Robot virtual deletion: Using immersive virtual reality to hide the robot during a robot-assisted motor task

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) due the rapid growth of off-the-shelf head-mounted displays (HMDs). Many studies investigated the impact of these VR system as a whole. However, the inherent properties of these technologies and how each of them impacts directly (motor performance/learning) or indirectly (user affect, such as motivation, that have an impact on motor performance) users' performance and learning are not well defined. This is especially true regarding IVR that offers a greater immersion and a potential increase of presence and embodiment.

Another category of neurorehabilitation that became more common in the last year is robot-assisted therapy. Patient are assisted, guided, or even voluntary disturbed in their task by the robot in order to maximize learning. However, all these forces that the robot applies to the user might have a negative affective impact (e.g., reducing presence) on the user. It is common to have robotic combined with VR in order to create positive affect (e.g., increasing motivation) while still having the direct learning benefice of the robot's control strategy.

The goal of this project is to investigate potential benefits and drawbacks of using IVR in combination with a robot to remove the robot's presence in the visual dimension. This strategy could increase participants' agency by tricking them to believe that they perform the movement themselves, forgetting about the robot. However, the risk is that the absence of visible robot create an additional visuo-sensory conflict that could reduce the presence and engagement feeling.

Aims:

1. Literature research: User affect in virtual environment.
2. Study design: Design a study protocol that aims to investigate the affective impact of the visual deletion of the robot in IVR. Implementation of the experiment (creation of the virtual environment, reproduction and animation of the robot in the VE).
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.
Burt robot (or another robot in the laboratory depending on availability).
Python/R notebook for data analysis. Basic scripts for data analysis are available from previous projects.
Requirements:
Programming knowledge. Experiences in on or several of the following topics are a plus: 3D environments; virtual reality; game engine; robotic control; statistics; data processing; kinematics.
Supervisor:
Prof. Dr. Laura Marchal-Crespo, Nicolas Wenk
Institutes:
Motor Learning and Neurorehabilitation Lab at ARTORG Center (UniBern)

Contact: nicolas.wenk@artorg.unibe.ch