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Wafa Tigra, Lucas Fonseca, Benjamin Navarro, David Guiraud, Antonio Padilha Lanari Bo, Emerson Fachin-Martins, Violaine Leynaert, Anthony Gélis, Christine Azevedo Coste

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TOWARDS FES-ASSISTED GRASPING CONTROLLED BY RESIDUAL MUSCLE
CONTRACTION AND MOVEMENT ON PERSONS WITH TETRAPLEGIA

W. Tigra¹, F. Lucas², N. Benjamin³, G. David¹, P. Antonio², F. Emerson⁴, L. Violaine⁵, G.
Anthony⁵, C. Azevedo Coste¹.
¹inria / lirmm, camin, Montpellier cedex 5, France.
²Brasilia University, lara, Brasilia, Brazil.
³LIRMM - University Montpellier, idh, Montpellier, France.
⁴Brasilia University, ntaai, Brasilia, Brazil.
⁵Centre de Rééducation Fonctionnelle Neurologique Propara, Union Mutualiste Propara,
Montpellier, France.

Introduction/Background

Functional electrical stimulation (FES) can be used on individuals with upper motoneuron
dysfunctions to restore grasping functions. To be functional and useful in daily tasks, the
patient must be able to pilot the device by means of an interface. We have investigated two
techniques that could address the situation of persons with tetraplegia: electromyography
(EMG) and inertial measurement units (IMU), respectively measuring muscle activity and
limb movements.

Material and Method

One group of 8 tetraplegic patients (EMG group) was equipped with two pairs of EMG
electrodes located on muscles of the upper arm. Selected muscles could be voluntary
activated in a comfortable way. Another group of 9 tetraplegic patients (IMU group) was
equipped with one IMU (3-axis accelerometer and 3-axis gyroscope) located on the arm. In
the EMG group a threshold detection algorithm was used to detect muscle contractions while
in IMU group a classification algorithm was used to detect two distinct movements of the
limb where the IMU was located. The detection algorithms outputs were used to trigger two
postures of a robot hand. The same outputs were also used, for patients where FES of arm
muscles lead to visible hand movements, to trigger the contractions of two muscles on their
contralateral lower arm.

Results

All the patients were able to control muscle contraction or limb movements to trigger
different actions. Patients were asked to control the robotic hand, following a randomized
sequence of two pre-defined postures. In EMG group the success score was of 95% and 92%
in IMU group. Whenever FES was used, patients could activate grasping movements and
wrist extension. Three patients were able to perform functional tasks such as grasping and
relocating objects.

Conclusion

Despite little training, all the patients were able to voluntarily control a robotic hand and,
when it was possible to test, their own hand with FES.

Keywords:
Movement analysis
Electromyography interface
Inertial Measurement Unit interface