EMULATED OPERATION OF A ROBOTIC MANITPULATOR BY ELECTROMYOGRAPHY SIGNALS

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Abstract:

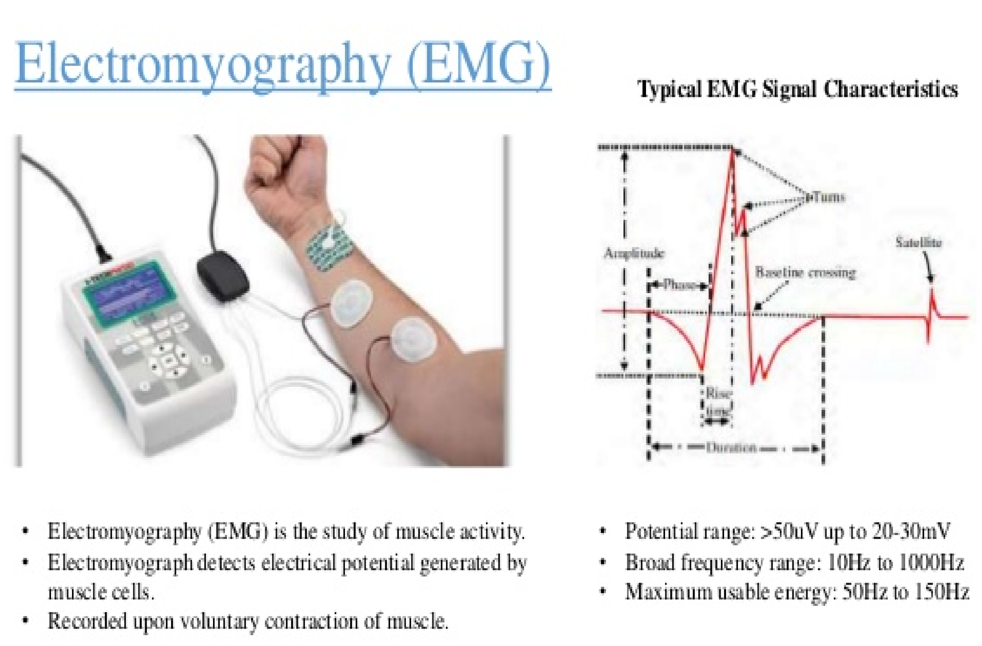
Electromyography (EMG) is an electrodiagnostic medicine technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using an instrument called an electromyograph to produce a record called an electromyogram.

This paper proposes to find a solution to the two possible challenges, namely the manipulator movement speed and accurate angle the manipulator lifts. This challenge can be resolved using Electromyography (EMG) signals taken from the muscles of the body. The extracted signals have some noise which must be filtered in order to analyze the correct muscle signal, this can be imitated using a manipulator. The system consists of a control part which maps the coordinates to the position of manipulator. The control part maps the position of the manipulator based on the amplitude and frequency of the EMG signals. These signals are distinctive to individual poses and can be discriminated using a suitable classifier.

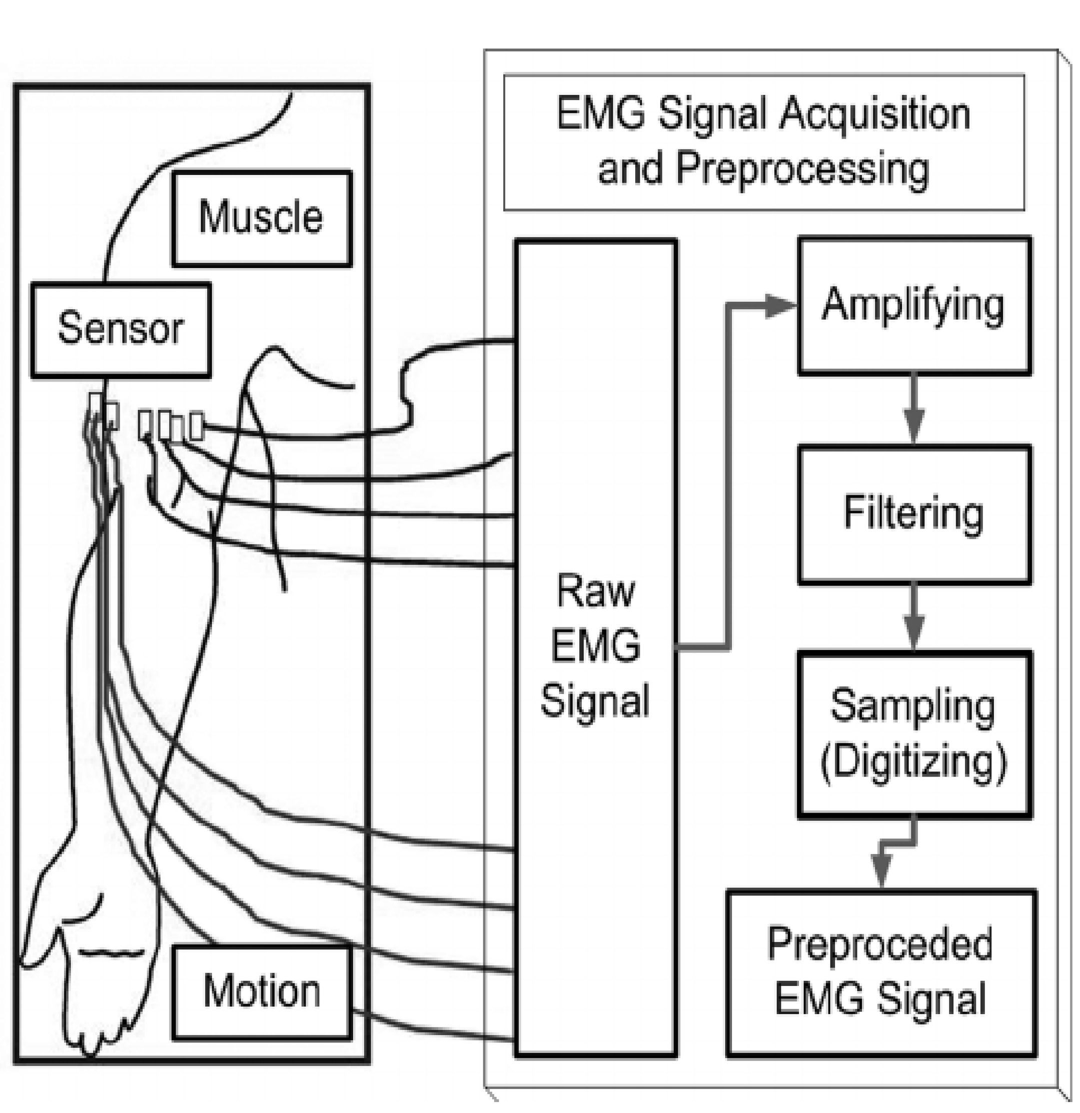
Once the above issues are resolved this application can be very useful for amputees. For an example, a war veteran who has lost his arm can make the use of this technology to make his/her life easy. The brain sends the arm muscle signals which we can read and filter only muscle signals which can be sent to the robotic manipulator as an electrical signal and make it work accordingly.

Introduction:

Electromyography is the discipline that deals with the detection, analysis, and use of the electrical signal that emanates from contracting muscles. This signal is referred to as the electromyographic (EMG) signal. An example of the EMG signal can be seen in Fig. 1. Here the signal begins with a low amplitude, which when expanded reveals the individual action potentials associated with the contractile activity of individual (or a small group) of muscle fibers. As the force output of the muscle contraction increases, more muscle fibers are activated, and the firing rate of the fibers increases. Correspondingly, the amplitude of the signal increases taking on the appearance and characteristics of a Gaussian distributed variable [1].



As we know robots find useful in many fields. The human robot interface has been proposed in several studies earlier. Most of the previous work proposes complex mechanisms where the user should be trained to map his/her action to the motion desired for the robot. In this project, a new means of control interface is proposed, in which the user performs natural motions with his/her hand. Surface electrodes which are placed on the user's skin record the Electromyography (EMG) activity of the muscles of the forearm. The recorded muscle activity was processed such that they can be used to control the robot arm. Here we use a pick and place edge robotic arm which moves according to the arm movements. In this project, we propose a methodology for controlling an anthropomorphic robot arm using surface recordings from the muscles of the upper limb, which is robust to time variation of EMG signals.

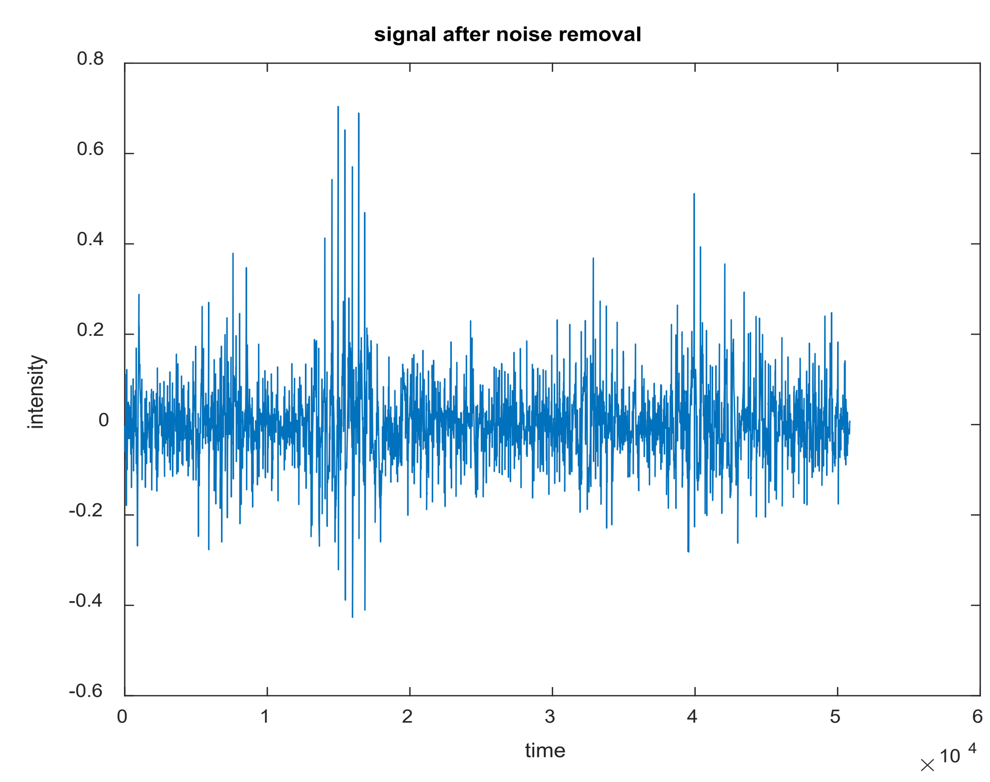


Methodology:

There is no doubt that the EMG signals are non stationary signals which are complex. However, they can be used for interfacing the human with the robotic devices. Here, a human-robotic interface arm is proposed using the EMG signals.

EMG sensor is placed on the rear side of the Brachii Bicep. This selection is feasible due to fact that there is very less clutter from surrounding muscles during movement. Sampling of 1000 Hz is enough as given in Burden and Bartlett (1999). Signals are acquired through Arduino Board. Uno or Mega is preferable due to its easy functionality. These signals are read in MATLAB. Signals undergoes a first set of filtering to remove high frequency noise. After noise removal, the signals are amplified.

The amplified signals are decomposed for a frequency selective analysis of EMG signals. The frequency component of the signal corresponds to speed of the motor and the amplitude of the signal angle of rotation of the motor. Motor used for this project have auto lock mechanism. Until and unless a signal comprising to return to original position is initiated by the user or a reset button is activated, the robotic arm will remain in its position.



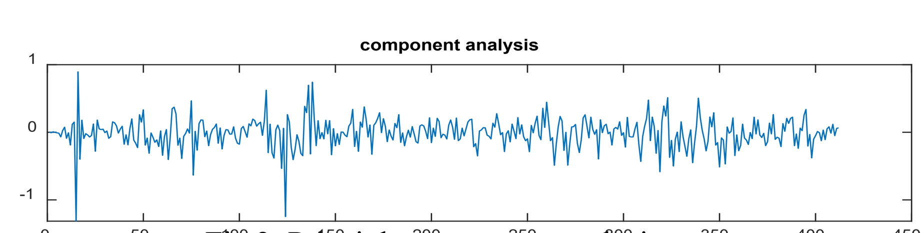


Fig 2: Principle component analysis

Analysis:

Theoretically, EMG signals contain various frequency components with various amplitudes. The first task here is to filter the signals from different muscles. Placing the sensor near the Brachii Bicep is advantageous because it extends from shoulder to the middle of the fore arm. A 3 - DOF manipulator can easily be controlled Principle Component Analysis (PCA) selection. PCA decomposes different movements of the arm based on the frequency component. Figure 2 shows PCA of the EMG signal in figure 1. Distinguishing the signals through PCA gives a clear image on the amplitude and frequency. According to theory, after the PCA an averaging filter is used to average out the amplitude of the peaks. This will provide a smooth curve for the arm to map the coefficients for the angle and speed.

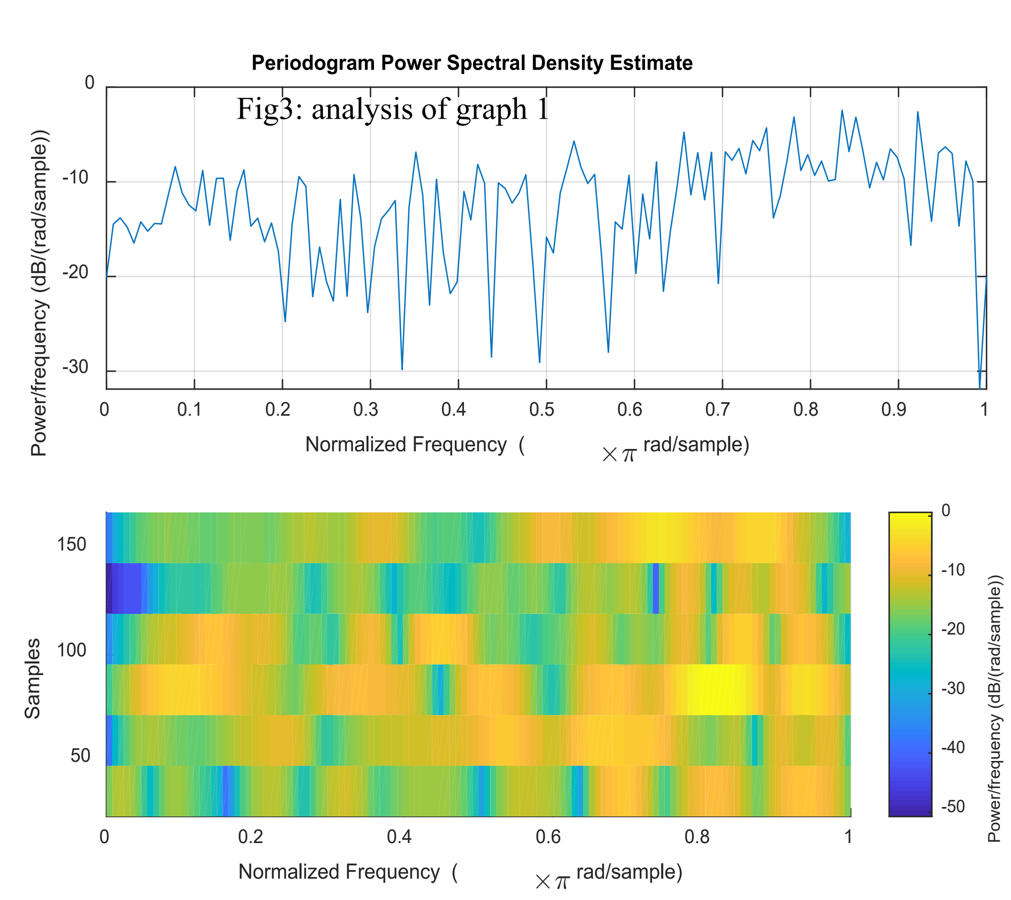
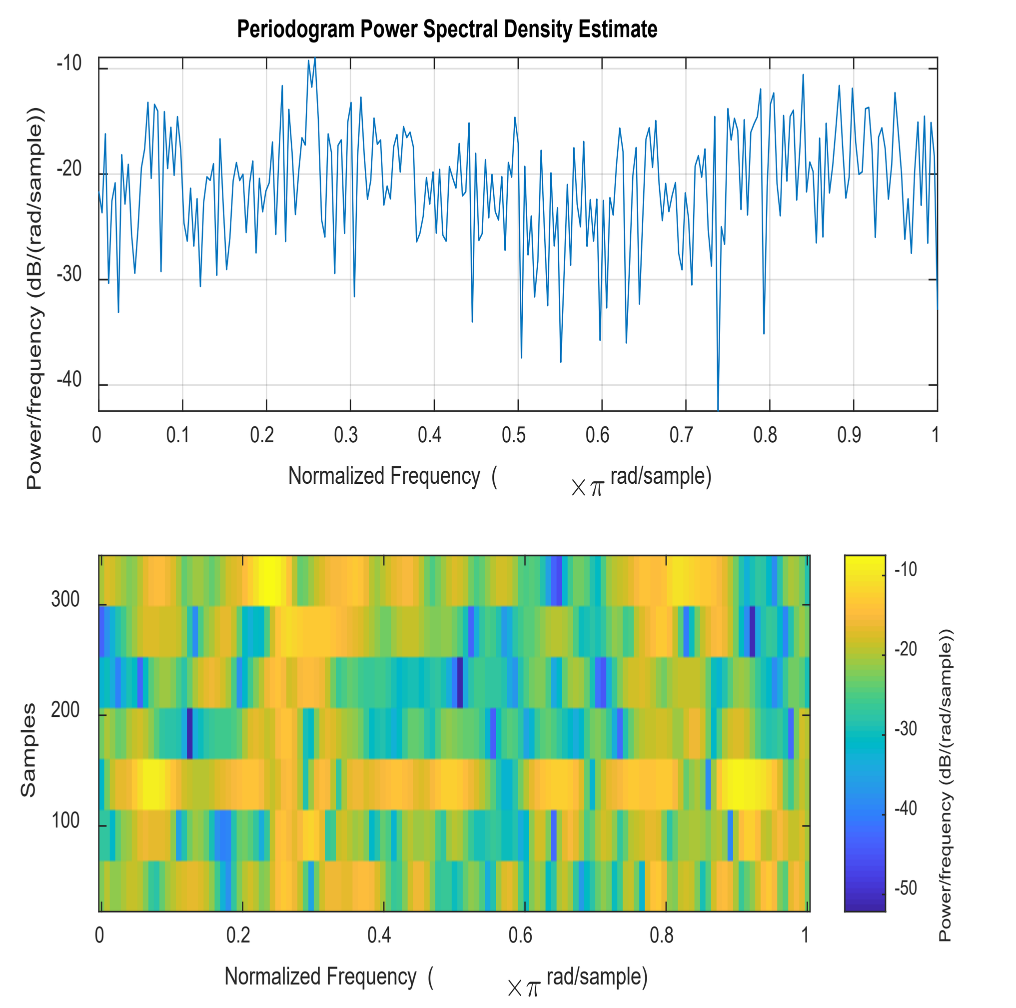
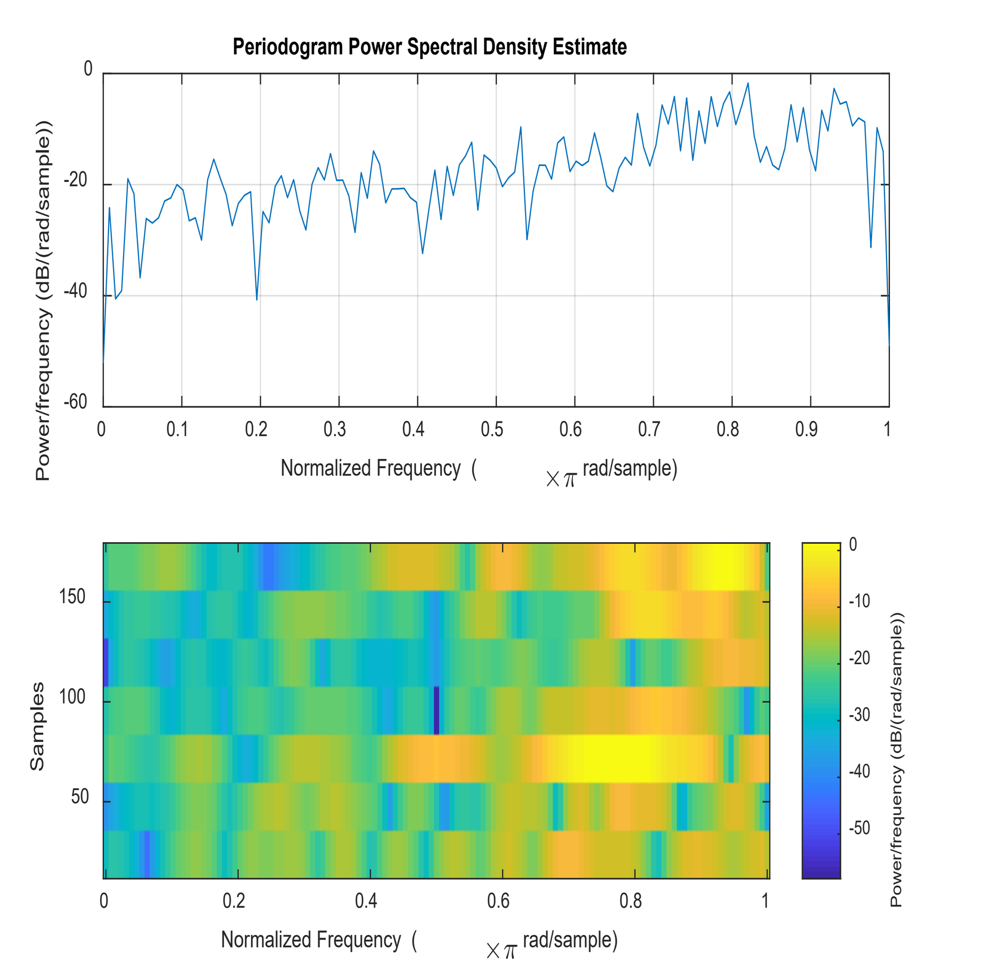


Fig3: analysis of graph 1



Any bio-signals are non stationary in nature but also, they are causal and non deterministic. The periodogram and spectrogram of signals in figure 2 are plotted above, respectively. Analyzing the spectrogram we come to know the signals do not have a loss over -30 db. Which makes it possible to map the coefficients based on the frequency and amplitude. The periodogram of the signals shows Fourier transform of the autocorrelation function of each signal. the frequency of each muscle can be distinguished using the specified method which makes it possible to obtain a movement of a 3 –DOF manipulator.



Conclusions and Future Work:

As neural interfaces are picking up enthusiasm for various fields extending from therapeutic applications (engine restoration, neuroprosthetics, assistive gadgets) to human PC interfaces (gaming innovation, remotely worked gadgets, human-machine association), EMG signals assume a huge job because of their common sense and noninvasiveness. It is, in any case, the effectiveness of this human machine control interface that will at long last choose whether they will be utilized in consistently life applications or not. Advances both in equipment (brilliant terminals, on board processing, and so forth) and programming (auto-adjustment, high-transfer speed data interpreting, and so forth) are required for making EMG a proficient control interface.

The EMG flag can be utilized as a solid marker of strong sicknesses. In the present work, discrete wavelet transform, and the neural system classifier are introduced as indicative devices to help the doctor in the examination of solid infections. A wavelet based neural system classifier has been proposed for EMG arrangement.

In this paper, a novel human– robot interface for robot teleoperation was presented. EMG signals recorded from muscles of the upper limb were utilized for extricating kinematic factors (i.e., joint points) in order to control a human robot arm continuously. In this paper, the strategy was tried for movements in the 3-D space, with vary-capable speed profiles. Additionally, this paper proposes a system that can be effectively prepared to every client and sets aside little opportunity to fabricate the de-coding model, while the computational burden amid ongoing operations unimportant.