Surface Electromyography Signal Collecting Strategy for Artificial Hand Controlling Purposes

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Surface Electromyography Signal Collecting Strategy for Artificial Hand Controlling Purposes

Abdul-Sahib N. Kadhim, Mohammed M. Abdul-Sattar, and Hasan S. Falah

Abstract—**Surface electromyography technique is presented for muscle activation detection and intuitive control of prostheses or robot arm. This research aims to develop a strategy for collecting EMG signal in order to be used as input control for an artificial hand. Methodology of this research composed of, collecting EMG signal using clinical device to choose the best position. Collect the signal using myoware muscle sensor depending on these positions locating above with determining the threshold value for each position. The test was done on a healthy female person and an amputee person, a number of three position were used by the clinical myotrace 400 each positon composed of four channels i, four channel location were chosen from the three position that were used by the myoware sensor on the forearm in addition to two locations on the ulna, while the amputee included only two locations on the ulna. The locations obtained from the myotrace targeting muscles (extensor carpi ulnaris, flexor digitorium sublimis, brachioradialis, flexor carpi ulnaris). The threshold values obtained were on a range of 150-320 that consider a non-sensitive. For the amputee the threshold values were the form 150-220 for both the healthy arm and the amputee arm which consider a weaker value.**

Index Terms—**Surface Electromyography; Threshold Value; Electrodes Positions; Artificial Hand.**

I. INTRODUCTION

has been demonstrated that the signal gathered from the muscle can be utilized to generate input commands for the control of prosthetic hand [1]. With the change of electromyography strategy, the surface EMG signal has turned into a progressive means for control of prosthetics upper limbs [1].

Electromyography signal is an aggregate electrical signal from skeletal muscle which denotes the electrical activity of a muscle during contraction. In the previous years there has been a colossal enthusiasm for the presenting natural interfaces that can perceive the user's body developments and convert into machine commands. EMG signal is random signal which is controlled by sensory system which is reliant on the anatomical and physiological properties of muscles. EMG signal acquires noise in very high degree which can be excluded by good implantation of electrodes and good wire connections of sensors. [2].

The RAW EMG signals consider a very fluctuated signals with a low voltage (~5 microvolt) that only gives a representation of the excitation of the muscle. Most clinical devises record this signal without giving further signals processing. These signal can't be used as input commands

for a most controlling units, thus, in order to make it allowable to be used as commands the signal need to be filtered, magnified, and optimized these procedures are done by using special designed circuits that are designed for this propose, such circuits are myoware muscle sensor developed by the advancer technologies company.

MSC can be isolated essentially into two gatherings pattern recognition and non-pattern recognition based. In the primary gathering, the desired functions are segregated from signal patterns by classifiers and the assortment of capacities depends specifically on characterization execution. While the non-pattern recognition based controllers are constructed on threshold control and or potentially limited state machines only yield restricted and pre characterized control charges in light of an arrangement of info signal patterns [3].

The signal–threshold technique is an essential and basic phenomenological approach. In this technique, rectified raw EMG (Fig. 3-17) is compared with thresholds that are acquired based on the mean power of background noise. It is quick and straightforward in usage. It suits coarse ON/OFF location instead of its moment esteem.

Tremendous amount of works was done previously concerning with recording of EMG signal such as [4] as they introduced a framework that enabled an individual finger movement using sEMG data collected by 32 bipolar electrodes placed on the ble-bodied individual forearm while performing 10 separate finger movements using traditional signal analysis tool [5].

Studied the upper limb muscle activities during basic upper limb motion in daily works to help power assist robotic exoskeleton systems to estimate upper limb motions in based on electromyography signal collected from the related muscles and used as input to control the exoskeleton [6].

Represented the relationship between the thumb tip forces and electromyogram signal (EMG) to develop more natural controlled prosthetic thumb; They depend on the Raw EMG that are classified by the neural network based on different force and thumb configuration and collected from the thumb intrinsic muscles.

Myotrace 400 devise prove to be a very useful in the field of the recording and measurements of the muscle activation. For instant, [7] used the devise to measure the acceleration and velocity (vibrational data) of human arm of hard works. And also implement the device in measuring the vibrational data of older people with hip replacement.

In this work EMG signal generated from the excitation of the upper limb is recorded by two methods. Both clinical device and a controller sensor is used to locate the best position to generate the efficient signal that can be used as control input to an artificial hand. first the signal was recorded using a clinical device from four channel on the

forearm in three sets, then the best positions were chosen to use them as efficient locations for the sensor that will be used as controller input. The generated signal was compared and tested on a five finger artificial hand moved by servo motors.

II. METHODOLOGY

The method summarized in two sections, first using the myo Trace 400 clinical device to record the EMG signal, then after locating the best positions, we implement the myoware muscle sensor and observe the generated signal with locating the threshold value that can be used as input value for controlling of artificial hand.

A. Myotrace 400 signal recording

The myotrace 400 consider the latest portable handheld measurement rechnology that is designed and manufactured by naraxon coopration for clinician interested accurate and quick measurements. It can be used for EMG evaluation and biofeedbach with sEMG sensors. It can be connected with four sEMG sensors which gives the opportunity of recording four muscle excitation in the same time. It can be connected to PC and used for more advance analyzing with the MR3(Muscle Research 3) software.

Steps of the test procedure
1- Locating the positions required.
2- Preparing the skin of the volunteer.
3- Apply the surface electrodes.
4- Connect the sensors
5- Connect the device to PC and open the software.

The test was done on a 17 years female person weigh 60kg for three sets, each set represent a four positions of the four electrodes. The test protocol considered seven movements with a seven interval of rest. The movement which consider an excitation of the muscle, last for 5 second following a rest interval of 5 second as well and so on to the next movement. The movements involved are, in sequence, full hand close, full hand open, pinch, four fingers full close, index full close, ring finger full close, wrist flexion.
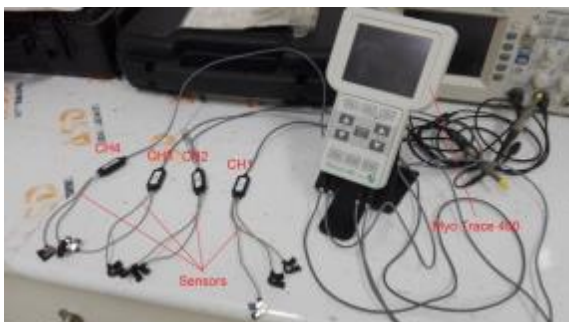

Fig.1. Myotrace 400

Fig.1. Channel location (interior view).

Fig.3. Channels locations (posterior view)

Fig.4. Movements required

B. Myoware muscle sensor signal recording

It is a 3 lead muscle sensor designed especially for collecting surface EMG signal. It is a very sophisticated electronic circuit that can be used in the field of robotic and prosthetic. It can be connected with any controller such as the Arduino mega 2560 which is used in this work.
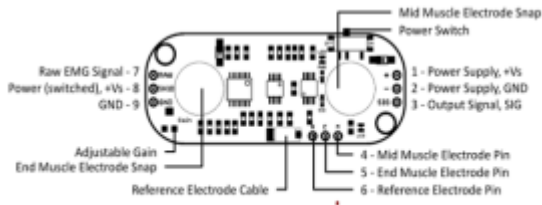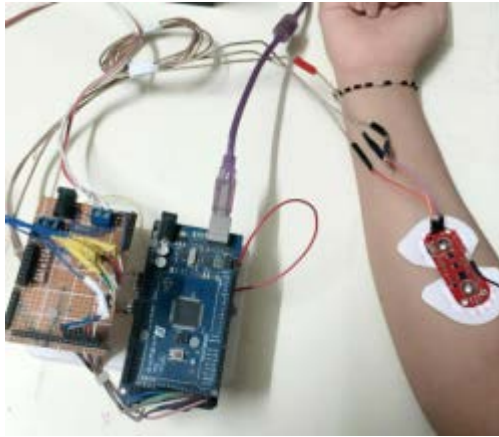
Fig.5. Schematics of myoware muscle sensor

Fig.6. Complete hardware of myoware muscle sensor

The test involves four positions on the forearm also extra ones on the ulna were targeted for the healthy person. For the amputee person Only two positions were located, one on the biceps(X1) and the other in the middle radial distance between biceps and triceps (X2), the same positions were located on the healthy arm (Left arm) so we can make a comparison between the healthy and the amputated arm.
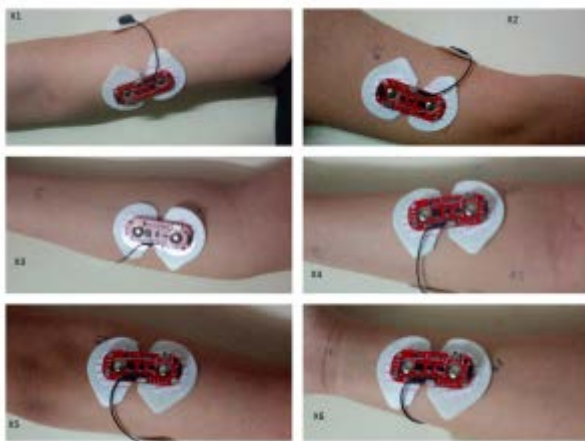

Fig.7. Myoware muscle sensor locations

TABLE I: POSITIONS WITH TARGETING MUSCLE

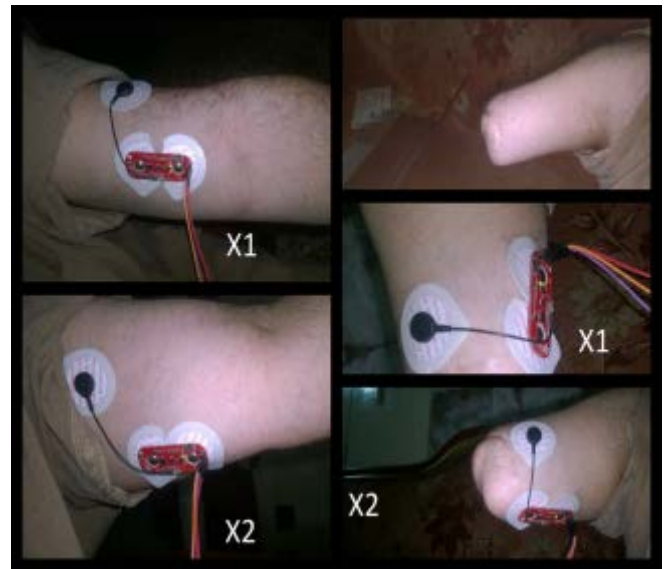| Position	Muscle
X1	Biceps
X2	Triceps
X3	Flexor Carpi Ulnaris
X4	Brachioradialis
X5	Extensor Carpi Ulnaris
X6	Flexor Digitorum Sublimis

Fig.8. Myoware muscle sensot location on the amputee

III. RESULT

A. Myotrace 400

The MR3 software gives the possibility to examine the response of all four channels i.e muscle with a signal movement. Fig. 9 to 11 show the generated excitation of each channel with the sets of movements. Each row represents each channel.

Fig.9. EMG signal from position 1

Fig.10. EMG signal from position 2

Fig.11. EMG signal from position 3

For position 1 the location of CH1, CH2, CH3 consider suitable positions for obtaining valuable EMG signal. For position 2 CH1, CH4 and slightly CH3 were able to differentiate and record the signals for a number of movements. For position 3 CH2 obviously represents the best suited position from this test. Finally, we can say that the best chosen locations from the three set are:

TABLE II: Best Channels and Positions

Channel	Test	Muscle
CH1	Position Two	Extensor Carpi Ulnaris
CH2	Position Three	Flexor Digitorum Sublimis
CH3	Position One	Brachioradi-alis
CH4	Position One	Flexor Carpi Ulnaris

B. Myoware muscle sensor

1) Healthy person

After determining the best positions by the Myotrace, they were used in the myoware muscle sensor. we used a some extra positions on the ulna to give the observe the signal as with conserving with the amputee person After recording the signal, threshold value is set for each position.
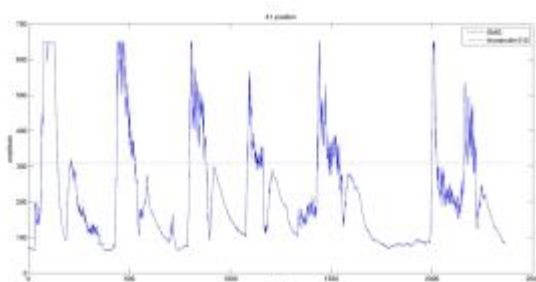

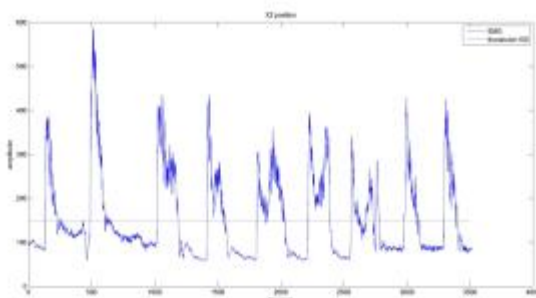Fig.12. Generated EMG signal from X1
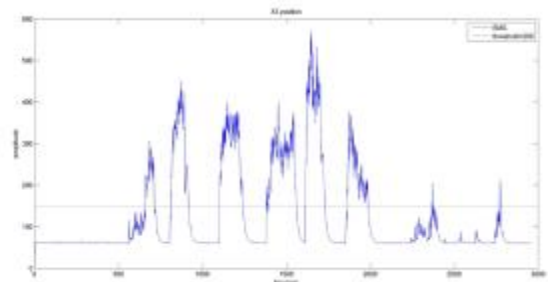

Fig.13. Generated EMG Signal From X2

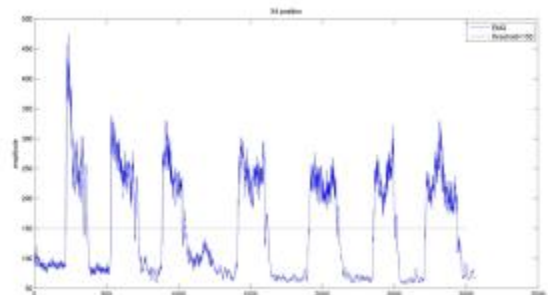Fig.14. Generated EMG Signal from X3

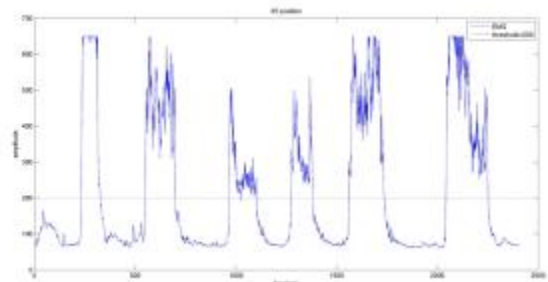Fig.15. Generated EMG Signal from X4
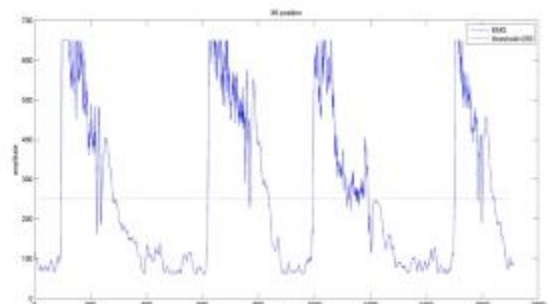

Fig.16. Generated EMG Signal from X5

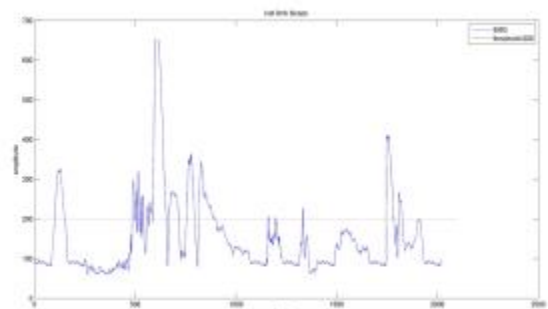Fig.17. Generated EMG Signal from X6

2) Amputee person

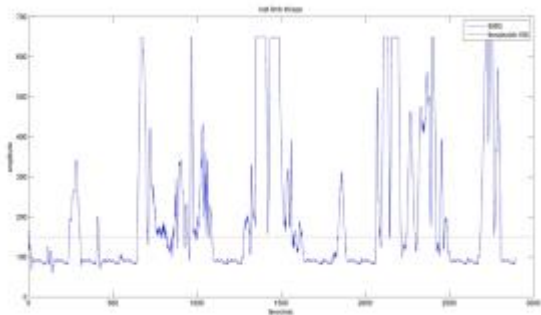Fig.18. Generated EMG for the lost limb triceps
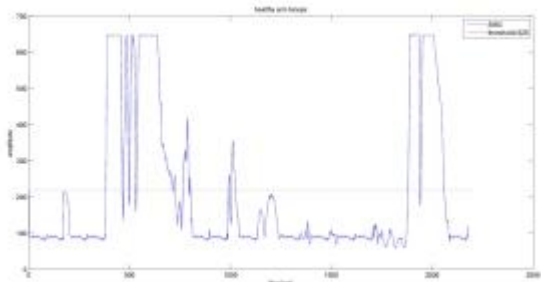
Fig.19. Generated EMG for the lost limb biceps
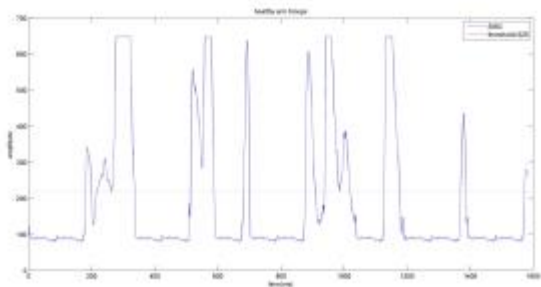

Fig.20. Generated EMG for healthy arm biceps

Fig.2. Generated EMG for healthy arm triceps

C. Obtaining the threshold value

1) Healthy Person

TABLE III: Healthy Person

Position	Threshold
X1	310
X2	150
X3	200
X4	150
X5	200
X6	250

2) Amputee person

TABLE IV: Amputee Person Lost Limb Threshold

Position	Threshold
X1(Biceps)	200
X2 (Triceps)	150

TABLE V: Amputee Person Healthy Limb Threshold

Position	Threshold
X1(Biceps)	220
X2 (Triceps)	220

IV. CONCLUSION

The residual limb test showed a promising ability of working with the proposed design of the artificial hand. The EMG signal recorded is valuable that has a clear, located threshold value that can control the artificial hand. The degree of amputation of the limb affects highly the performance of the muscle, thus, affecting the ability to control the artificial hand. In order to control the artificial hand, it was noticed that the muscle needs to be strong without any stress. These factors affected highly the recorded EMG signal from muscles (amputee person, myo trace 400 test) which represent the muscle condition. There is no big difference of the EMG values of multiple muscles of individual, thus, a single value can be chosen for the number of muscle, i.e, location.

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