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LOW-COST REAL-TIME ELECTROMYOGRAPHY (EMG) DATA ACQUISITION EXPERIMENTAL SETUP FOR BIOMEDICAL TECHNOLOGIES EDUCATION

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Abstract: Electromyography (EMG) is a technique used in electro-diagnostic therapy by recording and evaluating the skeletal muscle electrical activity. When muscle cells are activated, electric potential, which is produced by these cells, is detected via an electromyography. These signals can be use analyzing of medical activation levels, anomalies and detection of recruitment order. At the same time they can used to make analyses of biomechanics motions of human or animals. In this study, it was developed a real time EMG data acquisition system based on threshold level. Firstly, it was generated an EMG sensor and it was obtained EMG signals by communication between Arduino and LabVIEW interface by using muscle electrodes. It was purposed to use for developing of a low-cost real-time application in laboratory for biomedical technologies education.

Keywords: Real-Time Electromyography (EMG), experimental setup, LabVIEW, biomedical technologies education.

Introduction

Electromyograph (EMG) makes a diagnosis by measuring and recording electrical activities of muscles. These electrical signals of active muscles are easily obtained with electrodes, which are placed on surface of the skin to identify neuromuscular diseases, kinesiology and motor control disorders in medicine.

In literature, there are several studies based on different algorithms. Classification of EMG signals based on PSO-SVM, artificial neural network and radial bases functions for pattern recognition, and analysis depicting the superiority of ANFIS model (Adaptive Neuro-Fuzzy Inference System) were worked. These signals based on algorithms were used for controls of some type motors like stepper motors, in robotic applications.

In this study, it was developed a low cost real time EMG data acquisition system based on threshold level. Firstly, it was generated an EMG sensor and it was obtained EMG signals by communication between Arduino and LabVIEW interface by using muscle electrodes. It was purposed to use for developing of a low-cost real-time application in laboratory for biomedical technologies education.

Methods

Muscle Sensor / EMG Circuit Designing

In designing of EMG sensor, it is exploited from "http://www.instructables.com/id/Muscle-EMG-Sensor-for-a-Microcontroller/", but it is used INA 122 instead of INA106 because it is obtained good results from the study of "ANDRYNOWSKA A., KLEKIEL T." and the signal was boosted 7 times by using resistors.
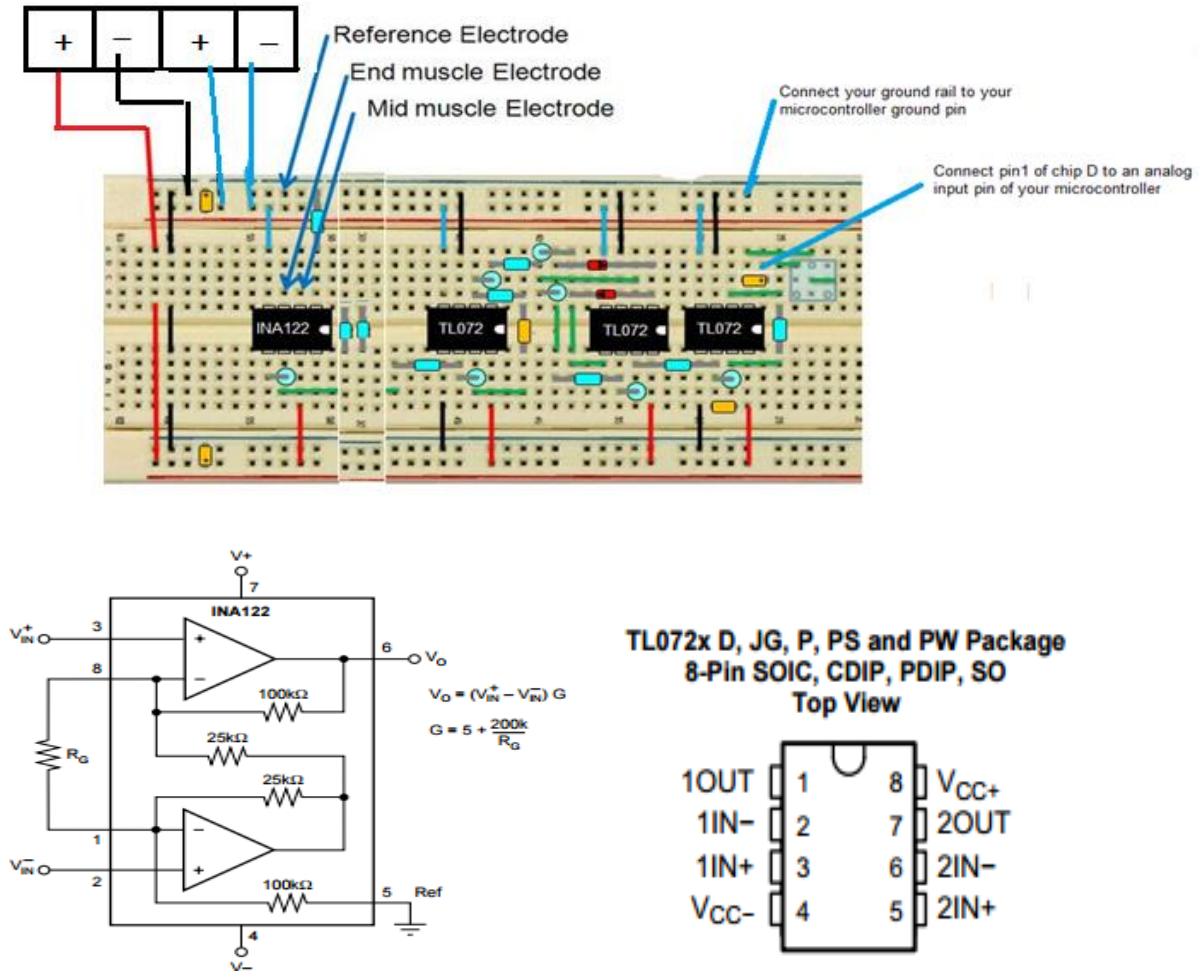
Figure 1. EMG Circuit / Muscle Sensor, INA122 and TL072 pin configurations

As Circuit Chips, three TL072 IC Chip and one INA122 IC Chip were used and, as Cables and as Electrodes, one EMG Cables (set of 3) and three EMG Electrodes were used. As Capacitors, two 1.0 uF Tant, one 0.01 uF Ceramic Disc and one1.0 uF Ceramic Disc were used and as Resistors three 150 kOhm (1%), two 1 MOhm (1%), two 80.6 kOhm (1%), six 10 kOhm(1%), three100 kOhm Trimmer and one 1 kOhm (1%) were used. As Misc, two 1N4148 Diode, some Jumper wires, three Alligator clip cables were used. Above figure, it is given circuit schema and, INA122 and TL072 pin configurations. Next figure shows the EMG circuit design. Figure 2 shows the EMG circuit design.
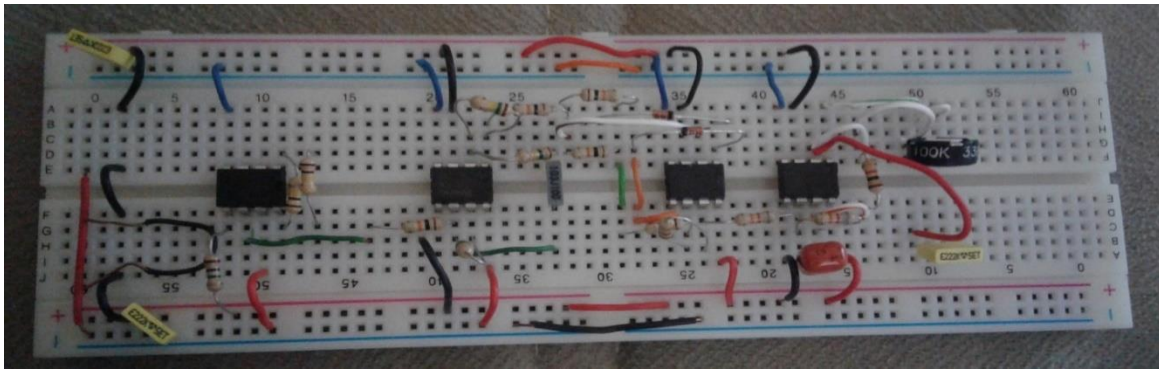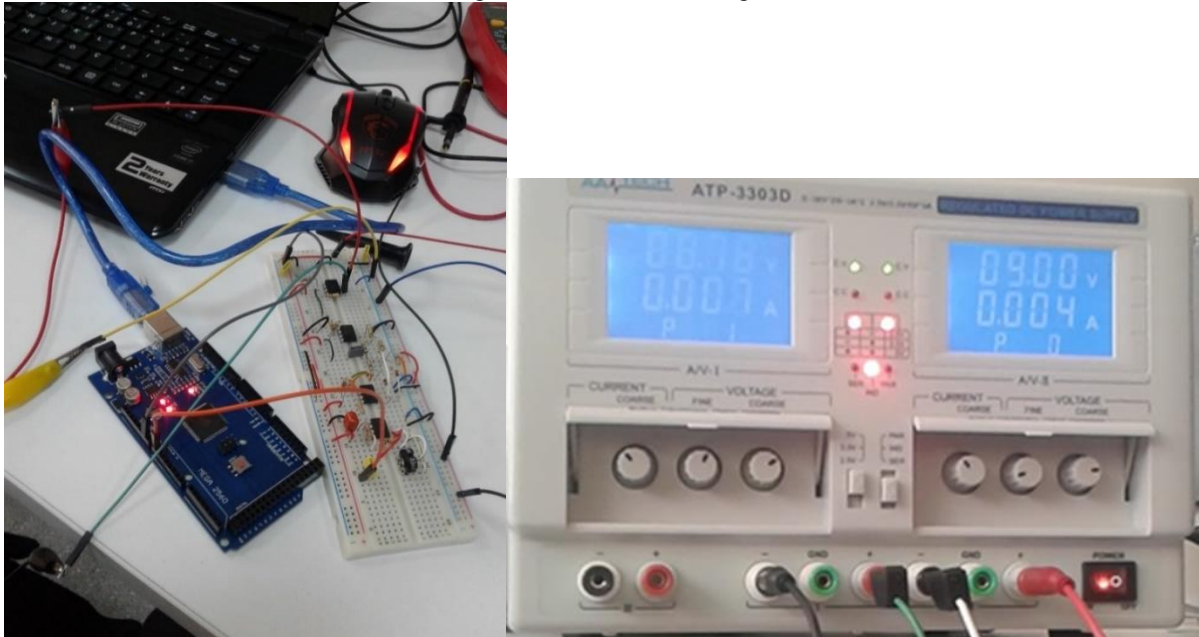
Figure 2. EMG circuit design

Figure 3. Connection of EMG circuit design and Arduino

EMG Thresholding Algorithm By Using LabVIEW

It was used VISA in NI LabVIEW (2016) programming for taking of EMG raw signal. Figure 3 shows VISA code. In this system, it is needed a +9V and a -9V power supplies. If it is connected two 9V batteries as series, it is gotten a +18V power supply. To obtain -9V, battery1's positive terminal is connected to battery2's negative terminal and it is chosen ground or reference point. Thus, it is obtained +9V as positive terminal of battery 2 and -9V as negative terminal of battery 1 as seen in Figure 3.
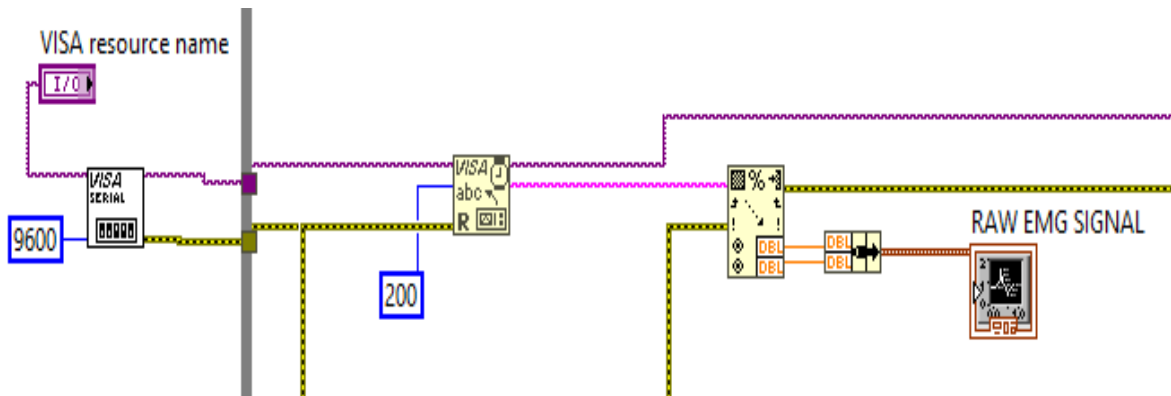

Figure 4. Taking of EMG signal by using VISA in LabView

Above block diagram displays real EMG signal and it is fed into with low pass filter as what is wanted in the EMG acquation system. Obtaining sample data with providing 200 sampling frequency is important in this step. This signal bases on FFT and FFT is a system makes spectral measurements which include the power spectrum,

averaged magnitude spectrum and phase spectrum. At the same time, it is needed high pass filter which has equi-ripple characteristics for obtaining this signal. In Figure 5, it is shown the wavelet denose and it is benefit for reduction of the noise both in 1D and 2D. Filtered signal is given by using Building Waveform and this signal is used as an input signal for multiscale peak detection. In this step, a treshold value of this filtered EMG signal is set for EMG thresholding Peak Level. In this algorithm, initial value is set 0.001 and it can be choosen as per needing of muscle potential.
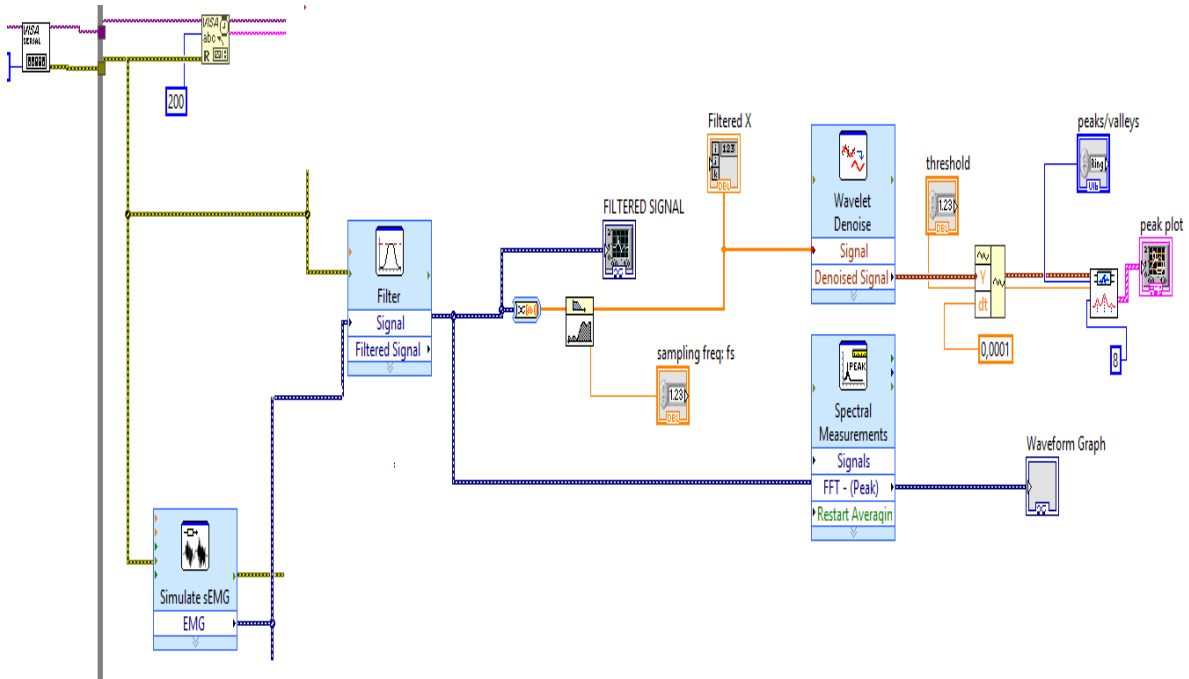

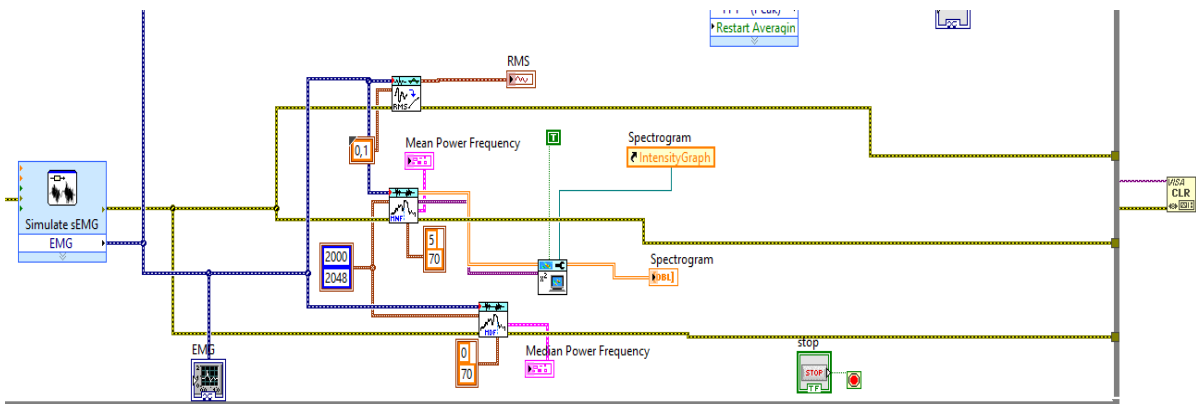Figure 5. EMG thresholding algorithm by using LabVIEW

Figure 6. EMG signal mean calculating

Bio signal RMS VI is used to calculate the RMS of EMG signal. EMG Median Power Frequency VI and EMG Mean Power Frequency VI are used to calculate the MDF and MNF. They also provide the spectrogram of EMG signal, which can be visualized using TFA Configure Spectrogram Indicator VI in LabVIEW Advanced Signal Processing Toolkit. Bio signal RMS VI is used for calculating EMG signal's RMS and, EMG Median Power Frequency VI and EMG Mean Power Frequency VI calculates MNF and MDF. Also, it can be obtained the spectrogram of EMG signal by using TFA Configure Spectrogram Indicator VI in LabVIEW Advanced Signal Processing Toolkit. Figure 6 shows these steps.
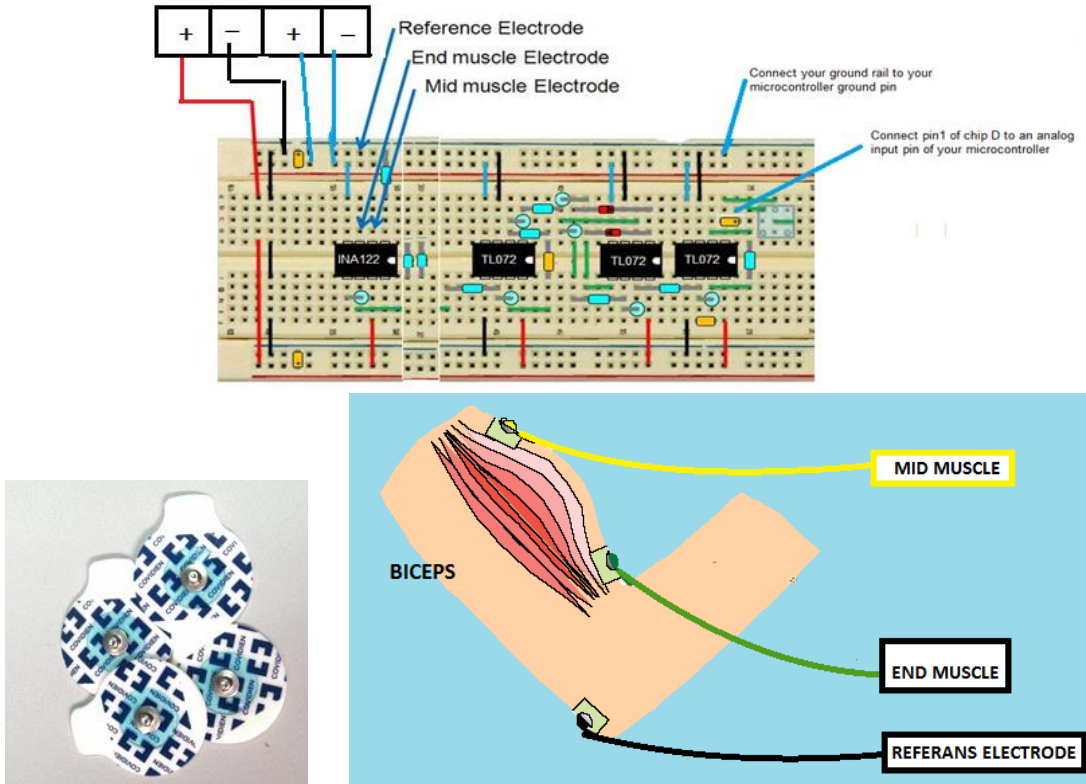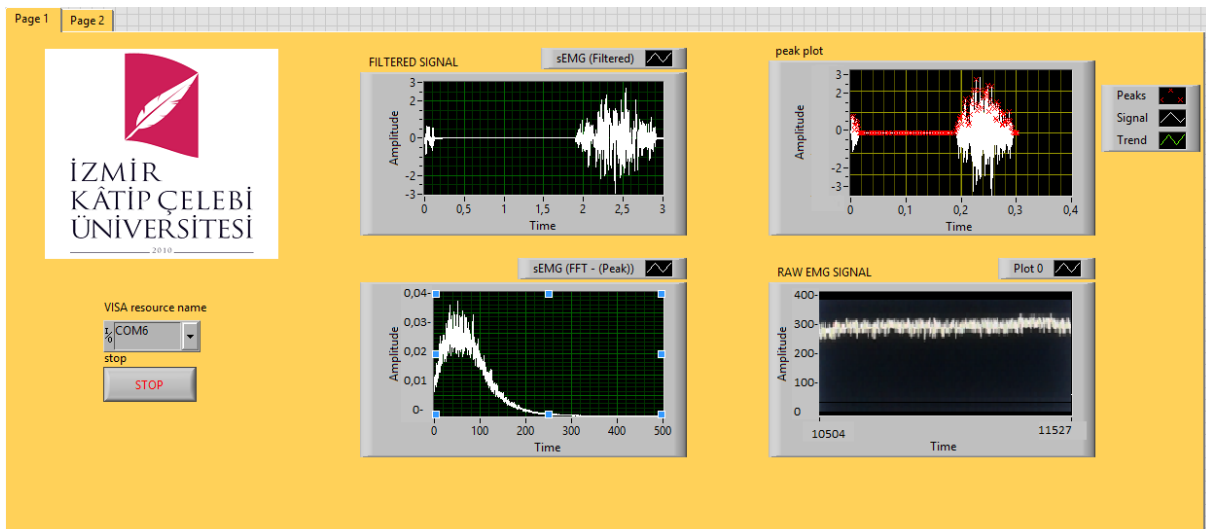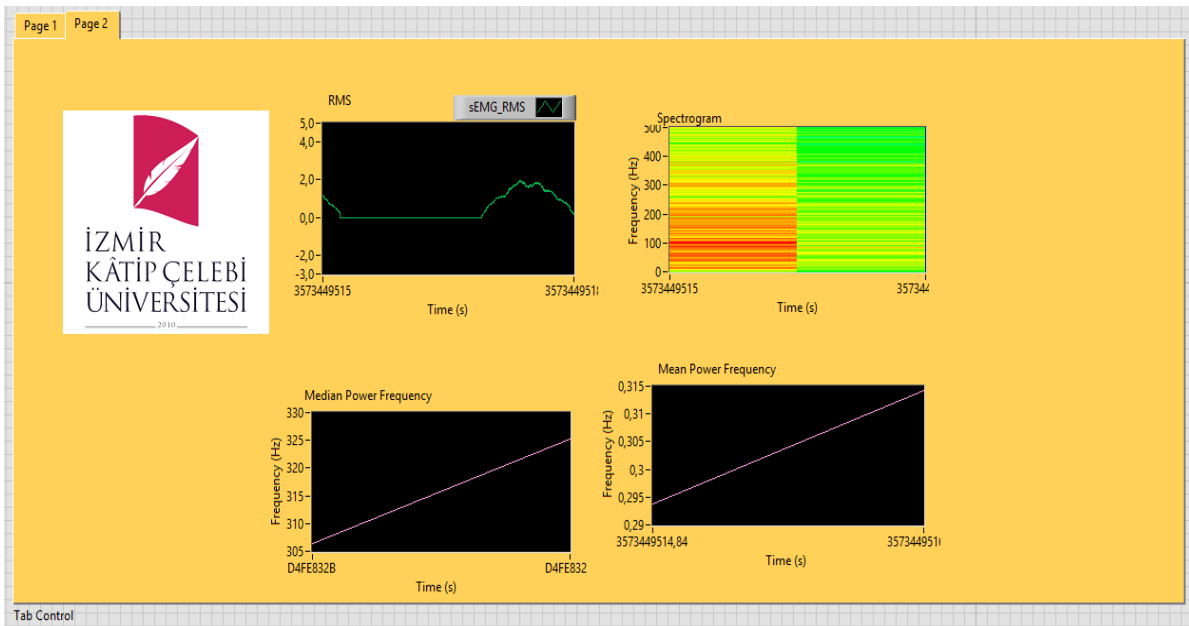
Figure 7. Low-cost real-time electromyography (EMG) data acquisition experimental setup system working schema

Introduction of the Low-Cost Real-Time Electromyography (EMG) Data Acquisition Experimental Setup

Interfaces of the system were designed in LabVIEW programming. EMG signals is taken via Arduino by making connection between EMG electrodes and Muscle Sensor and Arduino with alligator cables as in Figure 7. It was used VISA in NI LabVIEW (2016) programming. It is chosen resource name and the system is started. In Page 1, Filtered Signal, peak plot, sEMG(FFT-Peak) and Raw EMG Signal are obtained as in seen Figure 8 (a). In Page 2, RMS, Spectrogram and Men Power frequency and median Power Frequency Analyses of EMG Signal can be seen as in Figure 8 (b). Arduino codes is given in Figure 9.

(a)

(b)

Figure 8. Interfaces of low-cost real-time electromyography (EMG) data acquisition experimental setup

Figure 9. Arduino codes of the data aquation system

Results and Findings

Obtained EMG signals can be analysed easily and interfaces give clear results to student understandable way. These interfaces permit students with an opportunity to understand about relation and connection between Raw EMG signal and filtered EMG signal. At the same time, it can be seen some evaluations of EMG signal in LabVIEW program.

Conclusion

In this study, it is designed Low-Cost Real-Time Electromyography (EMG) Data Acquisition Experimental Setup for biomedical technologies department. It can be used by the biomedical engineering students to

understand of EMG signal analysis and obtained data can be used favor for different studies and analysis. It is hoped that this system can be benefit for student who makes investigation in this area.

References

Rajput J., Prof. Jignesh Vyas, M.E. Student Head of Department, EMG Thresholding Algorithm by using LabVIEW, Department of Biomedical Engineering Government Engineering College, Gandhinagar, Gujarat, India, IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 01, 2015 | ISSN (online): 2321-0613

Retrived from https://en.wikipedia.org/wiki/Electromyography,

Alkan A., Gunay M., Identification of EMG signals using discriminant analysis and SVM classifier, Elsevier Journal of Expert Systems with Applications, Vol. 39, Issue 1, pp. 44-47, January 2012.

Gonzalez-Ibarra J.C., Soubervielle-Montalvo C., Vital-Ochoa O., Perez-Gonzalez H. G., EMG Pattern Recognition System Based on Neural Networks, Eleventh Mexican International Conference on Artificial Intelligence: Advances in Artificial Intelligence and Applications, 2012..

Subasi A., Classification of EMG signals using combined features and soft computing techniques, International Journal of Applied Soft Computing, Vol. 12, Issue 8, pp. 2188-2198, August 2014..

Pradeep C, George S., K2 Control of Stepper Motor Using Surface EMG Signals International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue 10, October 2015 Copyright to IJAREEIE DOI: 10.15662/IJAREEIE.2015.0410038 8326

Retrived from http://www.instructables.com/id/Muscle-EMG-Sensor-for-a-Microcontroller/

ANDRYNOWSKA A., KLEKIEL T., Application Of INA122 Amplifier To Measure Of Emg Signals, Aktualne Problemy Biomechaniki, nr 5/2011