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

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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