Gestures Identification for Myoelectric Based Control of the Robotic Arm

D.O.I - 10.51201/12514
https://doi.org/10.51201/12514

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Abstract: *Human robot interaction have been ever the topic of research to research scholars owing to its importance to help humanity. Robust human interacting robot where commands from Electromyogram (EMG) signals is recently being investigated. This article involves study of motions a system that allows signals recorded directly from a human body and thereafter can be used for control of a small robotic arm. The various gestures are recognized by placing the electrodes or sensors on the human hand. These gestures are then identified by using neural network. The neural network will thus train the signals. The offline control of the arm is done by controlling the motors of the robotic arm.*

Keywords: **neural network; myoelectric signal; Signal Acquisition; pattern recognition**

1. INTRODUCTION

The human robot interaction particularly for control of human arm is very emerging technique now a day. This article describes a methodology to the control of a multifunctional prosthesis with the classification of myoelectric patterns. It also inters that myoelectric signal exhibits a particular structure during movement of a muscle retrenchment [1-2]. Several data can be collected by taking many repetitions from machine with myoelectric signal to reserve pattern structure. These extracted features be used for training an artificial neural network [3-5] and can be used for further classification. The new patterns can be classified based on the neural network which is trained earlier using this technique. The complex nonlinear Neural network which is trained in in this way could more assist the amputee and will also not increase its efforts[6-9].

Such individuals with amputation can he really benefited with Myoelectric systems have as controls of prosthetic devices of upper limbs. Such systems are now geeting more popularity with various organs (hand, elbow and wrist). These systems may use proportional or derivative change of signals for extracting the patterns.[10-14]

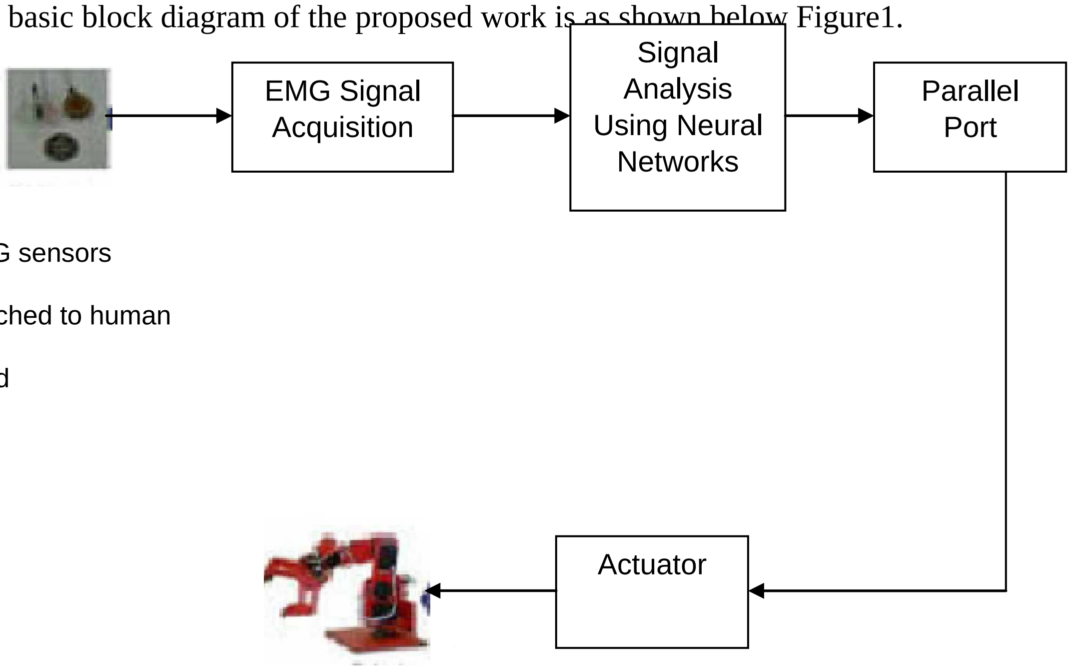
The Electromyographic signal (EMG) is a one dimensional array pattern which could be important data for input to the pattern recognition system. All multifunctional myoelectric control systems implemented using pattern recognition have been based on the given electrode location and the other parameters [15-18].

This article describes the extraction of EMG signals, gesture identification for the control of robotic manipulators [19-20]. In the extraction the myoelectric signals are acquired using a single bipolar electrode pair which provided data for training of the neural network. During the network training the group of training sets is presented to the neural network which can classify it. The back propagation algorithm is a adaptive training method which changes the weights. These weights are stored and can be used to retrieve the data after classification. The robotic manipulators are controlled by sending the signals [21]. The simulation and port programming is done in Matlab software and hardware is implemented for stepper motor based robot arm manipulator. The study of robotic hands has been the foremost in the robotic science. Robotic arms, with a gripping end -effectors, have been in production for a long time [22-23]. Robotic hands which are anthropomorphic in nature have also been under research in universities for a long time. Stanford/JPL hand and Utah/MIT hand attempt to do this. The Stanford hand has 9 DOFs while the MIT hand has 16 DOFs [24-25]. They also resemble the human hand in shape and size. A hand developed by DLR (Deutches Zentrum fur Luft-und Raumfahrt) has four fingers with sensors, with 12 DOFs in total. The Robonaut hand developed by the NASA Johnson space centre has total of 14 DOFs. The most advanced Robotic hand built till now is the Shadow hand, built by the Shadow Robot Company. It uses pneumatic “muscles” to incorporate 24 DOFs in their robotic hand, which is as much as the human hand. These all have one thing in common. They attempt to resemble the human hand in shape, size and utility.

2. Basic methodology

The first step of the work is the acquisition of EMG signals .This is done using the EMG machine. Before going to the acquisition we will see the basic block diagram of this project.

The basic block diagram of the proposed work is as shown below Figure1.



Robotic Arm **Figure. 1 Basic Block Diagram**

As shown in the Figure 1 first we will attach the sensors to the human hand to acquire the EMG signal after that the signals are trained using neural network and then through the parallel port we will control the motors of the robotic arm.

3. EMG Signal Acquisition

EMG surface electrodes are used in bipolar conFiguration where two electrodes with a small distance between each other are placed in the muscle to pick up the local signs with in the muscle of interest.

Four surface electrodes are used to acquire the EMG signals from the two muscles. These electrodes comprise of two active electrodes, one reference electrode and one active ground electrode. An EMG signal is obtained by taking the differential voltage between the reference electrode and an active electrode. The active ground electrode is used to cancel out the common mode 60 Hz noise between the reference and the two active electrodes. The same reference electrode and active ground electrode are used for both EMG recorders.

4. Gesture Identification with Neural Network

In MATLAB we can create a feed forward network easily. After that we will train the network and then simulate the network. The algorithm for creating and training the network is as follows.

Feed-forward networks contains neural architectures which have weights as per data training and number of layers.

4.1 FLOW CHART FOR NETWORK TRAINING

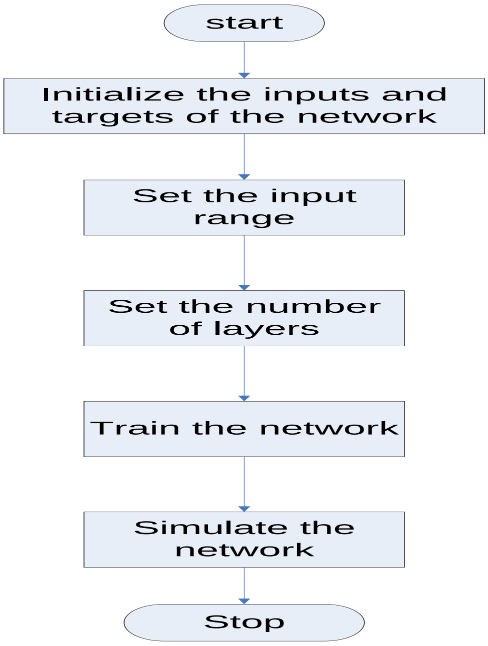


Figure 2. Flow chart for network training

4.2 ARCHITECTURE OF NETWORKS TRAINED

The Fig. 3 and 4 are the different types of feed forward networks trained by using the MATLAB programming the algorithms are described in earlier section.

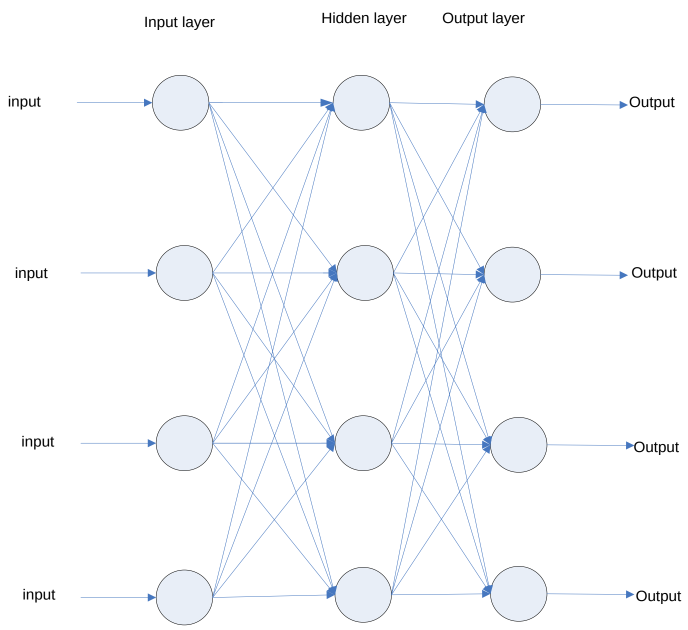


Figure 3. Two layer network

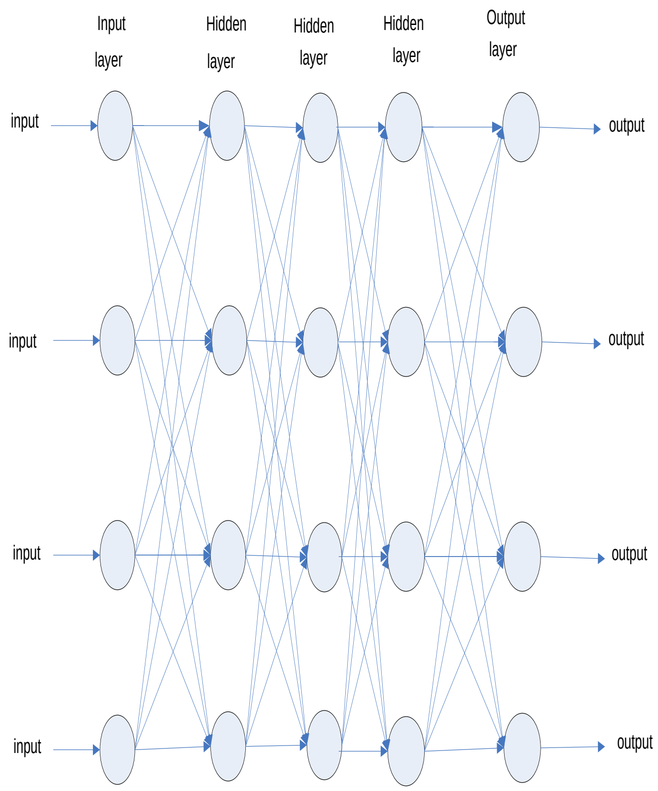


Figure 4. Four layer network

5. Results and Discussions

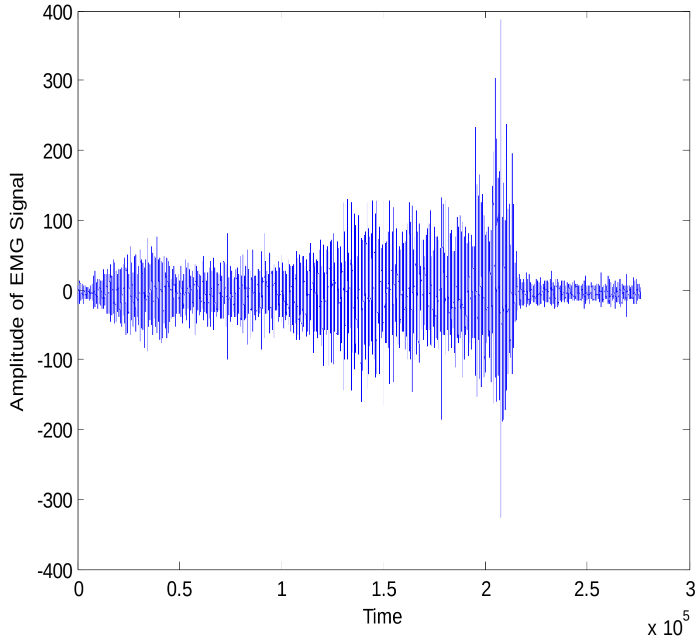


Figure 5. EMG Signal for down movement of hand

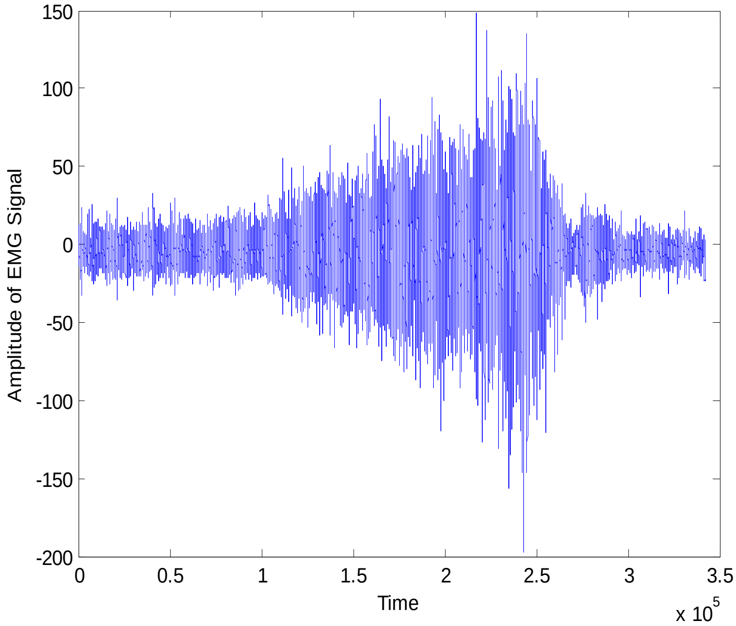


Figure 6. EMG Signal for up movement of hand

As explained in earlier, the Fig. 5 is the one of the gesture of EMG signal for the downward movement of the hand. The same movement is taken for five number of times and similarly the are plotted. The EMG signal for this movement is taken and plotted for different times. Here only one signal for one movement is shown.The Figure 6 is the EMG signal obtained for the upward movement of the hand. The signal is also taken for the different times then they are processed further. This signal shows in Fig 7 the downward movement of the wrist of the hand. Like the above gestures these are also taken and then plotted.

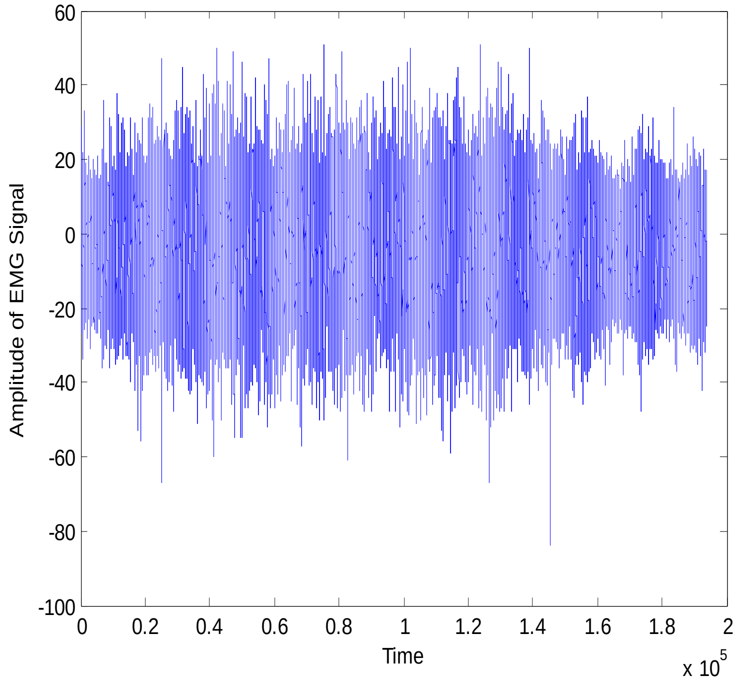


Figure 7. EMG Signal for wrist down movement of hand

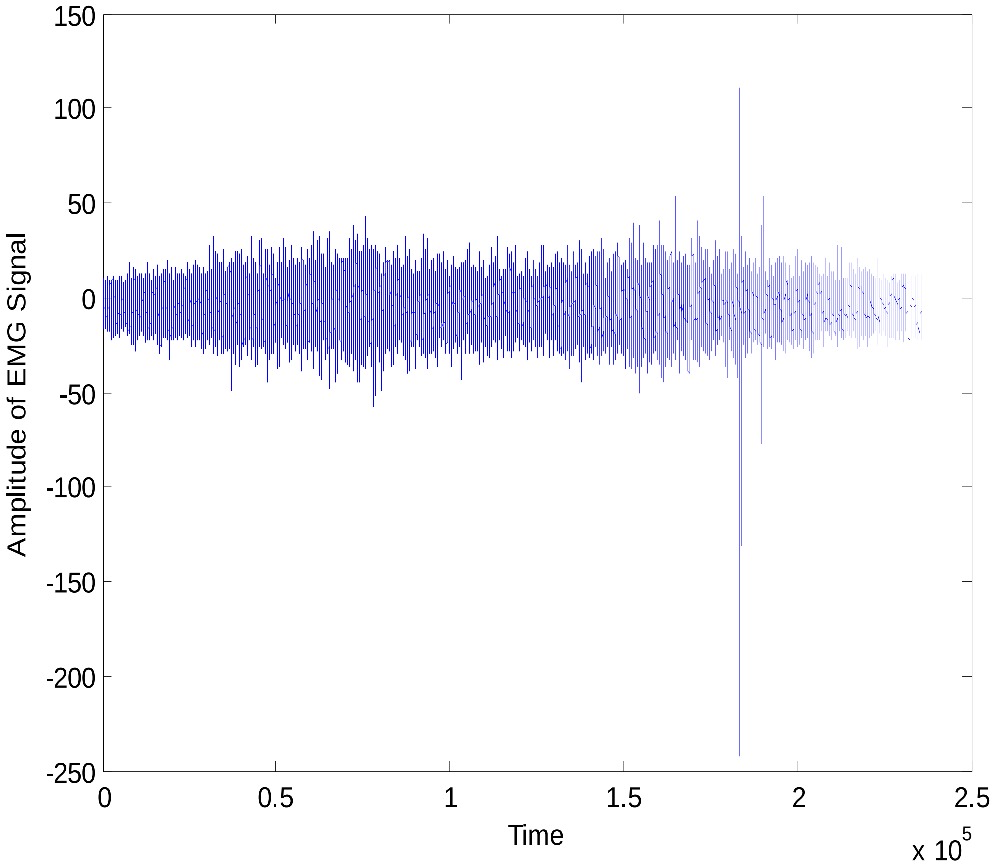


Figure 8. EMG Signal for wrist up movement of hand

This Figure 8 shows the upward movement of the wrist. For the different gestures the signals are taken. Here for each gesture we have shown the single signal only. But like this we have taken five signals for each gesture.

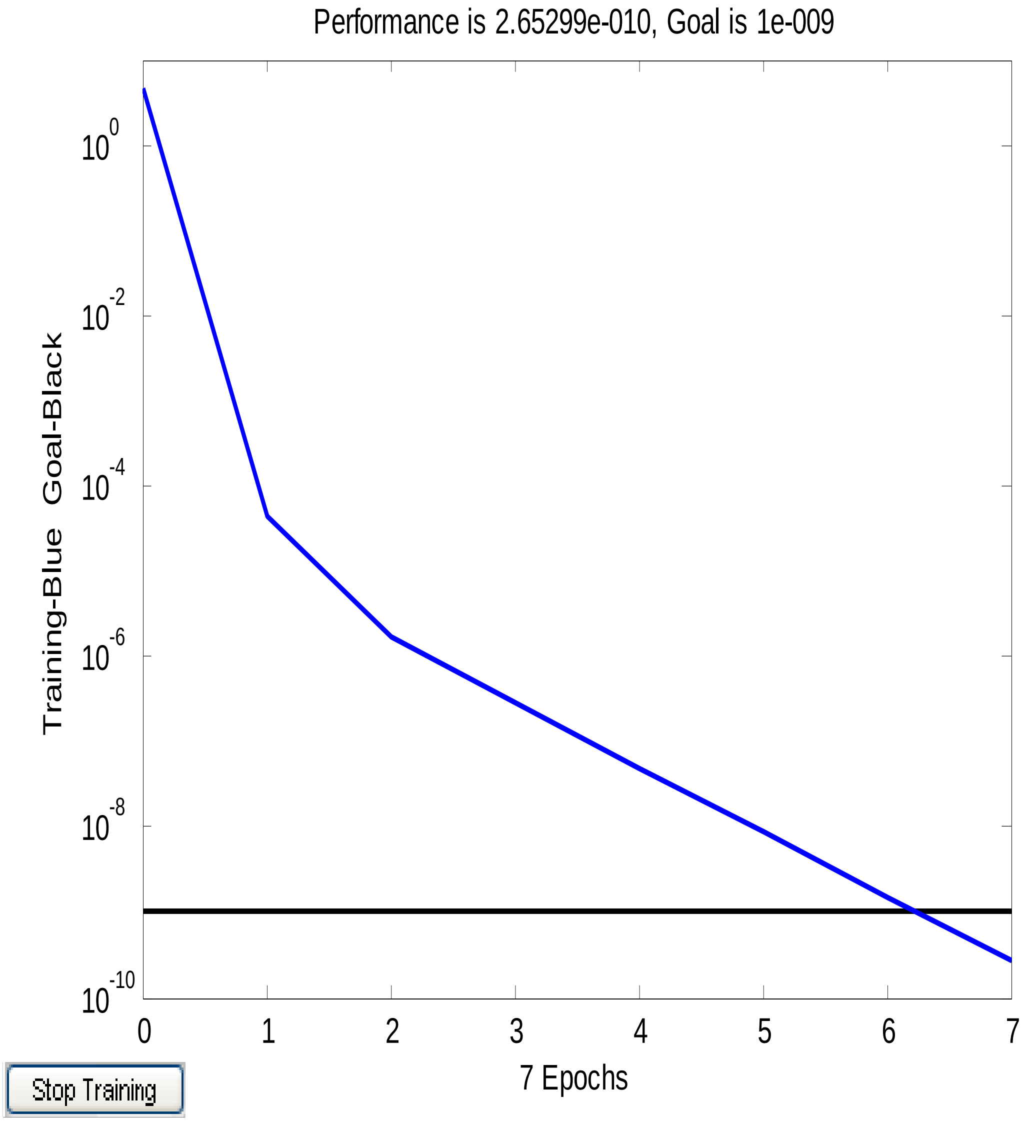


Figure 9. EMG Signal training using feed forward network by 4layer network

By using the feed forward network we will train the signals and the network can be trained for different layers here the above Fig. 9 shows the training of a 4 layer network. The various training patters will give a particular pattern for varous types of data input and then can be used to control the robotic arm.

6. Conclusion and Future Scope

The article has described an EMG based control of human arm gestures. The signals are identified by the well known neural network feed forward algorithm to train the signals. The results show the various gestures, how they are processed and they are trained to meet the necessary goal. Thus, by using the EMG controlled robotic manipulator we can develop an adaptive human supporting system. We can control the robotic arm successfully using the EMG signal. In this way we can help the amputated people and can give them support.

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