Title (tentative): Development and testing of a Body-Machine Interface integrated in a 3D Virtual Reality environment to enhance rehabilitation after spinal cord injury

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Description

Motivation and application domain

Body-Machine Interfaces (BoMIs) decode upper-body motion for operating devices and can be used to promote the recovery of movements following spinal cord injury or other neurological disorders that impair motor functions. BoMIs provide users with feedback about their body motion through visual clues. Virtual Reality (VR) offers the possibility of creating engaging rehab exercises to increase the patient motivation. We aim to assess the potential of a VR paradigm to enhance BoMI-based training.

General objectives and main activities

VR allows creating environments where the intensity of feedback and training can be systematically manipulated and enhanced to create appropriate, individualized rehabilitative therapy, so that the patient feels immersed in the simulated world, increasing his motivation which is key to recovery. The proposed thesis has 2 main aims:

• Aim 1: Developing the technology for a Body Machine Interface based on mapping body motion sensors and EMG signals onto a variety of control tasks. The combination of EMG and movement signals will be mapped into a lower-dimensional control space via linear methods.
• Aim 2: Developing 3D computer games to be used with a VR headset (i.e. Oculus Rift). The controls of the game will result from the low-dimensional space obtained via the interface. The study will begin with control subjects to validate the interface and the VR environment but will be tested on spinal cord injury participants to assess the potential of the VR-enhanced BoMI rehabilitation.

Training Objectives (technical/analytical tools, experimental methodologies)

The student will learn to:
1. Analyze and correlate body signals from different sources such as movement and EMG
2. Develop the control of an external device based on body signal coming from different sources
3. Create a 3D VR environment to be used with an Oculus Rift
4. Integrate a BoMI within the 3D VR scene to control computer games with body motion
5. Improve the knowledge of C#/Unity, machine learning algorithms and statistical analysis

Place(s) where the thesis work will be carried out: Centro di Unità Spinale, Ospedale Santa Corona, Pietra Ligure (SV) - DIBRIS

Maximum number of students: 1