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PROSTHETIC HAND CONTROL USING WEARABLE GESTURE ARMBAND BASED ON SURFACE ELECTROMYOGRAPHY

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ABSTRACT

Surface electromyography is a technology that provides detection of electrical activity produced by the physiological contractions of muscles; the sEMG is widely applied in medical assistive applications such as gesture control for upper limb prosthetics. Nowadays, there are many useful devices for innovative and new medical technologies in health care. Myo armband is an example for these devices which can be used for many applications in computer, mobiles and gaming system. In this paper the control of prosthetic hand of 3DOF in each finger via wearable MYO armband communicates wireless with the Arduino microcontroller via Bluetooth piece. The MYO armband has eight electromyography (EMG) sensors for collecting bioelectric signals from different parts of the forearm muscle; Myo armband is a wearable gesture and motion control device that uses a set of electromyography sensors, combined with a gyroscope, accelerometer and magnetometer to detect movements and gestures, the test was done on a healthy person and an amputee person .In this work another sensor was used the FSR sensor to make the prosthetic hand smart when touching specific object this feature made the prosthetic hand intelligent.

Keywords: surface electromyography, Myo armband, prosthetic hand, force sensor resistive.

1. INTRODUCTION

Muscle contraction in the human body gives rise to a bioelectrical signal proportional to muscle activity. The signal is called Electromyography (EMG), an important instrument for diagnosis, treatment and the automatic control of the prosthesis and orthotic [1]. The EMG signals are also important for the control of robotic systems. Hand amputees can use such systems using EMG signals.

Electromyography (EMG) is an electro diagnostic medicine technique to measure muscle responses or electrical activity produced by skeletal muscles. The nerves control the muscles by electrical signals called impulse; these impulses possible to determine and analyzed with assistance of EMG detectors [2].

EMG signals can be obtained directly from muscles by needle and surface electrodes. The received EMG is recorded by surface electrodes are reliable and simple methods for utilization of muscle energy. Because of this reason this method is mostly preferred for this aim EMG signal are acquired using suitable sensors (either from surface of the body or from muscle) from the person are greatly used in inducing prosthetic instrument. These devices rationally recognize limb movement of the human being and the pulsation are produced by using microcontroller and the particular motors. The motor is operated for motions of the Manus and wrist, hand spread, fist, wrist inflection, wrist expansion etc. limited motion is possible when registration electromyography signals from elbow or wrist infliction / expansion through equal dimension constriction are recorded by the surface sensors are enough to monitor the motions of a handy prosthesis [3].

This work presents the control of artificial hand via wearable MYO gesture control armband. The MYO armband detects electrical activity in forearm muscles using surface electromyography (sEMG). It acquires the raw signals real time, using dry platinum electrodes. Myo has 8 pods, each acquiring independent signals along a bracelet and streaming the acquired data through the central pod (the one with the logo) using Bluetooth communication, to a computer. Then, the software from Thalmic Labs will process the signals to detect and determine the arm wearing the device, the orientation of the Myo and a set of fixed poses, also allowing intuitive linking to other apps or functions within the pc, whether using their application, or writing simple codes in lua programming language [4].

[5] The Myo armband sensor built to work best at the widest part of the forearm that is the upper forearm. Sizing clips are available which allow for a more constrained grip, better suited for smaller arms. The Myo vibrates to send information to the user. (E.g. when it is synced with a pc or when a gesture is detected.) The battery should support a full day of use, as said on the company site, and it can be easily recharged by through a micro USB port. By detecting muscle movements when a gesture is made, Myo is trained to guess which gesture has been made and respond accordingly. This sensor measures the electrical action of the muscles of the forearm at frequency of 200 Hz with eight bits of resolution for each sensor. The forearm muscles are responsible for the motion of the different parts of the arm. The Myo transfer its readings to the computer by Bluetooth. Additionally, the Myo consist of an inertial measurement unit (IMU) with nine DOF (accelerometer, gyroscope, and orientation in the x, y, and z axes). The raw data of 8-EMG channels and IMU sensor is sent to personal computer. At this time, data is transmitted using Bluetooth. The sample rate of the EMG signal is 200Hz. The raw data of EMG sensor and IMU sensor are processed by the proposed algorithm.

Force Sensor Resistive (FSR) is available in various shapes and sizes; for the application on the prosthetic hand, the former have the advantage that only one element determines a uniform region of sensitivity along the whole finger where it is applied. The latter have been found to be slightly more sensitive; however, at least three connected in parallel are necessary to obtain a sufficiently uniform sensitivity along the finger. FSR made up of two thin leaves of polymer (0.2 mm in all), one of which is covered with a network of interlaced electrodes, while the other is covered with a semi-conductive material. When no force is applied, the resistance between the electrodes is high; when a force is applied, the semi-conductive material comes into contact with the electrodes, creating a short circuit area that determines a drop in resistance [6].

2. METHODOLOGY

The method summarized in two sections, first using the sensor Myo Armband to collect the EMG signals to control the prosthetic hand. The microcontroller Arduino Nano communicates wireless between the prosthetic hand and MYO armband via Bluetooth module HM-11, then we use the FSR to make the hand smart by touching that sensor for objects then the force sensor reads the data and sending it to the signal conditioning circuit that includes amplification and filtration. The generated signal were compared and tested on a five finger artificial hand moved by servo motors.

Figure-1. Wearable gesture control system.

A. Myo armband sensor

The myo gesture control armband features wearable gesture recognition, motion track and muscular activity measurement. The EMG signals obtained using this eight-channel sEMG sensors, these signals can be sent wirelessly through Bluetooth Low Energy HM-11connection to a host device and no complex wiring is required. Especially embedded systems can profit from the portability of the device, like the Arduino platform. Unfortunately, most BLE hardware has a very limited feature set, none of the available BLE modules could directly connect to the myo armband out of the box. But this can be solved by developing a custom firmware for these modules, which then provides access to the myo data and delivers it Arduino Nano ATmega328 as microcontroller which is used in this work. The MYO armband has also a nine axis IMU; we can take motion data from IMU.

Figure-2. MVO armband.

We use Five gestures (Fist, Spread, Double tap, Wave in, Wave out,) performed by Myo sensor for healthy person as shown in figures below:

Fist movement

Spread movement

Double tap movement

Wave in movement

Wave out movement

Figure-3. Movements required.

After these steps, we can control the prosthetic hand

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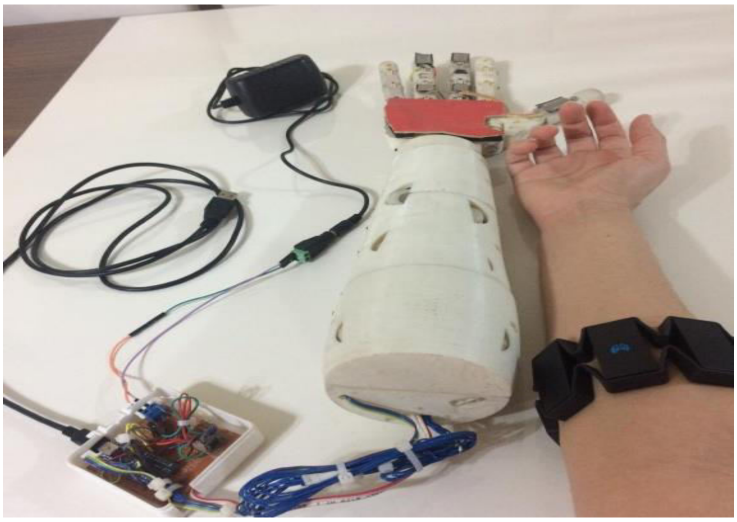

Figure-4. Complete system.

For the amputated person, a case study was taken for the person with amputation of the right hand. The person performed the following movements (spread and fist), these movements were performed and got EMG signal naturally as shown in the figures below:

spread movement Fist movement

Figure-5. Movements required for the amputee person.

B. Force sensor resistive (FSR)

FSR 408 series are two wire devices, the sensor is of low cost and easy to use Actuation force as low as 0.1N and sensitivity range to 10N.The force sensor must tell the amputee if there is an object/surface touching the finger, and what amount of force is being created. Once the sensors have been placed in the fingers of the hand, the inner side of the hand should be covered with something which will create a good amount of friction in order to be able to touch, pick up or catch the object/surface in a safe way and with the least amount of force. The most effective and economical way to do this is by using a rubber substance which is not heavy, yet strong enough not become easily damaged, it has good friction, and is inexpensive. Some of the applications of FSR are Detect & qualify press. Use force for UI feedback. Enhance tool safety. Find centroid of force. Detect presence, position, or motion of a person or patient in a bed, chair, or medical device. Use in electronic devices and robotics applications.

Figure-6. FSR 408 series.

3. RESULTS

A. EMG recorded signal for healthy person

Five gestures (Double tap, Spread, Fist, Wave in, Wave out) performed by myo sensor for healthy person.

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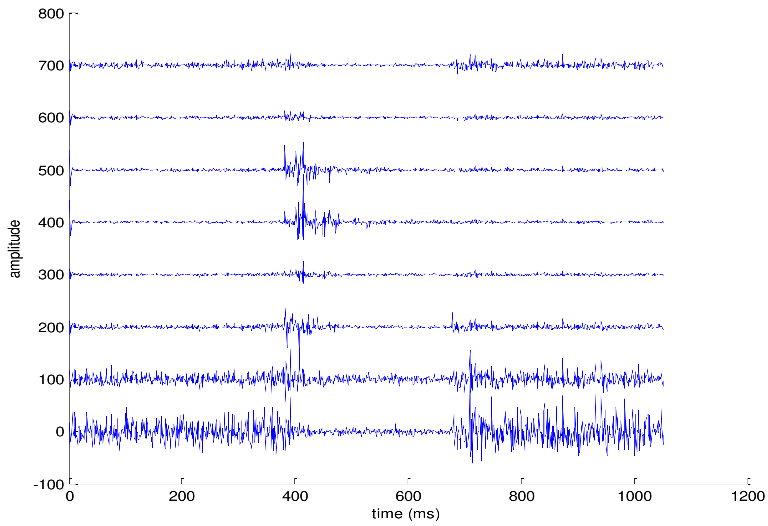

Figure-7. EMG signal of double tap movement.

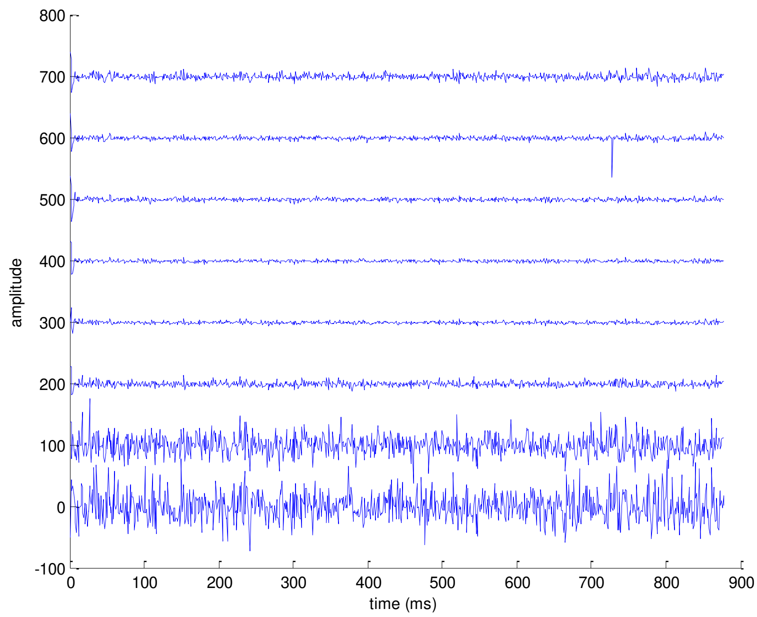

Figure-8. EMG signal of spread movement.

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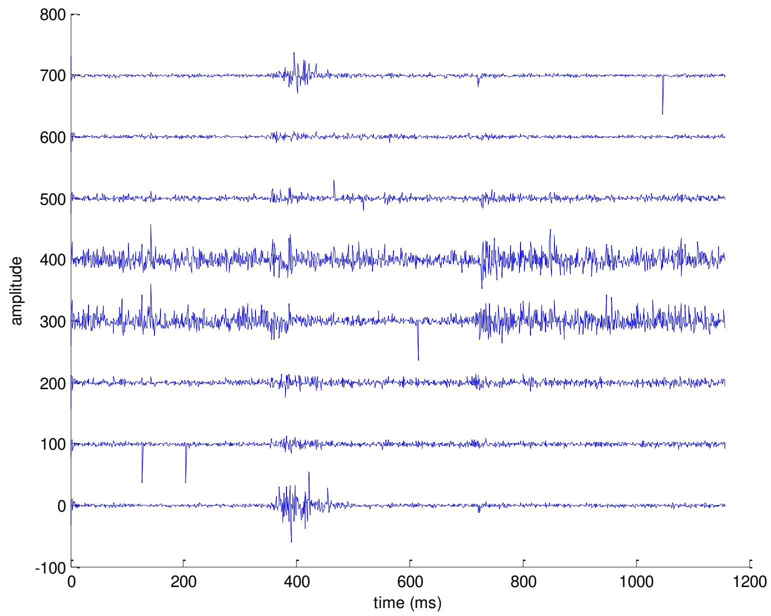

Figure-9. EMG signal of fist movement.

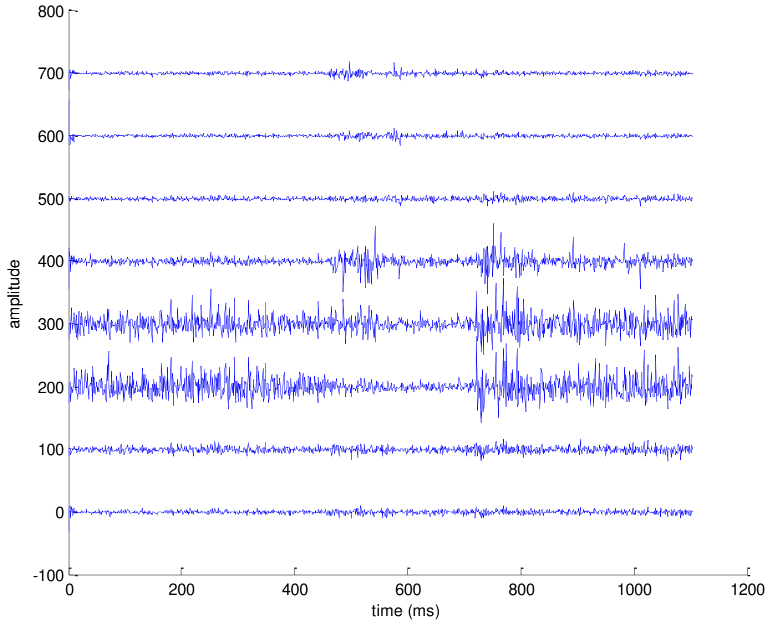

Figure-10. EMG signal of wave in movement.

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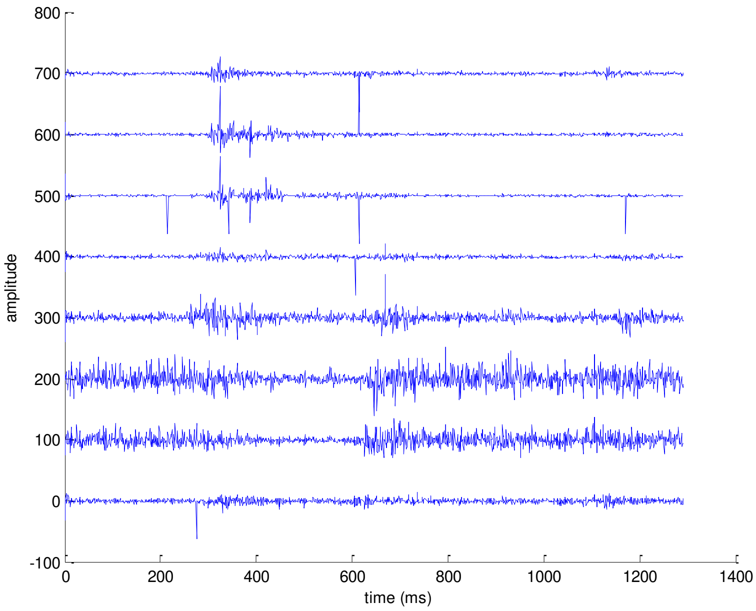

Figure-11. EMG signal of wave out movement.

B. EMG recorded signal for amputee person

The results gained from myo sensor for the amputee person movements are shown in the figures below.

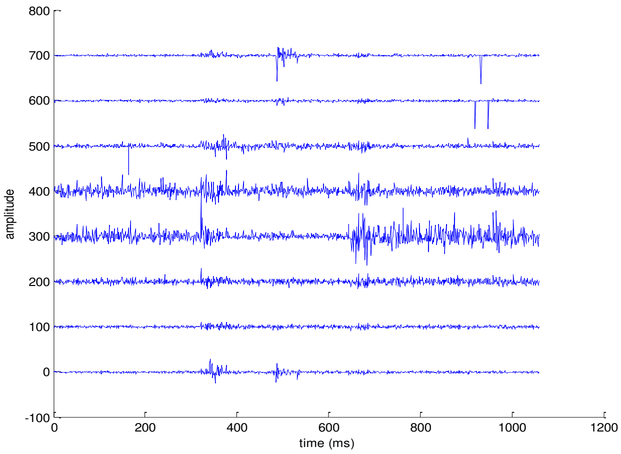

Figure-12. EMG signal of fist movement for amputee person.

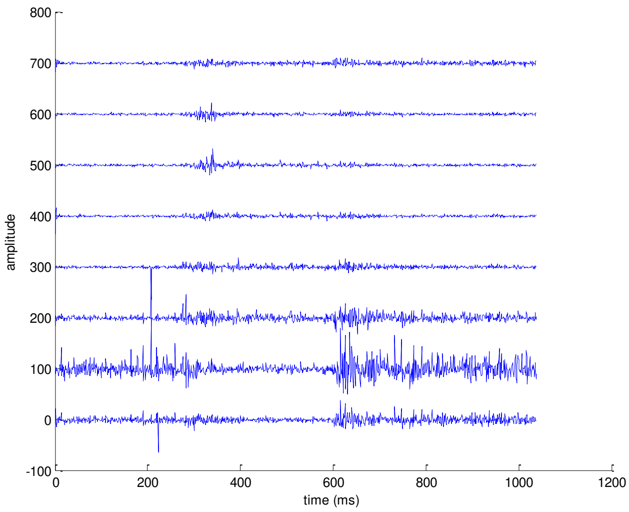

Figure-13. EMG signal of spread movement for amputee person.

4. CONCLUSIONS

a) This study concluded that the Myo armband sensor used was efficient in high degree since it was able to record the EMG without any noticeable delay and the output sensitivity is stable which made it promising when working with upper limb prosthetic, also the linearity was excellent over their dynamic range also, myo sensor provided scope to enhance of features in accurate detection and positioning. The performance of sensitivity myo armband sensor for amputee person is less than for healthy person.

b) Force sensor resistive FSR improved the signal efficiency with (70%), good shock resistance, catching force good, reduced the slipping for objects,

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also the FSR showed the sensitivity of Force-sensing is good and stable**,** so this sensor was used to help the amputee person when hand touch some object to detect the physical pressure and weight.

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