

Movement Control of Robot Using Surface Electromyogram Signal

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Abstract — The Electromyogram signals or EMG signals are generated whenever there is any muscular activity. These signals can be detected easily over the surface of the body. As these signals are generated whenever there is any muscular activity, so, we can recognize any muscular activity made by the human by measuring the amplitude of the signal. Based on decision made upon the amplitude of the EMG signal we can take many decisions or we can make machine of our interest. In simplest form any disabled person can turn on or turn of the machines just by contracting his fist. In this paper we have made an offline prototype of such machine which, in our case, will move the robot in one direction whenever there will be a sign of muscle contraction in the recorded EMG signal.

Keywords — EMG; LabView; Biopac; AVR Microcontroller; Matlab.

I. INTRODUCTION

Around the world, there are a large number of persons with amputation due to war, disease and accidents [1]. There are many difficulties in their daily life, so it needs to design a prosthetic control device such as control nature, easy to use, the signal stability and painless to solve the problem. Surface electromyography (SEMG) is a kind of bioelectric phenomena as muscle activity associated on the skin surface, which contains an abundance of muscle movement information. SEMG can record muscle biological signals on the surface skin by electrode when the muscle movement [2]. Because of the control signal is derived from the prosthesis surface of the skin of the patient's own biological signals, the SEMG is a source of painless, steady and continuous prosthetic control [3]. For example, it is used in the mechanical arm by EMG application [4] and is used in upper limb prosthetic by control of SEMG [5].

II. NATURE OF EMG SIGNAL

The bioelectric potentials associated with muscle activity constitute the electromyogram, abbreviated EMG. In other way we can say the contraction of the skeletal muscle results in the generation of action potentials in the individual muscle fibres, a record of which is known as electromyogram. In voluntary contraction of the skeletal muscle, the muscle potentials range from 50 μ V to 5 mV and the duration from 2 to 15 ms. The values vary with anatomic position of the muscle and the size and location of the electrode. In a muscle, the intensity with which the muscle acts does not increase the net height of the action potential pulse but does increase the rate with which each

muscle fibre fires and the number of fibers that are activated at any given time. The amplitude of the measured EMG waveform is the instantaneous sum of all the action potentials generated at any Some important details of EMG signals are given in reference [6-7]. Since, most EMG measurements are made to obtain an indication of the amount of activity of a given muscle, or a group of muscles, rather than of an individual muscle fibre. The EMG pattern is usually a summation of the individual action potentials from the fibres constituting the muscle or muscles being studied.

Because these action potentials occur in both positive and negative polarities at a given of electrodes, they sometimes add and sometimes cancel. Thus, the EMG waveforms appear very much like a random noise wave form [7]. Figure 1 shows the picture of row EMG signal.

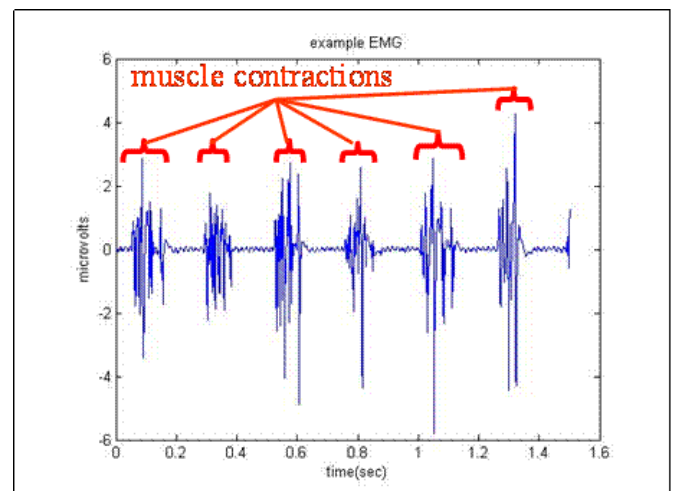


Fig. 1. Example of EMG signal

As shown in figure these EMG burst can be easily identified and shows that at this interval there is a muscle contraction EMG signal is taken. We can use this information to design a system which will make any device active when the muscle will be contracted.

In this paper we have designed an algorithm which will convert these EMG burst into electrical pulses and then these pulses will be sent to the custom made robot via serial communication. These type of machines can help several disabled man in their small day to day works.

III. ACQUISITION OF EMG SIGNAL

For the EMG acquisition, group of muscles involving reciprocal movements were targeted. The flexor-pronator

v. extensor-supinator group was selected due to their isolation to movement of the arm as a whole and the close relation to the hand muscles [8].

A. EMG Electrodes

The EMG can be measured by applying conductive elements or electrodes to the skin surface, or invasively within the muscle. Surface EMG is the more common method of method of measurement, since it is non-invasive and can be conducted by personnel other than medical doctors, with minimal risk to the subject [9].

Measurement of surface EMG is dependent on a number of factors and the amplitude of the surface EMG signal (sEMG) varies from μV to the low mV range. The amplitude and time and frequency domain properties of the surface EMG signal are dependent on factors such as [9]:

- The timing and intensity of muscle contractions
- The distance of the electrode from the active muscle area
- The properties of the overlaying tissue (e.g. thickness of overlying skin and adipose tissue)
- The electrode and amplifier properties
- The quality of contact between the electrode and the Skin

Two types of surface electrodes are commonly in use. The first one is dry electrodes in direct contact with the skin and the second one is jelled electrodes using an electrolytic jell as a chemical interface between the metallic parts of the electrode [9].

Jelled electrodes uses an electrolytic jell as a chemical interface between the skin and the metallic part of the electrode. Oxidative or reductive chemical reaction take place in the contact region of the metal surface and the jell. Silver-silver-chloride (Ag-AgCl) is the most common composite for the metallic part of gelled electrodes. The AgCl layer allows current from the muscle to pass more freely across the junction between the electrolyte and the electrode. This introduces less electrical noise into the measurement, as compared with equivalent metallic electrodes (e.g. Ag). Due to this fact, Ag-AgCl electrodes are used in over 80% of surface application [10].

Jelled electrodes can either be disposable or reusable. Disposable electrodes are the most common since they are very light. Disposable electrodes come in a wide assortment of shapes and sizes, and the materials comprising the patch and the form of the conductive jell varies between manufacturers. With proper application, disposable electrodes minimize the risk of electrode displacement even during rapid movements.



Fig. 2. Disposal Jelled electrodes

In our experiment for the acquisition purpose of the EMG signal we have used disposal jelled electrodes. Figure 2 shows the picture of the electrodes used in our experiment.

B. Biopac MP36 machine for Signal acquisition

Biopac is a company which makes biomedical signal acquisition system. MP36 [11] is also one of them and this machine can be used for acquiring various types of signal like EMG, ECG, EEG, Respiration signal etc. This machine comes with a software named Acknowledge, which is used to display the acquired signal on the computer screen in real time. This software also provides the facility to implement various types of signal processing tools like filters, FFT, PSD and many others. These tools can be operated on the signal one signal is recorded. The following figures 3 and 4 shows the biopac MP36 machine and acquired signal on software.



Fig. 3. Biopac MP36 biomedical data acquisition machine

IV. PROTOTYPE AUTONOMOUS ROBOT

For implementing the algorithm we have developed we have a custom made hardware. It is an autonomous robot with AVR microcontroller on board. AVR microcontroller

works as the brain for this device and receives the commands given from the computer. We have attached two d.c. motors to it to provide the movement to the robot. There are two separate power supplies one drives the microcontroller and other drives the d.c. motors. For sending and receiving the command from the computer we have an MAX232 IC attached to the microcontroller.

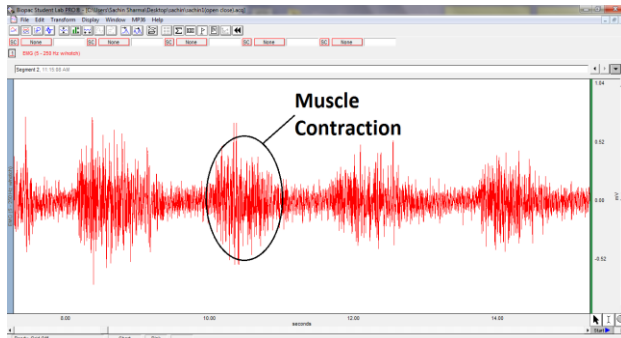


Fig. 4. Display of the acquired EMG signal on software

The connector in order to connect the RS232 cable are not on board they are separately attached to the board. The code for receiving the commands and then performing the desired operation is written in embedded C and is burned or loaded into the microcontroller. The logic is like, If there will be '1' coming from the computer then it will move the d.c. motors and robot will move in the forward direction and when there will be '0' coming from the computer the d.c. motors will stop. Figure 5 shows the picture of the custom made robot.

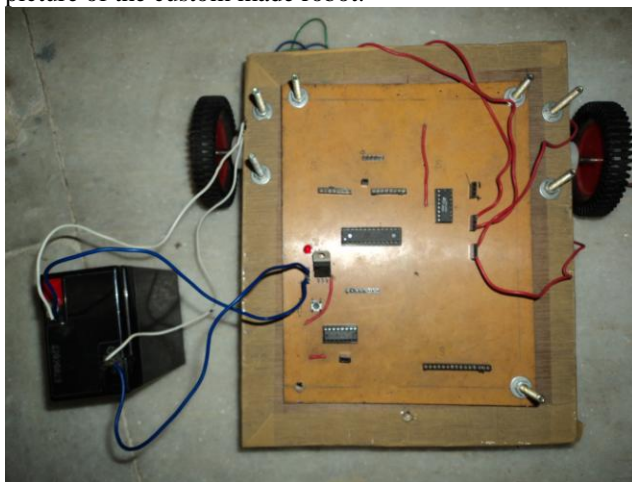


Fig. 5. Diagram of the prototype robot

V. RESULTS

The recorded EMG signal from MP36 is saved into Matlab table and the data is used in Matlab in order to develop the algorithm. First we made the algorithm in Matlab then by using matlabscrip node available in Labview we write the Matlab code into it and called the algorithm written in Matlab through Labview.

Figure 6 shows the picture of the recorded EMG waveform which is taken from the MP36 machine. This waveform is displayed on graph in LabView using matlabscrip node. Figure 7 shows the picture of the result

of the algorithm which we have developed to convert these EMG burst signal into the series of pulses. Wherever there is muscle contraction in the figure 6, corresponding to those events there is pulse in figure 7 having value "1".

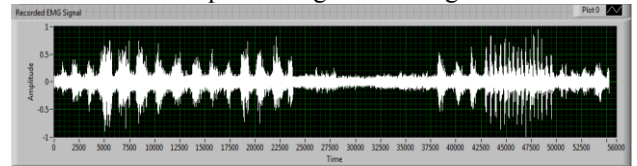


Fig. 6. Recorded EMG signal displayed in LabView

Further we scan the result given by algorithm as in figure 7, to find out at which time instances there was muscle contraction by the user. Whenever we find a "1" for sufficient long duration it indicates that during this time period there was a muscle contraction by the user. Then this information is sent to the microcontroller unit via serial communication and on receiving "1" microcontroller starts the motor and robot start to move in the forward direction.

Whenever we encounter the "0" in the scan on the result we transfer it to the microcontroller and robot stop. It indicates that during this time there was no muscle contraction and muscle was in relax position.

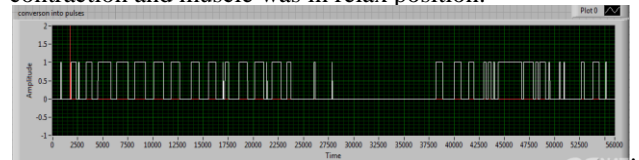


Fig. 7. Output of the algorithm developed

The scanning of the result and serial communication program was written in LabView because of it's simplicity to interface the hardware with it. Figure 8 shows the glimpse of the block diagram of the labview program.

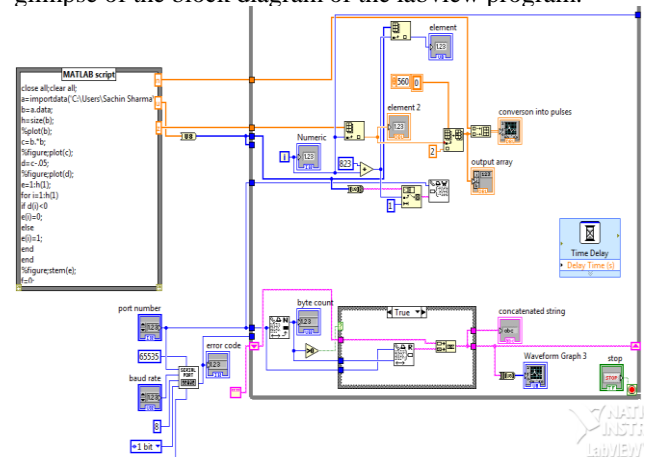


Fig. 8. Block Diagram window of the LabView program

A. Discussion on the results

These results have been verified by my guide Mr. S.K. Pahuja sir. The algorithm and labview program worked well in normal conditions but when we go for other recorded EMG signal the same result will not be achieved and to achieve the desired result we have the adjust the value of the threshold which we have used in the development of the algorithm. This is primarily due to the fact that amplitude of the EMG signal is not fixed to the

defined value of voltage. It depends upon the many factors like strength used to contract the muscle, electrolyte jel etc.

VI. CONCLUSION AND FUTURE WORK

In this paper an offline machine prototype based on surface EMG signal has been tested and implemented. The result and working of the machine has been verified. In future the online version of this machine will be tested and implemented and work is going on in this direction. We will put our efforts to remove the dependency of the machine on the varying nature of the EMG signal and we will try to make a machine which can be suited for various persons without and considerable changes. We will try to make this machine adaptive in terms of the amplitude of the EMG signal. We will also try to make our own EMG amplifier [12] to take the signal directly to the labview. This amplifier will be used to make real time machine.

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