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Myoelectric Potential Visualization Using Butterworth Band pass Filter

Puviyarasan.S[1], Muthukumaran.S[2], Pratheen raj.B[3],
[1, 2,3]Research intern, KEDSGROUPS Research and Development, Coimbatore.
[1,2,3]3rd year Student, Department of Biomedical Engineering, Salem college of Engineering and Technology , Tamilnadu , India .
puviarasan161@gmail.com[1], sivakumaranpml27@gmail.com[2], pratheenrajb@gmail.com[3]

Abstract

Electrical revelation of neuromuscular information transmission generated in muscles contraction and relaxation is known as EMG signals. Electromyography (EMG) is real-time based method to assess and observe a series of electrical signals that expressed from body muscular cells. In recent researchers had provided many systems for monitoring myoelectric signals (EMG) to identify various abnormalities such as EMG, Microcontroller sensors technology, EMG software signal processor (SPU), PWM method, capacitive sensing method, UML method, EIM method, ADU integration, MC sensors method, Human computer interfacing (HCI) technology and Functional electrical stimulation (FES). This paper proposes a system to implement a wireless transformation technology for monitoring the electrical potential from muscles to identify internal injuries, blood clots, muscle cramps, muscle fatigue, muscle contraction, limb stiffness, and immobility. In this paper, electrical signals acquired from the muscles are detected using EMG sensors. These occurring signals transmitted by using wireless method and processed by using MAT Lab tool. This technique makes our system more unique from the previous methodologies. Finally accurate EMG signals are displayed graphically. Thus the expected configuration result will be with an accuracy of 98.74%, mean specificity of 99% and with a mean sensitivity of 96.58%.So the error occurrence will be Approximately 0.5% and also system is low cost, electrical safety, low power consumption, and can identify muscle disorders through observed abnormal EMGrange.

Keywords: Myoelectric potential, EMG sensors, Transmitter, Receiver, MAT lab tool, Butter worth band pass filter, amplifier

1. Introduction

One of the Electro diagnostic techniques is Electromyography (EMG), which is used to evaluate the muscle activities and detect electrical potential of muscular cells. Detect medical abnormalities, activation level, and other measurements using EMG signal analysis. Human arm involves in many working activities, so arms and muscles may have fatigue and pain. We have Developed Myoelectric potential monitoring System. From literature survey, the diagnosis and comparison of different muscular disorders are detected using Human Computer Interfacing (HCI), Non-invasive detection of neuromuscular diseases applying the technique of Electrical Impedance Myography (EIM), indicate the feasibility and efficiency of EIM. Design of cMOS transistors operating in low level version shown to offer the high level energy here the electrode-body interfaces offered for acquisition, electrode-tissue impedance measurement and optical Biosignalsensing. Monitoring of muscular activation for rehabilitation, muscle activation plans, prosthetics control, myoelectric bracelets, and identification of possible pathologies using Myoelectric interfaces was performed. In this paper we designed a system to monitor the

electrical signals of the muscles in the body through electromyography sensors. This system is specially designed to diagnose internal injuries, blood clots, muscle cramps, muscle fatigue, muscle contraction, limb stiffness, and immobility. It can be used by patients, children, exercisers and the physically challenged. Our proposed system was divided it into two parts .The first part is Sensing part that was fixed on the body. Another part is monitoring part, here we use an EMG sensor to detect electrical potential from muscle activities and also two types of electrodes are used such as Intramuscular electrodes and surface electrodes in medical Instrumentation. Especially here we used a Myoware Muscle Sensor.

The EMG sensor collects the signals and then converts it into an electrical signal. Electrical signals arrive at the monitor via a wifi router and then the signals are received by the wifi receiver and fed to the pre amplifier, where the frequency of the signal is slightly increased and noise where removed by using Band pass filter. The frequency of the EMG signal is highly increased by using an Instrumentation amplifier, finally The Amplified signals pre-processed and displayed by MATLAB.

2.Background

Since the innovation of Muscle monitoring by Edgardo L.Mercado Medina, Design of an Electronic System for Monitoring Muscle Activity. This system is a starting technique to observe the muscle activities. This Project had given more importance to design electronic circuits for monitoring electrical signals of muscles. In this project, neuro-muscular system studied by using Electromyograpy (EMG). This system compressed of two essential elements. First element is electrodes, that convert the potential current in the body muscles. Next one is electronic circuits, which is used for signal conditioning and output observations. Electrodes used in the previous studies might be invasive or non - invasive. In this paper, they selected non-invasive type electrodes that were placed in the surface of the body. Thus the EMG signals produced by transporting of ions through cell membranes of muscle fibers, thus the amplitude of common EMG signals will be in the range of 0.1 mV to 5 mV and the frequency of sEMG signals go from 0 to 450 Hz. In the low frequencies, Most of energy of the signals located.

The Journal of Electromyography requires the corner frequency of 10 Hz. In this paper the author recommend a method using high frequencies that include intense physical activities. The EMG signals uses additional applications such as bio-mechanic analysis of movement, rehabilitation and monitoring system for muscle activity in sports.

In 2008, Young.et.al. developed a wireless EMG micro system to performed the myo-electric control of aprosthesis

B. Khalid, et.al .In this system he identified the field of muscle monitoring of a normal person by varying load as a application of EMG signals. This helps us to get signals from patient's body very efficiently. EMG technique and reveal the methodologies for analying the occurring signal. This paper study EMG signal detection, decomposition, process and discovery of the disadvantages in one method leads to other improving methods. Bernabe Rodriguez Tapia . Myoelectric Interfaces referred the Human Computer Interaction field (HCI). It's a next level improvement of Electromyograpy technique. In this paper, Signals acquisition consists of four main stages: [1] Signal collection, [2] Signal amplification,[3]Signal filtering,[4] Analog to digital converters. In this technique they improved the parameters for implementation of EMG signals. SohmyungHa [5] Integrated circuits and Electrode interfaces, it is a advanced tremendously over the year make a huge impact on medical diagnostics and personal healthcare. This innovation was designed by using semiconductor technologies. In this paper, we designed a system using EMG sensor technology to evaluate themuscle activities and detect electrical potential of muscular cells by EMG signals acquired through EMG sensor. This system is designed to diagnose internal injuries, blood clots, muscle cramps, muscle fatigue, muscle contraction, limb stiffness and immobility. The EMG sensors was inexpensive, easy to wear and we modified that to easily attached patients muscles. In this system we developed a wireless methodology. We use wireless transceiver technical device for transmitting EMG signals to visualization. Most important part is MAT Lab processing unit, that is used for filtering, Amplifying, pre-processing. We designed this system mostly using software algorithms for observed the accurate EMG signals.

3.Literature survey

Serge H. Roy proposed the system for physical activity by using body worn sensors. This system achieved `FIM related activities, which is used for evaluate the action mobility of patients and also identify the disorders of motor units. This study referred the movement of muscular activity during walking patterns.

CharnLoong described the medical system for medical assessment of abnormalities and treatment. This EMG system using for Remote Healthcare Monitoring(RHM). This system build by using biosensors.

Li Yuan derived the IOT techniques for updating human based terminals. C.Pylatiuk make a system for clinical use. In this system, they used four different polymers for EMG detecting and different clinical applications.
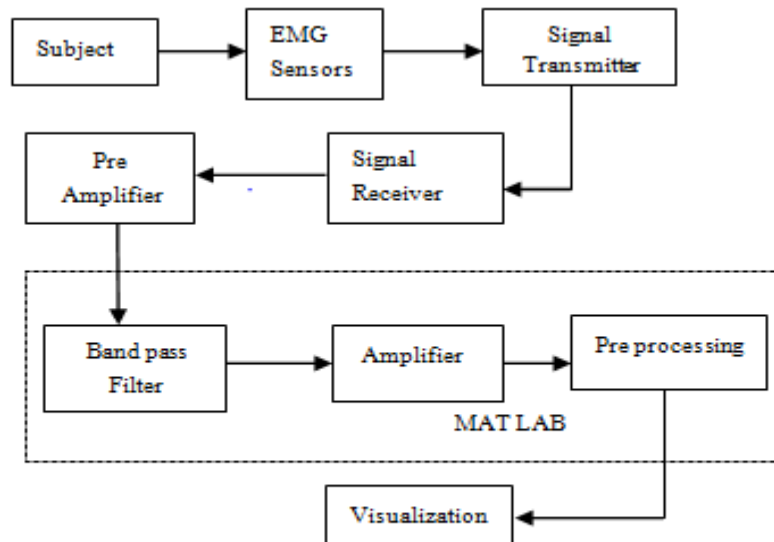
4. Block Diagram

Fig.1. Block Diagram of the System

5.Working

The EMG signals of muscle fatigue, activities from patient's body collected using latest EMG sensors. We use EMG sensors with Arduino, Myoware versions. This whole muscle activity process starts from brain. Muscle activities also related with neural activity in the motor cortex signals to the spinal cord. The Neuro impulse is conveyed to the muscle part via motor neurons. In this process motor neurons directly connected to the muscle fibers, release of calcium ions within the muscle and produce mechanical changes.

5.1 EMG sensing & transmitting process:

We use surface Electromyography sensing electrodes (sEMG) for detect electrical potential of muscular activities from muscle fibers. The Signal sensing process initiated with EMG sensor placement. EMG sensors will sense the Muscle signals.Therangeofasignalisabout0.20Vto 0.40 V for biceps , limb and muscle fibers. No patches need for these sensor. We designed this system with a transmitter attached to EMG sensor this is called as attachment part attachment part. This transmitter will transmit the signals from the range of 40 Hz to 450 Hz and its bandwidth range will be 25 --500 Hz .Next is stable part for viewing output.

5.2 Receiving Process

We use the wireless transceiver module for collecting the EMG signals from EMG sensors. It is NRF905 work band wireless transceiver it has 170 channel numbers and it is used for the transmission and receiving process. To perform this process this transceiver uses a PLL frequency stabilization method. Its maximum is about +10.5 dbm depends upon the transmitting signal range. Its receiving frequency capacity is 120 Hz to 915 MHz**.**

5.3 Pre amplifying process:

We use PAM8403 based preamplifying circuit, it is used to amplify the signals from 1- 200 kHZ. In this process the value repeating voltage is about 1 to 1.5 V. This preamplifier is used to increase

small amount of gain level (upto 560 dB),it is used for the signal processing. These pre-amplified signals are preceded with the filtering Unit.

5.4 Signal processing:

We use MAT lab for signal processing. This software programming is a modified technology to replace the electrical circuits. Before the signal processing, the EMG signals should be filtered and amplified for visualization.

5.4.1 Filtering process:

Mostly four types of filters are used in electrical system such as low pass filter, high pass filter, band pass filter and band stop filter. In the modern programming technique the Butterworth filters are used for signal conditioning process. Butterworth filter also classified into four types such as Low pass Butterworth filter, High pass Butterworth filter, Band pass Butterworth filter and Band stop Butterworth filter. In this project, we use Band pass Butterworth filter it is a 20-th order Butterworth band pass filter with a lower cutoff frequency is about 500 Hz and its higher cutoff frequency is about 560Hz. We can change the low and high cutoff frequencies depends upon the input of EMG signals. In this system we use MAT lab to perform filtering process using "designfilt". [b,a] = butter (n,Wn,ftype) is a common syntax code for designing low, high, band pass and band stop butterworth filters depends upon its applications. The Bandpass filter use the 'bandpass' hint for "ftype". The input arguments are n and Wn, n represents one half order of the filter, Wn represents the cutoff frequency. Incase Wn is the two element vector [W1,W2], W1 is the low cut off frequency and W2 is the high cut off frequency in digital form it is represented as W1=0 andW2=1.

The transfer function coefficients (b,a) is used in the output arguments. The row vector of length is

Table.1.Myoelectric potential for identification

n+1 for low pass and high pass filters as well as the length of 2n+1 for band pass and band stop filters.

Finally we filtered the EMG signals without noises using Band pass Butterworth filter with the required frequencies.

5.4.2 Signal Amplification:

For Electrical applications, mostly Instrumentation amplifier and operational amplifier are used. In instrumentation amplifier the voltage gain will be higher. So instrumentation amplifier is commonly used for many systems. In this system we used software coding amplifier this amplifier does not require any circuits, semiconductor devices, because the amplification is performed by using MAT Lab. In MAT lab, amplifier is a 2 port RF circuit object and we can use 'rfbudget' and 'circuit' object elements for EMG signal amplification. amp =amplifier (Name,Value) is the common syntax of amplifier coding.

5.5 Properties:

Name of the amplifier, Gain values, Noise figure (NF), Output third order intercept (OIP3), Input Impedance (Zin), Output impedance (Zout), NumPorts(number of ports), Number of portterminals (Terminals), these are the basic properties of amplifier in MAT Lab. In this paper we use Instrumentation amplifier focusing its features. The gain rangeincreased up to 120 dB to 140 dB. Noise figure value is Zero. We using impedance matching for get maximum output, so Input impedance and output impedance are equal and maximum value will be up to 1 G ohm.

Finally the processed EMG signals fed to the visualization part. Through monitoring system we represents the signals both Analog and digital form for real time applications.

Potential	Normal value	Abnormal value
Resting position	-70 to -90mV	NIL
Contraction and relaxation	-50 to -55mV	450 to 780mV

Table.2. Comparison table for result Accuracy

Systems	Technique	Problem statement	Result accuracy
Muscle Activity in Weight- lifting	Real time human computer interfacing.	Diagnosis and comparison	55%
Non- invasive Monitoring.	Body-electrode interface,	Muscle monitoring systems	76%
Muscle Monitoring system (varying load)	Electromyography, EMG signal sensors.	Diagnosis and comparison	73%
Electrical Impedance Myography	Optimized electrode configurations.	Non- Invasive detection of neuromuscular diseases.	79%
Myoelectric Interfaces	EMG acquisition system, myoelectric control.	Monitoring of muscular activation	84 %

In this paper, we use upgraded EMG sensors for collecting myolectric potential from the human body. And also use MAT Lab tool for result accuracy. In this study the result accuracy ranges of 98%.

6. Result

The electrical potential of the muscle fibers are electrically inactive at rest position. During the contraction & relaxation of the muscles and limbs nodes the electrical potential will be active. Thus the Measured EMG signal range will be initiated at 30 microvolt up to 30 milli volt depends on muscular activities. So EMG signals lies in the frequency range from 5 to 450 Hz and most dominant range will be 50 to 150 Hz and in damaged muscles the frequency range lies between 450mVto780mV,It is a abnormal range of EMG signals occurred from injured part of the muscular fibers. We can identify the muscle disorders using these abnormal values.

Conclusion

This study clearly delivered a system for identifying the range of electrical potential of muscle activities. It is enable to diagnosis of muscle injury and disorders through observed EMG signals. In this paper, the EMG signals collected from the body and transmitted using attached transmitter system, transmitted signals observed by the receiver. Finally EMG signals processed and displayed using MAT Lab. For EMG signal filtering, amplifying, pre-processing, we use MAT Lab. So this system low cost, electrical safety, low power consumption and as programmed circuits, give more accuracy outputs.

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