific MV type (e.g., users can embody an avatar potentially increasing learning due to mirror neurons activation).

Currently, a vast majority of rehabilitation applications are using indirect or abstract MVs. Most of these applications are delivered as games to increase participant motivation. Amongst other reasons, the choice of the MV could be due to advantages from a game design perspective. Restricting movements to be directly mapped on an avatar might lower the interaction possibilities and the variety of tasks as, for example, bringing all interactions in a small and near workspace.

The goal of this project is to investigate the impact of MV in IVR, considering the motor learning benefits and the game-design possibilities, measuring motor performance motivation. One strategy could be to have a task goal in far space but having virtual elements in near space that an avatar interacts with and that causes the interactions in far space (e.g., controlling a crane with levers).

Aims:

1. Literature research: Movement visualization and its impact in VR and IVR.
2. Study design: Design a study protocol aiming to investigate the impact of MV in IVR. Implementation of the experiment (creation of the virtual environment, interactions, and MV).
3. Pilot experiment: Conduct a pilot experiment on a small sample of healthy participants to valid the feasibility of the study or discover its weak spots.
4. (Optional: Full-size study - Data collection and analysis: Conduct an experiment on healthy participants. Statistical analysis of kinematics and subjective (questionnaires) data.)
5. Scientific reporting: Scientific reporting of the methods and results of the study.

Materials and Methods:

Game Engine (Unity3D) + HTC Vive HMD for the virtual reality development. Avatar animation and other plugins for immersive virtual reality are already available. HTC Vive controllers and trackers (with wearable orthosis) to record the movement for its real-time visualization or further analysis are available. Python/R notebook for data analysis. Basic scripts for data analysis are available from previous projects.

Requirements:

Programming knowledge. Experiences in one or several of the following topics are a plus: 3D environments; virtual reality; game engine; game design; statistics; data processing; kinematics.

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