Measurement of Muscle Activity with Different Range of Motion using Arduino Advanced Software

Article *in* Journal of Green Engineering · September 2020

3 authors:

Zainab Majid Nahi
Middle Technical University/Electrical Engineering Technical college

Noor Al-sharify
Issra UNIVERSITY

Zainab T. Al-sharify
Al-Mustansiriya University

Journal of Green Engineering (JGE)

Volume-10, Issue-9, September 2020

Measurement of Muscle Activity using Arduino Advanced Software for Sustainable Aid

[1]Zainab Majid, [2]Noor T. Al-Sharify, [3,4]Zainab T. Al-Sharify*

[1]Electrical Engineering Technique College, Medical instrumentation Engineering Department.
[2]Assistant Lecturer, School of Engineering Medical Device Technologies, Issra University, Baghdad, Iraq.E-mail: z.t.alsharify@uomustansiriyah.edu.iq
*[3]*Lecturer, Department of Environmental Engineering, College of Engineering, Mustansiriyah University,Bab-al-Muadhem, Baghdad, Iraq.*
[4]Academic visitor, School of Chemical Engineering, University of Birmingham, Edgbaston, Birmingham, United Kingdom.E-mail: zta011@alumni.bham.ac.uk

Abstract

The permanent human activities on daily basis to improve the living environment affect the person health which needs a sustainable medical aid. Biomedical and chemical engineers play a great role in applying advanced technologies to medicine to ensure health care field progress. Electromyography (EMG) is an analyzing, recording, and evaluation technique for muscle-generated electrical activity. The current research aims to design an electrical system that introduces techniques of electromyogram (EMG) encoding and analysis that provide data on the strength of muscles or their work in human movement. In this research, we design an electrical system to estimate the activity of any muscle in the human body. The designs measure the power of contraction in the normal case, athletic body muscles and in case of Neuromuscular disease is a group of nervous disorders that control the voluntary muscles which are the muscles of the body that a person can control, such as the arms of the arms and legs. This design has the same efficiency of EMG instrumentation but with a simpler circuit. The basic of design depended on my-sensor on biceps muscle and uno-arduino. Muscle activity measured with different weights loaded by hand and different range of motion of elbow joint.

Journal of Green Engineering, Vol. 10_9, 4965–4976.

Alpha Publishers

Keywords: Myo-Sensor, Arduino, Range of Motion, Elbow Joint Bicep Muscle, Biomedical and chemical engineers, sustainable, environment.

1 Introduction

Electromyogram (EMG) is a traditional technique for measuring the electrical activity of the muscles. EMG uses electromyography, which provides a record known as an electromyogram[1-4]. The EMG signals are used to examine the cause of muscle weakness, numbness, several types of limb pain, cramping, and muscle disorder such as polymyositis or biomechanics of living beings movement that can be used to find the weakness and strength level of muscles for recovery purposes[5].

Electrical muscle planning as the process of recording the electrical activity of the captured muscle and indicated that electrophysiological planning of the muscle is another standard method of studying movements and showing the involvement of muscles in a movement where myo-sensor are placed above the place of the muscles[6].

The myo-sensor are working directly and are fixed with adhesive tapes on the skin located above the muscle wanted to be tested. It makes the signals of this activity processed by connect the sensor with arduino and estimated with different cases.

On the strength of muscle contraction, the amplitude is generally indicated a greater contractile strength. Although the relationship between the muscle signal and muscle strength ranges is good and under controlled conditions of a particular muscle, the researcher may encounter several conditions that reduce the degree of the relationship; therefore, the amount of power generated does not adequately reflect the amount of muscle activity recordings performed routinely in normal condition[7-9].

In general, the electrophysiological recordings of the muscle in this form are useful for obtaining information about the current composition of motion forms but with limited use to determine the forces contributing to that work[10-13].

In a manual lifting task, an object of definable dimensions angles is grabbed with both hands and move the objects without the use of any automated device vertically,[14-16]. Lifting tasks frequently are performed by manufacturing employees to relocate items to the requested location. Even though there is so much mechanized and automated equipment available, manually lifting tasks is a common choice and a critical method to operate material handling tasks[17, 18]. The faulty elevation could lead to wounds like pain in the back. Back pain is a common problem and causes numerous losses, including an increase in medical costs, low productivity and a lack of care[7, 19-21].

Much research work has been done to analyze the EMG signal, and many techniques have been proposed. Some used a fast Fourier transform (FFT). However, the magnitude and frequency of EMG signals are variable, and FFT is appropriate for the stationary signal. Also, it provides spectral information only[22-24].

In this study, EMG signals are analyzed to identify muscle activity by locating the cases and characters in different angles of muscle. Male biceps produced an EMG signal. The raw signal was divided into four cases that are used to analyze the recorded data to get the mean power frequency (MPF). The muscle activity in different cases can be evaluated to detect the muscle forces based on the peak voltage of the case.

2 Experimental Work

Many types of equipment were used in the experiments to measure the parameters, including Arduino UNO (Microcontroller), Muscle Sensor (Myo Ware), adjustable shelf, loads, weight scale and FEATURES of Myo Ware. EMG circuit board is the leading equipment for recording signals of each lifting. The electrical activity produced by the muscle contraction was recorded, and the response of biceps muscle is collected. Figure 1 shows the final assembly of the project design.

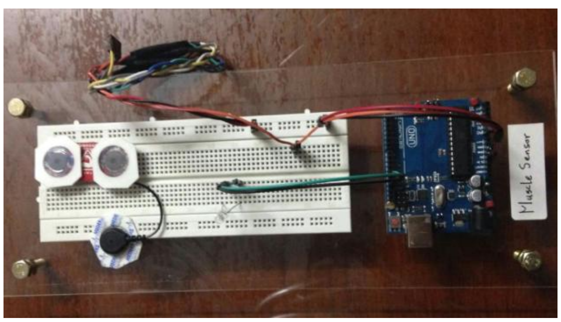

Figure 1: Assembly of project design

Muscle signals were recorded from four persons who have no history of musculoskeletal difficulty. All the subjects were right-handed.

The participants were urged to lift the weights of 2, 4, 6, and 8 kilograms at different angles of 30, 60, and 90 degrees. In the lifting exercise, each participant has to contract the arm to stimulate the biceps muscle. The weight must be lifted until the selected angles are reached. Every lifting has produced muscle contraction signals, and every signal has been separated into three cases based on the lifting angle. The lifting angles are illustrated in Figure 2.

Figure 2: Lifting angles

The Project Algorithm of the lifting procedure is shown below in the following Flow Chart of Figure 3. Depending on analog voltage value, the led will turn on off and the voltage signal will plot eventually. If the time recorded is less than 500, the instrument will read the voltage form the beginning.

A self-designed EMG circuit, backyard spike logger, and algorithm program have captured, processed and analyzed the EMG signal produced by muscle movements. In order to ensure that all EMG processes were recorded, the non-invasive EMG surface assessment was stated. The electrodes were positioned as an electrode input to biceps. Figure 4 shows the place of the EMG electrode on the biceps branchii.

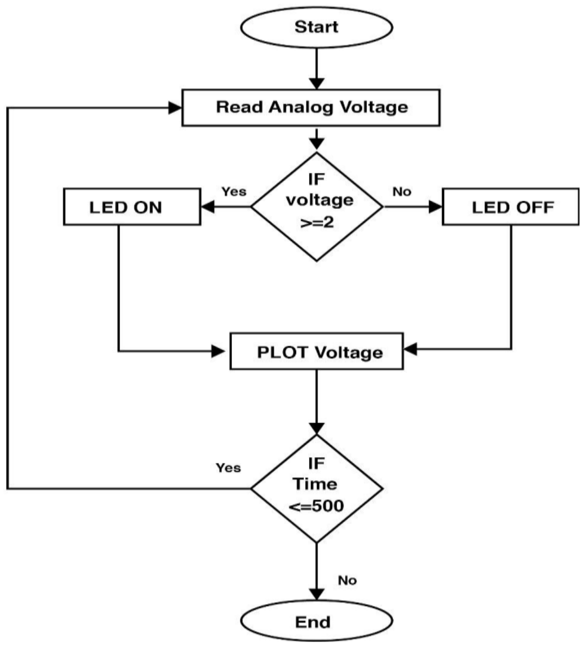

Figure 3: Flowchart of lifting procedure

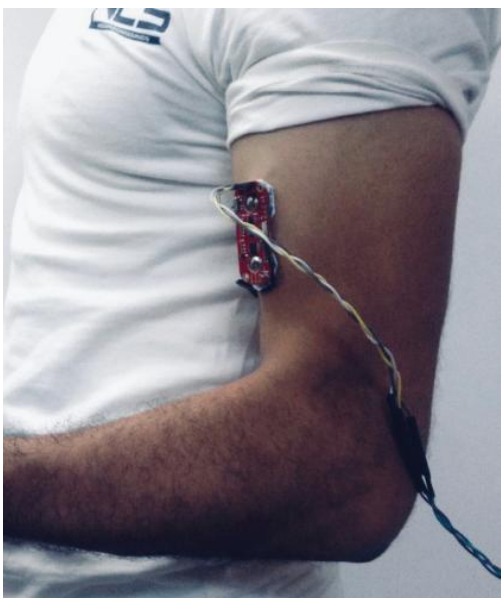

Figure 4: The place of the EMG electrode

On spike recorder software, the EMG signal was recorded. The recorded signal was then divided into three different sets of experiments in which each set was further broken down into three angles.

After getting the values of each case of every angle, mean power frequency was calculated by Muscle Sensors designed to be used directly with a microcontroller. The output sensor is not only a raw EMG signal, but an amplified, rectified, and combined (AKA EMG envelope) signal, which works excellently with the analog-to-digital converter (ADC) microcontroller. A descriptive signal from EMG reveals this discrepancy below. This method produces the best outcomes for research, which can help the researcher understand muscle tension during manual lifting, based on the intensity of the signals.

3 Result and Discussion

During physical loading, the EMG pulse was assessed using workout muscle activity. The participants reiterated the lifting mechanism till the muscle exercise was experienced.Algorithm Software had been utilized to analyze the data recorded and to identify various parameters, such as average rectified electronic transmission, built-in EMG, root medium square, electrical transmission and frequency analysis. The algorithm software also identifies muscle arm initiation to recognize the exertion of the muscle. The selected signals were separated into three sub-divided cases. In the same way, all the results of the contraction muscle are divided one by one and subdivided into four cases and tested until arm faced with algorithm software to get the voltage data for the muscle exercise. The average values of signals for all angles during the manual lifting tasks are shown in Table 1.Table 2 shows the results of the ANOVA One-Way-Test, which shows that the average frequency parameters for all muscles during manual lifting were not significantly different (P-value>0.05). Data Analysis function in Microsoft Excel was utilized for getting the ANOVA One-Way-Test. In addition, the table shows the average values of the muscle activation for each experiment.The raw Electromyography signal recorded during the lifting task is shown in the Figure 4. In this figure , the two pulses are shown.

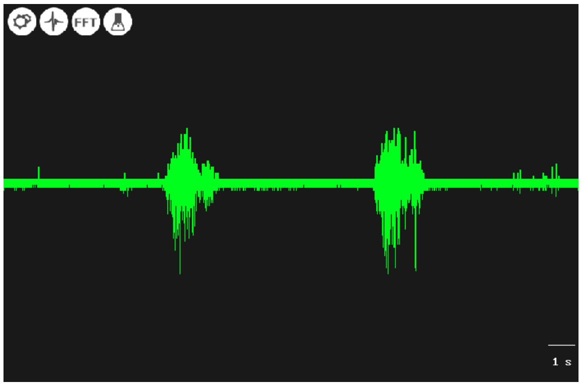

Figure 5: Sample of the raw signal

Table 1. Values of signals for all angles.

Lifting Angles	Load (kg)	Muscle activation (mV)				
		Participant #1	Participant #2	Participant #3	Participant #4	Participant #5
30°	2	8.1	8	7.9	7.95	8.03
	4	40.6	40.6	41.05	40.8	41
	6	62.11	60.92	61.2	62.15	62.5
	8	74.15	73.12	72.84	72.83	72.94
60°	2	5.24	4.73	4.54	5.6	5.01
	4	32.44	33.01	32.65	32.5	31.43
	6	54.1	53.72	52.8	52.92	52.8
	8	66	66.2	66.7	66.7	66.1
90°	2	3.1	2.83	2.95	3.2	2.88
	4	23.43	23.98	24.11	24.1	23.03
	6	42.02	41.8	43	43.11	40.64
	8	55.2	55.64	56	56.2	55.54

Table 2. Single-factor ANOVA analysis

Groups	Count	Sum	Average	Variance
Row 1	5	39.98	7.996	0.00583
Row 2	5	204.05	40.81	0.0455
Row 3	5	308.88	61.776	0.46003
Row 4	5	365.88	73.176	0.31003
Row 5	5	25.12	5.024	0.17483
Row 6	5	162.03	32.406	0.34673
Row 7	5	266.34	53.268	0.36392
Row 8	5	331.7	66.34	0.113
Row 9	5	14.96	2.992	0.02387
Row 10	5	118.65	23.73	0.23095
Row 11	5	210.57	42.114	1.01428
Row 12	5	278.58	55.716	0.15448

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	33092.27	11	3008.388	11130.33	8.65E-78	1.99458
Within Groups	12.9738	48	0.270288			
Total	33105.25	59				

Figure 6 illustrates the mean values graphs relative to muscle cases in various angles of the muscle's movements. The experiments presented show that EMG technology is feasible and that it has practical research applications. The simple-to-use EMG is inexpensive, durable, easy to construct and user-friendly.

The analysis revealed that when operating at different angles, different levels of muscle activity were observed. The expectations were met that performing with the lift at 30 leads to the lower muscle strain, the lift at 60 and the lift at 90 as a direct result of muscle contraction. It means that training to 90, combined with lifting at 60 and below, increases the likelihood of muscle activity. At low weight, the voltage signals were very close or all angles. Afterwards, increasing the weight lead to an increase in the gap between different angles. The maximum gap reaches the heights weight.

Muscle exertion state is a state when the capability of muscle to contract and generate force is decreased. It is generally describing as a point when the participants cannot continue the task further in time. Among all the cases, case 1 experiences maximum muscle exertion by doing lifting tasks with deferent angles as compared to cases 2 and 3 but other cases also experience muscle exertion because, at that point, the participants will utilize his all energy to lift the load.

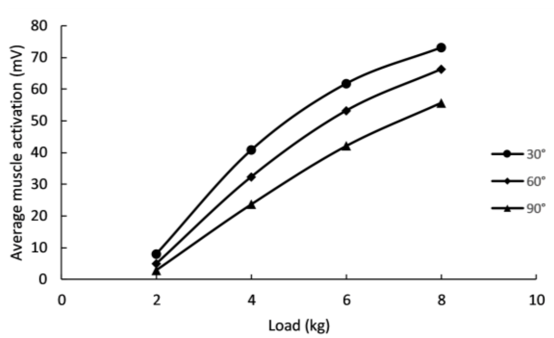

Figure 6: Voltage signals of all muscle movements

4 Conclusions

A new, minimally invasive muscle sensing tool was designed for recording data on muscle activity in normal and abnormal environments. The device allows simple usage, allowing novice users to collect data over a long period. The results of the study indicate that muscle stress rises with weight development (muscle contraction tension).

Through the decrease in the Elbow joint length, muscle relaxation pressure decreases. The highest muscle relaxation is when the elbow joint angle is 30 degrees or less for the most significant strain.

5 Acknowledgement

The authors acknowledge the support of Medical instrumentation engineering technical department, Electrical engineering technical college, Middle Technical University, Issra University and Mustansiriyah University, College of Engineering and their Laboratory staff for their support with the experiments.

6 Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the data and the paper are free of plagiarism.

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Biographies

Zainab Majid is a lecturer at the Electrical Engineering Technique College, Medical instrumentation Engineering.She received her BSc and MSc from Al-Nahrian University, Iraq. Her research focuses Biomedical engineering and its new applications, Imaging process and biomedical materials.

Noor T. Al-Sharify is a lecturer at the Medicisl instrumentation Engineering Department, University of Issra. She received her BSc and MSc from Al-Nahrian University, Iraq. Her research focuses Biomedical engineering and its new applications, Imaging process, biomedical materials and Nanotechnology.

Zainab T. Al-Sharify is a lecturer at the Environmental Engineering Department, University of Mustansiriyah. And she is academic vistior at chemical engineering department, University of Birmingham, UK. She received her BSc and MSc from Al-Nahrian University, Iraq, and PhD degree from the University of Birmingham, UK. Her research focuses Fluid flow, Nano particles, computational fluid dynamics and formulation technology.