IMPLANTED MAGNETS TRACKING AS A NOVEL METHOD FOR PROSTHETIC HANDS CONTROL

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ABSTRACT

Restoring dexterous motor functions equivalent to that of the human hand after amputation requires the implementation of an effortless Human-Machine Interface that bridges the artificial hand to the sources of volition. New research approaches span from invasive interfaces (e.g. peripheral nerve electrodes) to techniques aimed at increasing the number of independent signal sources available for control (e.g. targeted muscle reinnervation). Among those, solutions based on Implantable Myoelectric Sensors (IMES) are very promising. IMES are small electrodes that wirelessly transmit intramuscular EMG signals to the prosthesis. Their main drawback is that they need to be powered wirelessly with unavoidable power consumption. As an alternative solution, within the framework of the MYKI project (ERC-SG #679820), we propose to implant small magnetic markers (MMs) directly in forearm muscles. By doing so, it is possible to detect the muscles deformation during contraction by tracking the MMs using a localizer and use such information to drive a prosthetic limb. We dubbed this the MYoKInetic (MYKI) interface (Fig. 1).

In order to test the feasibility of the MYKI interface, we built a physical mock-up (PMU) of the human forearm aimed at reproducing its muscles' natural position and deformation. Muscles were modelled as a wire attached on one side to a servo motor. Four MMs were attached to four wires in the PMU, associated to four muscles actuating the adduction/flexion of the thumb and flexion of index and middle fingers. The localizer comprised two printed circuit boards, each equipped with three 3-axis magnetic field sensors (HMC5983, Honeywell International Inc.) and a host PC used to solve the magnetic inverse problem (i.e. retrieving the 3D position of the four MMs using the magnetic sensors readout) at 25 Hz. The maximum accuracy and repeatability errors of the system were found to be 16% and 1% the mean stroke of the MMs (13mm), respectively. Albeit large, the accuracy is of minor importance for this system as it relies on the ability to discriminate a movement. The geomagnetic field also affected the system reliability (100% error). However, simulations showed that such disturbances can be attenuated by using a magnetic shield (μ_r=200000, residual error 0.5%). Future work will focus on increasing the number of MMs tracked and study the influence of magnets orientation.

Implantable MMs are not subject to failure and don't need to be powered, potentially increasing the life time of the implant with respect to previous solutions.

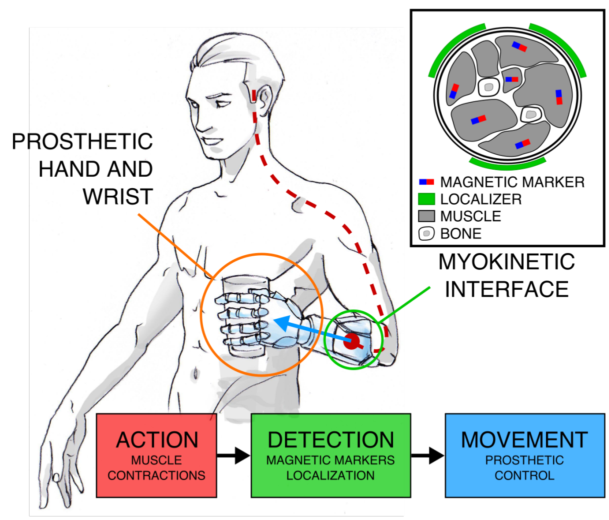

Figure 1 Overview of the MYoKInetic interface.