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Study of Advanced Techniques Onreal Time Analysis of Muscle Activities

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ABSTRACT*: The Electromyogram is an Electro diagnostic medical technique for evaluating and recording the electrical activity produced byskeletal muscles occurring during the contraction are measured at a given electrode location. The relationship between humans' muscles activity and generation of EMG signal is investigation by different methods. This EMG signals were captured from the right-hand muscles and measured in response to various stimuli.*

EMG is an electrical signal related with the activation of the muscle. This may be unsimilar muscle contraction such as normal, adding weights 1kg, 2kg with support and without support is related tension. This technique can be adjusted to allow the required percentage of match to be obtained between the signals. The collected data was then used to extract a set of features using various techniques such as MATLAB and is classified.

KEY WORDS: *EMG, BIOPAC, neuromuscle, medical safety standard*

I. INTRODUCTION

EMG (Electromyography) is an instrument for measuring the electrical activity of the muscles. When the muscles are in work or under action, they produce some electric current. The current produced isgenerally proportional to the level of the muscle activity. EMG is a signal that measures the current in muscles during neuromuscular activities [1]. The analysis of EMG is a biomedical application.

The study of the recording of electrical activity of muscles is started in the early eighteenth century and is continued till date. These studies are proven to be the best for clinical diagnosis and estimation of nuclear diseases and damage in peripheral nervous system [3].

In the process of EMG, we transform the physiological information from muscles to the visual signals. The process of EMG is to detect the abnormal electrical activity of muscles.

EMG makes use of surface electrodes to analyses the electrical activity. The signal from the electrodes is given back to the user in a visual format. There are two kinds of electrodes that can be used surface electrodes and needle electrodes. Surface electrodes helps in analyzing the small voltage changes in working muscles. The electrode gel helps in converting the biological signals to electrical signals, and also help to reduce the noise. Needle electrodes are used in neuromuscular appraisals. The needle of the electrode is placed in the muscle and the muscle activity is analyzed using the needle [1]. The signal is collected by the electrode and is amplified generally using a differential amplifier in the first stage and other amplification stages may include based upon the device used. The signal before displaying can be further reduced in low frequency or high frequency noise but in EMG we highly concentrate on the amplitude of the signals obtains. So, always the signal obtained is rectified and averaged before obtaining and displaying the EMG amplitude.

EMG is generally a function of time and can be represented in terms of amplitude, frequency and phase. The amplitude of the EMG signal varies from 10Hz to 3000Hz [2].

The EMG signal is controlled by the nervous system and depends upon various factors such as type of body tissue, anatomical and physiological properties of the muscle.

Many researches have been conducted in the past by using different types of advanced methodologies, comprising wavelet transforms, Wigner-Ville Distribution, Independent component analysis, Empirical mode decomposition, and higher-order statistics for analyzing the EMG signal appropriately.

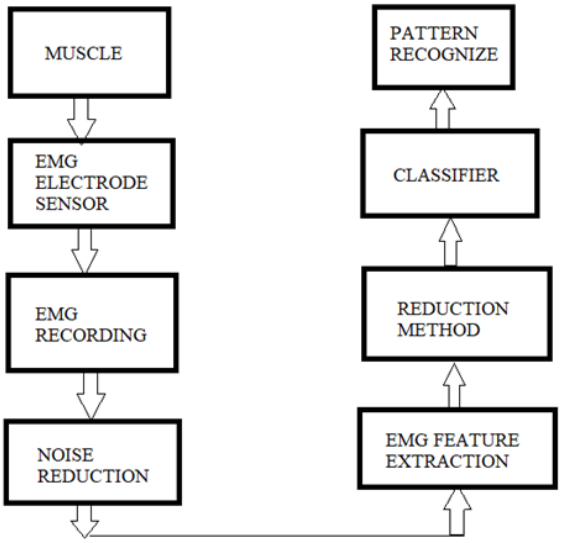

Fig 1: *Block diagram of EMG biofeedback system*

II. METHODS:

EMG analysis is done using many techniques. Initially the data acquisition was done using basic circuitry with RLC components. Later researches has developed its range and introduced many devices for the data acquisition and analysis.

2.1. BIOPAC:

BIOPAC is one of the most efficient and accurate data acquisition system. Filtering options include both real-time and post-acquisition filtering for optimal conditioning of data. BIOPAC includes inbuilt advanced filtering technique. Here we use BIOPAC and MATLAB. BIOPAC offers a variety of surface EMG and analysis options. EMG is recorded with reusable and disposable surface electrodes.
The data obtained using BIOPAC can also be processed through MATLAB tool which give different time domain and frequency domain analysis as shown in fig9.

2.1.1. MP ACQUISITION UNITS:

BIOPAC involves MP AQUISITION UNITS. The MP data acquisition unit is the heart of all BSL (BIOPAC students lab) System packages. There are internal microprocessors in the MP unit to control the data acquisition and communication with the computer. The input signals are converted into digital signals and are processed using a computer. The MP Unit is connected to the computer and electrodes, transducers, and or I/O devices must be connected to the MP Unit.

The MP acquisition unit used in the current study is the MP45 system.The MP45 satisfies the Medical Safety Test Standards affiliated with IEC 60601-1. The MP45 is designated as Class I Type BF medical equipment.

2.1.2 TYPES OF INPUTS:

There are three devices that are to be connected to the MP45 unit which are electrodes, transducers, and I/O devices.

- Electrodes are attached to the surface of the skin to pick up the required electrical signals
- Transducers are used to convert the physical signals obtained in electrical signals.
- Input and Output devices may be pushbuttons and head phones

.
The BIOPAC MP45 is shown in the below fig2 which shows two channels and a cable to communicate with the computer.

Fig2: *BIOPAC MP45 acquisition unit*

2.1.3. SPECIFICATIONS:

Analog Inputs Front panel DSUB 9f labeled "CH #"
Number of Channels : Isolated human-safe universal input amplifiers**MP45: 2 Channels**
A/D Sampling Resolution:MP45: 16-bit
Gain Ranges:5x to 50,000x (13 steps)
Input Voltage Range:Adjustable from ± 200 µV to ± 2 V
MP45 ± 10 V with SS70LA
Signal to Noise Ratio:MP45: > 75 dB min
CMRR:85 dB minimum
Software Filters:Three programmable digital (IIR) - automatic or user-adjustable filters
Hardware Filters:
Low pass –8 KHz
High pass – DC, 0.05 Hz, 0.5 Hz, 5 Hz

The study involved here includes the acquisition of the data of 13 subjects. The subject contains 4 females and 9 males with ages between 19-74. They are considered to have a normal health status. The measurements are performed in a normal atmosphere where the subject can sit in a relaxed manner. The subjects are enquired about the parameters like age, gender, height, weight, daily basis exercise etc.,

2.2. SIMULATION:

The simulation tool used here is MATLAB. The name MATLAB stands for MATrixLABoratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects. MATLAB is a modern programming language environment. It has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming.MATLAB has many advantages compared to conventional computer languages for solving technical problems. It has powerful built-in routines that enable a very wide variety of computations. It also has easy to use graphics commands that make the visualization of results immediately available.Specific applications are collected in packages referred to as toolbox. There are toolboxes for signal processing, symbolic computation, control theory, simulation, optimization, and several other fields of applied science and engineering.

In this study we use MATLAB tool to plot different plots regarding the measurements of each subject. We consider the data took from the BIOPAC signal and feed it to simulation tool to obtain the graphical formats.

The overall methodology including can be seen in the format as shown in fig3

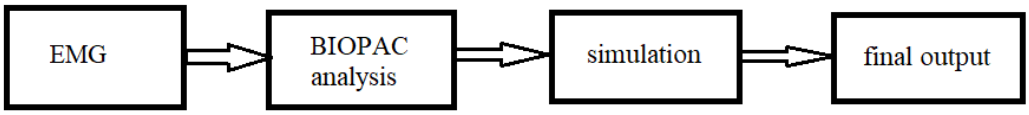

Fig3: *overview block diagram*

III. EXISTING METHOD:

Surface **EMG** is a **method** of recording the information present in these muscle action potentials. When detecting and recording the **EMG** signal, there are two main issues of concern that influence the fidelity of the signal. The first is the signal-to-noise ratio.

Higher-order statistics (HOS) is a technique for analyzing and interpreting the characteristics and nature of a random process. The subject of HOS is based on the theory of expectation (probability theory). Due to the limitations of:

- The detection and characterization existing nonlinearities in the EMG signal;
- Estimate the phase; and
- Exact information due to derivation from normality.

IV. PROPOSED METHOD:

The proposed method includes placing of surface electrodes on the skin and extracting the EMG signals using BIOPAC MP45.BIOPAC is a system which has inbuilt differential amplifiers and filtering techniques.

Here, in this study we conducted a survey to collect the real time inputs from 13 subjects using BIOPAC MP45.the subjects are given different tasks in order to stress their muscle and consider their ability.In the very first task the subject is asked to be in a normal state without stressing the muscles or the body. The subject is asked to relax for 30-50 seconds after every task.

The second task involves holding the hand tightly and release so as to stress the wrist muscles. The third one is lifting a 1kg weight without a support. the fourth and fifth tasks include 2kg weight with and without support to test the capacity of the subject. The final sixth task includes punching or applying force.

The EMG is taken while performing the task so that the clear changes in the muscle activity may be observed. Different parameters like peak-to-peak, mean, median, standard deviation, and maximum are taken from the recorded EMG data of each subject.

V. RESULTS

EMG signals are measured by non-invasive methods like using surface electrodes to measurethe EMG signals. SilveRestpregelled Ag-AgCl EMG electrodes are the commonly used standard in measuring electrodes. The data obtained from a module channel is a raw data from every channel in the form of voltage in units of mV amplitude in the time domain. Raw Data is used as input to the next module. Additionally, the raw data is stored in a file format ‘mat' so that the raw data can be viewed by others, such as MATLAB applications.

The main right muscles of the hand Flexor Carpi Radialisand Biceps BrachiiCaput Longus have been takeninto consideration for measurement. 13 persons of age group 19-74 have been taken into consideration for EMG signals measurement. Fig.3 shows the measurement of Surface EMG (SEMG) signals from the Flexor Carpi and BicepsBrachii muscles. Pair of electrodes of white and red colours has been used on the respective muscle and a reference electrode of black colour has also been used to reduce the interference and noise effects. Before the start of each measurement, at least 5-7 seconds preparation time, also called as delay time is taken. After that,the action time for 6 movements (Normal, Contract,1kg, 2kg with support, 2kg without support and Punch) in sequence is total of 07- 300 seconds. When the acquisition is over, the upper limb of the subject restores to the initial state and takes rest.

Fig3: *Measurement of EMG and Placement of Electrodes*

The 1000 Hz is fixed as sampling frequency and 16-bit A/D converter is used. The CMRR of module is 110dB. The six movements of hand which have been taken into consideration are (i) Elbow Normal, (ii) Elbow Contract and Relax, (iii) Hand with 1kg, (iv) Hand with 2kg, (v) Hand with 2kg without support (vi) Hand

Punch. The EMG signals measured for different movements of hand are shown in the Fig4 and fig5 and task performance 1kg and 2kg in fig5 and fig6 respectively.

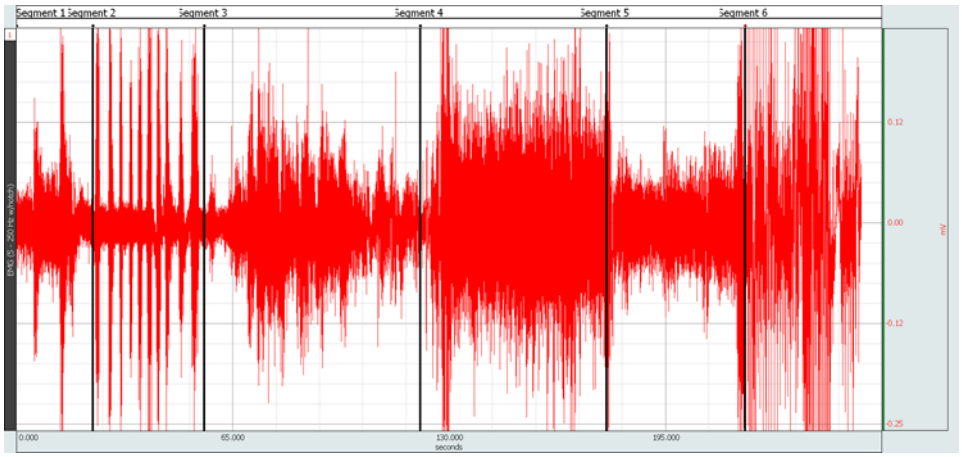

Fig4: *Signal Measured from Biopac*

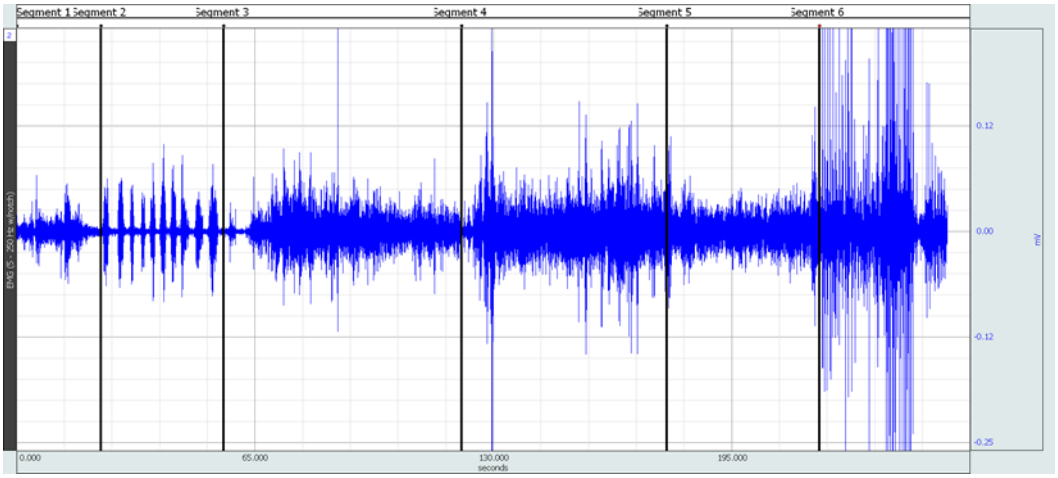

Fig5: *Signal Measured without Noise*

Fig5: 1kg *Fig6: 2Kg*

The different parameters obtained from the signal are shown in the table

		p-p	Mean	median	stddev	max
Task1	normal state	0.141	-0.003	-0.003	0.016	0.081
Task2	contarctrelastion	0.867	-0.003	-0.003	0.064	0.404
Task3	1kg weight	0.321	-0.003	-0.003	0.038	0.169
Task4	2kg with support	0.445	-0.003	-0.004	0.045	0.263
Task5	2kg with out support	0.769	-0.003	-0.002	0.075	0.392

Task6	punching		0.552	-0.005	-0.004	0.061	0.327

To make analysis easy with characteristics or features are extracted from the EMG signals shown in the Fig.7. A Software Analysis module has been developed for the whole processing (feature classification) of the EMG signals. After analysis of EMG signals for all five people for all six movements, it is clear that the simulation is working very accurately. After calculating the Mean, peak to peak, median, standard deviation and maximum of all five parameters for all 13 people for the six movements, graphs can be shown to analyze the data

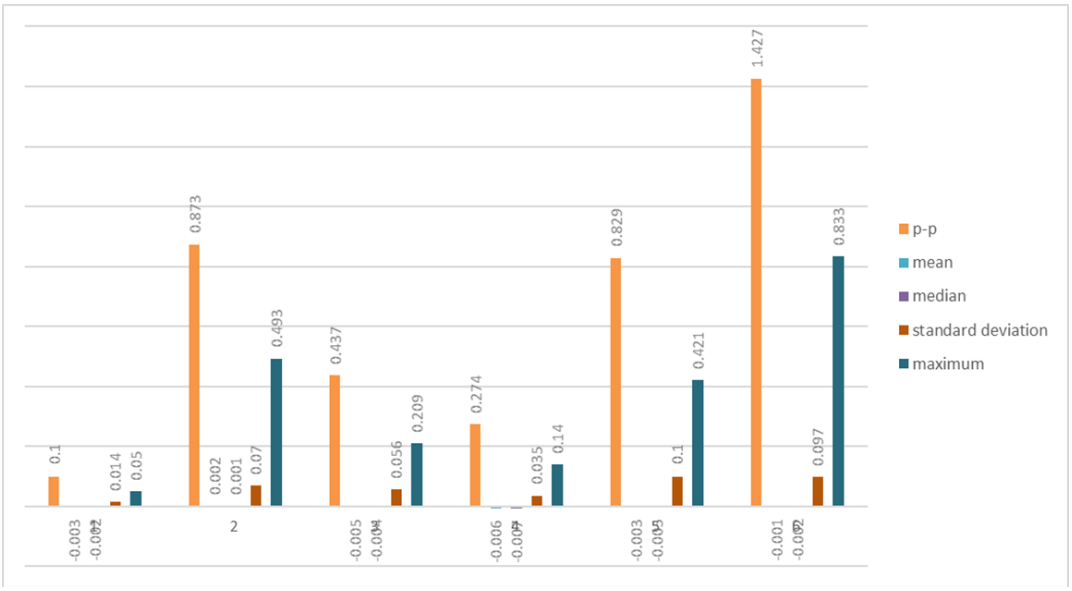

Fig7: *EMG Signals feature extraction*

To measure these five parameters on front panel window of MATLAB. The MATLAB software has been used to find and evaluate the true values of these parameters using the Biopic EMG signals shown in Fig8

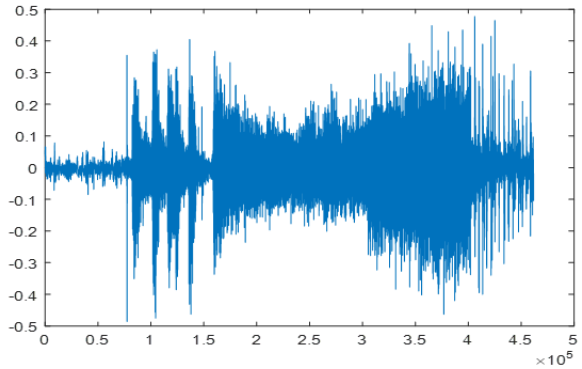

Fig8: EMG Signal Validated with MATLAB of EMG signal

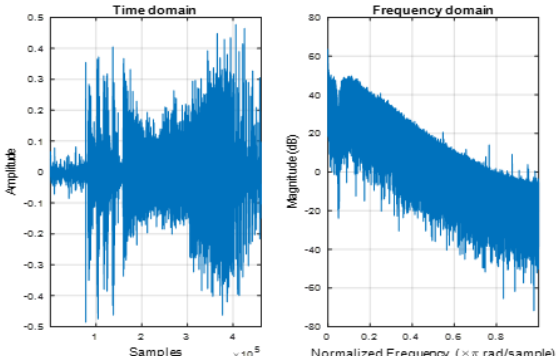

Fig9: time domain and frequency domain representation

VI. DISCUSSION

This study shows a linear relationship between RMS values of the EMG signal and contraction force, at some subjects, but not at all the subjects. We should select the subject randomly irrespective of body mass index between the normal values or other features of a healthy life. It was observed that only in the cases with the subjects with a regular physical activity and with the normal BMI values there was a good linear relationship between the RMS and percentages of maximum voluntary contraction.

This study also shows that many unwanted signal sources such as ambient noise, inherent noise in electronic equipment, motion artifacts can be attenuated to a maximum extent by using an active electrode.Anyway, this basic technique is not sufficient for the elimination of noise problems. Later to reduce this noise some advanced techniques have been introduced by the researchers. The use of the electromyography

pattern recognition method is very important in different applications such as rehabilitation devices, prosthetic arm or leg control, assistive technology, symptom detection for neuromuscular disorder, and so on.

VII. CONCLUSION

The moment associated with the long axis of the arm decreased with the addition of a mental task but with no other conditions. while grip condition affected forces in the proximal- distal direction and the moment across the arm. Muscle variance was thought to be an indicator of interference and was found to be increased in the deltoids with additional tasks. These are small yet significant findings which reflect the complexity of multitasking and may play a role in the development of long-term musculoskeletal disorders in the workplace.

The Biopic EMG analysis appears to be a powerful method for quantification of rhythmic oscillation in motor system from surface EMG. Oscillatory activity of Right-handmuscle could be of central and/or reflex origin. Strategies of EMGstabilization during a maximal contraction of the upper limb may be different according to gender.

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