Advancements towards a functional amputation of the hand.

Atzori Manfredo[1], Cesare Tiengo[2], Giorgio Giatsidis[2], Henning Müller[1], Franco Bassetto[2]

[1] Department of Business Information Systems, University of Applied Sciences Western Switzerland (HES-SO Valais)
[2] Clinica di Chirurgia Plastica, Azienda Ospedaliera Universitaria di Padova, Padova (Italia)

Introduction

The natural control of prosthetic robotic hands via surface electromyography (sEMG) remains a challenge despite the flexor-extensor muscular system of the fingers is usually partially preserved in patients with trans-radial amputations.
In this work we analyze the Ninapro database (Non Invasive Adaptive Hand Prosthetics, http://ninapro.hevs.ch) which is currently the largest sEMG database of hand movements. The aim of the work is to identify relationships between clinical parameters of the amputation and movement recognition accuracy, in order to foster the integration between amputation surgery and innovative robotic hand prostheses.

Materials and Methods

Eleven transradial amputated subjects and forty intact subjects participated to this study.
For all subjects we recorded age, weight, height, percentage of the remaining forearm, time elapsed since the amputation, intensity of phantom limb sensation (0 to 5 subjective scale), prosthesis use and DASH (disabilities of the arm, shoulder and hand) score.
During data acquisition, the subjects were asked to mimic 50 movements shown on the screen of a laptop with the missing hand. In the meanwhile, sEMG was recorded with 12 electrodes fixed on the remaining forearm.
Machine learning was used to classify the sEMG signals of the movements.

Results

Several clinical parameters (e.g. phantom limb sensation and years passed since the amputation) are significantly related to the capability to distinguish different hand movements through machine learning and sEMG.
Moreover, several subjects reported an increased feeling of control of the hand during the acquisition.

Conclusions

Clinical implications of these outcomes are substantial and have the potential to dramatically improve life expectations and prognosis for trans-radial hand amputated patients.
The relationships between classification accuracy and clinical parameters could help to better understand phantom limb sensation and they could lay the foundations for "functional amputation" surgery procedures, which could better integrate with robotic hand prostheses in the future.