INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATIONS AND ROBOTICS
ISSN 2320-7345

EMG ASSISTED ELECTROTHERAPY FOR ANALGESIA

B.SUBHA[1], V.JANANI[2], K.INDHUJA, P.PONMATHI, C.S. POORNIMADEVI, K.S.RENGANAYAKI[3]

[1] *Assistant Professor, Department of biomedical engineering, subhabme@gmail.com*
[2] *Assistant Professor, Department of biomedical engineering, jananim.tech88@gmail.com*
[3] *Final year students, Department of biomedical engineering, indu.kamarajan@gmail.com, ponmathi93@gmail.com, poornidevi92@gmail.com, k.s.renganayaki@gmail.com*
Author Correspondence: PSNA College of Engineering and Technology-Dindigul-624 622, 8973281169, subhabme@gmail.com

Abstract

Myalgia or muscle pain is a common complaint among adults. At some point of life everyone experiences muscle soreness. Preliminary experiments aimed at testing the system for giving the therapy to lissensephaly. In our project, the design of an electromyogram controlled massaging pad intended for use by a patient with muscle pain. The device was designed to treat the patients with muscle pain. The EMG signal is obtained by means of surface electrode, amplified, processed. The signal is fed into the electrotherapy device to give stimulation to the patient through massaging pads. Stimulation is done to make the nerves, cells and tissues to retrieve its normal condition. Acute and chronic pain can be reduced by using electrotherapy. The normal frequency and voltage range for EMG signal is about 5-2000 Hz and 50 µV-5 mV.

Keywords*:* EMG amplifier, Electrotherapy device, Electrodes, Massaging pads.

1. Introduction

According to the third national health and nutrition examination (NHANES III) survey(1988-1944) reported that 1% of American adults are taking muscle relaxants in a chronic conditions. Medications commonly used to treat the two types of conditions [1].the conditions are spasticity from upper motor neuron syndromes and muscular pain. Excitable tissue is stimulated by using electrical stimulating currents [2]. The effect of currents on the body tissue depends on duration, amplitude, frequency and many other factors. Directly tracking muscle activity is done by means of Dynamic electromyography [3]. EMG signal is assisted by using Functional Electrical Stimulation by deriving the robots from the patient after stroke [4].For post stroke rehabilitation, feasibility of using the EMG signal to assist the robot. To trigger the robot EMG signal may have the following advantages [5]. Allow the robotic therapy to be customized, during robotic therapy patients are actually trying to generate the movements can be verified, based on kinematic signals EMG can trigger the robot. By the use of chemical substance like beryllium allows to conduct experiments at remote site [6].stationary electro-physical facilities and EMG are not interchangeable. In the everyday clinical practice TENS (Transcutaneous electrical Nerve stimulation) is a therapeutic device used in different painful situations [7].It is inexpensive, Non-invasive, and does not cause any side effects. The main purpose of TENS is to activate the muscle fibres [8].TENS generates a strong painless electrical sensation beneath the electrodes. Surface electrode is used to

detect a change in skeletal muscle activity [9] and it is then fed back to the user by a visual or auditory signal. The risk of myopathy during treatment with Crestor can be increased with administration of lipid lowering therapies.[10].CRESTOR should be prescribed with caution in patients with myopathy (eg, age ≥ 65 years).

Adverse reactions reported in ≥2% of patients in placebo-controlled clinical studies and at a rate greater than placebo are shown below. These studies had treatment duration of up to 12 weeks. The below tabular column describe the adverse reaction during muscle pain.

Adverse Reactions	CRESTOR 5 mg N=291	CRESTOR 10 mg N=283	CRESTOR 20 mg N=64	CRESTOR 40 mg N=106	Total CRESTOR 5 mg - 40 mg N=744	Placebo N=382
Headache	5.5	4.9	3.1	8.5	5.5	5.0
Nausea	3.8	3.5	6.3	0	3.4	3.1
Myalgia	3.1	2.1	6.3	1.9	2.8	1.3
Asthenia	2.4	3.2	4.7	0.9	2.7	2.6
Constipation	2.1	2.1	4.7	2.8	2.4	2.4

Figure 1: Adverse reaction during muscle pain.

The most commonly reported adverse reactions in the CRESTOR controlled clinical trial database of 6000 patients were

- Headache: 3.7%
- Myalgia: 3.1%
- Asthenia: 2.5%
- Nausea: 2.2%

In the future sections we include different modules
1. EMG amplifier is designed
2. Electrotherapy device is designed using microcontroller
3. Interface the EMG amplifier with Electrotherapy device
4. Acquisition of EMG signal
5. Therapy is given to the patient based upon the muscle stress.

2. Methods and Materials

This project deals with the implementation of electrotherapy device for myalgia patients. Myalgia is commonly called as muscle pain. Electromyography (EMG) is a technique for recording the electrical activity produced by skeletal muscles. EMG is analysed using an instrument called an electromyography, to produce a record called an electromyogram. An electromyography detects the electrical potential generated by muscle cells when these cells are electrically or activated. The signals can be analyzed to detect medical abnormalities. Muscle pain can be detected by using the EMG waveforms. The normal range of EMG signal is 15µV-5mV. Patients with muscle pain does not have this range. These EMG signal is fed into the electrotherapy device. Electrotherapy device is to generate the pulses using the pulse generator.PIC microcontroller (16F877A) is used to fix the threshold level in electrotherapy device. Pulses are given to the patient using massaging pads.

2.1 Block Diagram

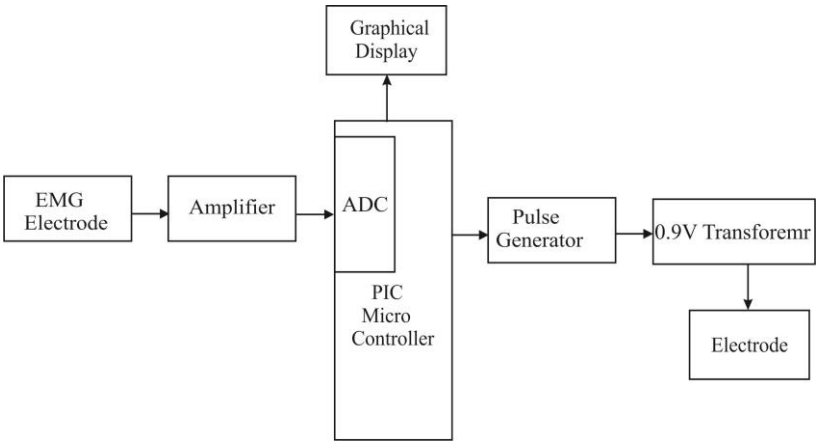

Figure 2: Main block diagram.

There are two kinds of EMG in widespread use: surface EMG and intramuscular (needle and fine-wire) EMG. Trained professional observes the electrical activity while inserting the electrode. The intentional activity provides valuable information about the state of the muscle and its innervating nerve. Normal muscles at rest make certain, normal electrical signals when the needle is inserted into them. Then the electrical activity when the muscle is at rest is studied. Abnormal spontaneous activity might indicate some nerve and/or muscle damage. Then the patient is asked to contract the muscle smoothly. The shape, size, and frequency of the resulting electrical signals are judged. These EMG signal is fed into the electrotherapy device. Electrotherapy device is to generate the pulses using the pulse generator.PIC microcontroller (16F877A) is used to fix the threshold level in electrotherapy device. Pulses are given to the patient using massaging pads. Needle electrode causes the tingling sensation to the patient and this electrode produces the discomfort to the patients.

2.2 Overall Circuit Diagram

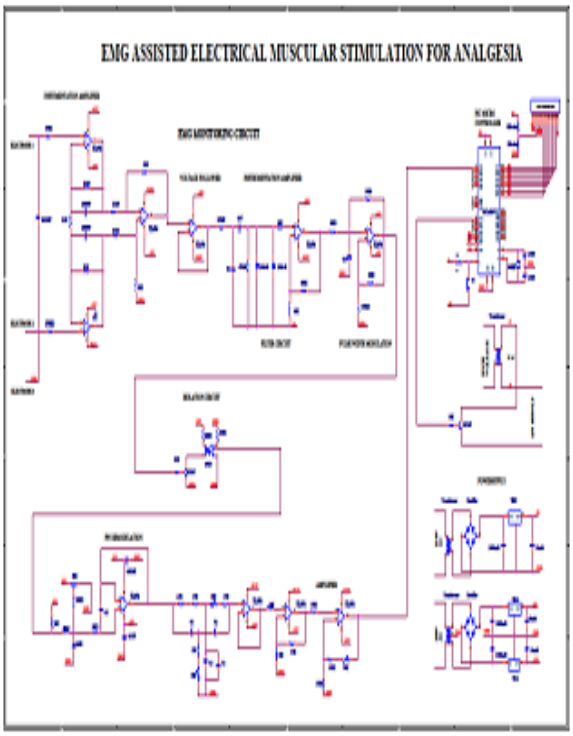

Figure 3 : Overall circuit diagram.

2.3 EMG Amplifier

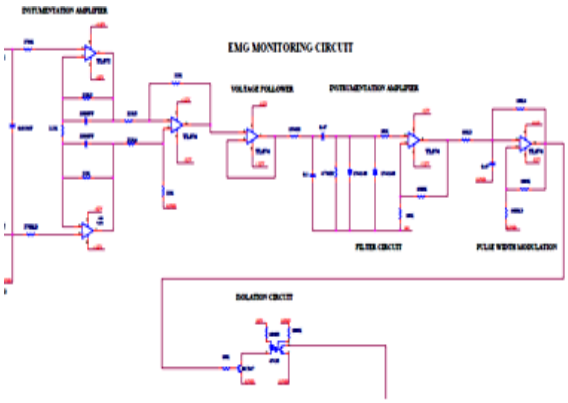

Figure 4: EMG amplifier.

EMG amplifier is to amplify the signals from the body using surface electrodes. Electromyographic sensors measure the electrical activity produced by the muscle during contraction. When muscles are active they generate an electrical potential. That potential can be read and measured.

2.4 Instrumentation Amplifier

Increase the amplitude and frequency level. Eliminate the electrode offset potential for impedance matching Characteristics are 1.Very low DC offset, 2.Low drift, 3.Low noise,4.Very high open loop gain.it is a type of differential amplifier.

2.5 Voltage Follower

To transfer a voltage from first circuit having a high input impedance to a second circuit with low input impedance. A low impedance input is to suppress the noise pickup than high impedance. The output voltage follows or tracks the input voltage and its gain is unity.

2.6 Filter Circuit

A filter circuit is designed to select the desired range of frequency and is fed as an input to the instrumentation amplifier designed with low impedance. In our project we are using Butterworth filter is to reduce the noise

2.7 Pulse Width Modulation

Modulation technique that conforms the width of the pulse, formally the pulse duration, based on modulator signal information. It is used to encode information for transmission

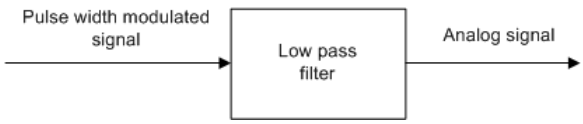

Figure 5: Pulse Width Modulation

2.8 Isolation Circuit

Isolation circuit is same as that of transformer. Transformer used to transfer electrical power from a source of EMG amplifier to electrotherapy device and is usually for safety requirements. Isolation are used to protect against electric shock, to suppress electrical noise in sensitive devices. In order to reduce the leakage of electric current isolation circuit is required.

2.9 Pulse Width Demodulation

PWM signal and carrier signal input to the product detector.PWM signal and carrier signal to be positive or negative simultaneously, then the output terminal of the product detector will receive a pulse signal. It send the signal to the low-pass filter to obtain the demodulated PWM signal Pulse width demodulation produces the analog signal to the amplifier.

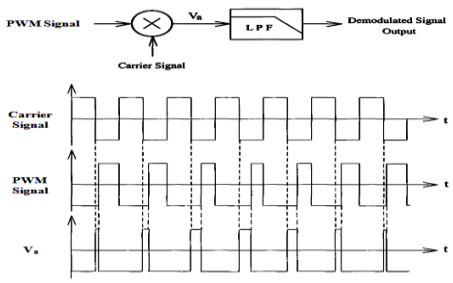

Figure 6: Pulse Width Demodulation

3. Electrotherapy Device

3.1 Pulse Generator

Pulse generator is to generate the pulses to the pain regions of the muscles.

3.2 PIC Microcontroller

PIC 16F877A is a high speed and less instructions is required. Data memory is 368 bytes and data eprom is 256 bytes.

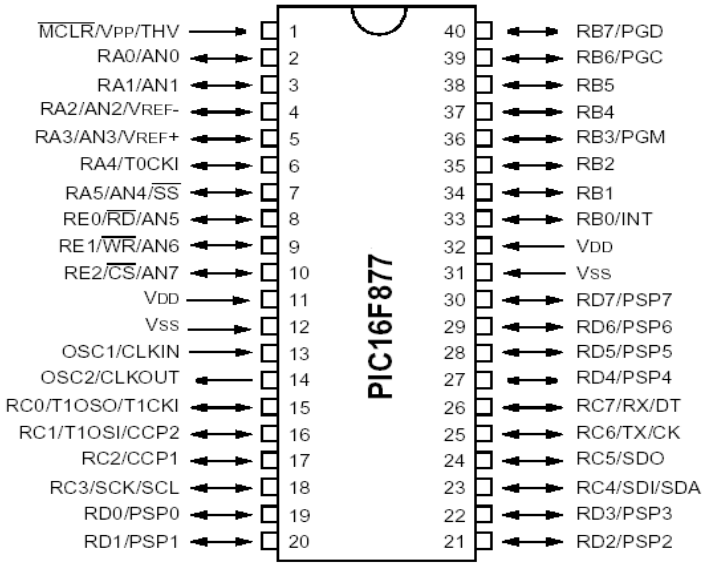

Figure 7: PIC Microcontroller.

3.3 Electrodes

Surface electrode is a terminal electrode whereas the electric current passes into the underlying tissue. An electrode is made up of metal as well as non-metal like carbon. The design of the surface electrode give the comfort to the patient, connection to stimulator is reliable, preventing skin irritation.

3.4 Results and Discussions

Figure 8: Snapshot of our work.

This report suggests that the EMG assisted relaxation is an effective long term treatment for patients with myalgia.

Table 1: EMG signal ranges

CONDITION		AMPLITUDE(MV)	TIME PERIOD(MS)
Normal		5.80	20.0
Stressed	Right	4.31	18.2
	Left	4.11	20.6
Relaxed	Right	4.22	19.6
	Left	4.10	21.6

The above table describes the EMG signal amplitude and time period under normal, stressed and relaxed state. Normal EMG range varies from 100 to 150

Table 2: Amount of stimulation given to the patient

S.NO	PATIENT NO	EMG RANGE	PULSE DELIVERED(mA)
1	1	176	200
2	2	131	0
3	3	142	0
4	4	156	199

The above table describes the amount of stimulation given to the patient to relieve the muscle pain.

4. Conclusion

A system for the EMG assisted electrotherapy was introduced. Our system efficiently gives the treatment to the muscle pain. It also helps in quick medical care by sending pulses to the patients through massaging pads. Muscle pain cannot be treated by surgery; it is often treated using electrical stimulation. We are having the advantages which include:

- Small, discrete device
- Applied directly to the outside of the muscles
- No surgery required
- Reduced atrophy

With the help of electrotherapy device we can teat muscle pain effectively within 3 months. In our project we include time delay if the stimulus is extending 2 seconds and in future EMG signal variation can be displayed with the proper amplification and the muscle stimulus can be analyzed. A system for the EMG assisted electrotherapy was introduced. System efficiently gives the treatment to the muscle pain. It also helps in quick medical care by sending pulses to the patients through massaging pads.

REFERENCES

[1] Roger chou, MD and kim Peterson, MS Portland., 2005, Review on skeletal muscle relaxants, Oregon health and science university-drug class, copyright©2005,orgeon health and science university, Portland, orgeon..

[2] Nissan kunju, Neeleshkumar, Dinesh Pankaj, AsseemDhawan., 2009, EMG signal analysis for identifying walking patterns of normal healthy individuals, Indian Journal of Biomechanics, NCBM-7-8

[3] Laura Dipietro, Mark Ferraro, Jerome Joseph Palazzolo, HermanoIgo Krebs, Bruce T. Volpe, and Neville Hogan., 2005, Customized Interactive robot Treatment for stroke: EMG-triggered therapy, IEEE transactions on neural systems and rehabilitation engineering, volume.13, no. 3.

[4] Anatoliy M. Buykoa, Sergey F. Garanin, Andrey V. Ivanovskl, Ivan V. Morozova, Vladislav N. Mokhova, Alexander A. Petrukhina, Valeriy B. Yakubova, Walter L. Atchisonb, Robert E. Reinovskyb., 2004, Basic Directions of EMG-Assisted Research- All-Russia Scientific Research Institute of Experimental Physics, 607190, Sarov, Nizhniy Novgorod Region, Russia bLos Alamos National Laboratory, New Mexico 87545, USA-BEAMS'2004-2044

[5] Asami Naka (1), Mohammed Keilani (2), Stefan Loefler (1), Richard Crevenna (2)., 2013, Does transcutaneous electrical nerve stimulation (TENS) have a clinically relevant analgesic effect on different pain conditions? A literature review-European Journal Translational Myology - Basic Applied Myology; 23 (3), pp.95-104 – 95

[6] Tashani O, Johnson MI., Transcutaneous Electrical Nerve Stimulation (TENS) A Possible Aid for Pain Relief in Developing Countries? Centre for Pain Research, Faculty of Health, Leeds Metropolitan University, UK, Leeds Pallium Research Group-DOI: 10.4176/090119.

[7] Oonagh M Giggins1,2*, Ulrik McCarthy Persson2 and Brian Caulfield1,2., 2013, Biofeedback in rehabilitation, Giggins et al. Journal of Neuro Engineering and Rehabilitation, 10:60.

[8] CRESTOR is licensed from SHIONOGI & CO, LTD, Osaka, Japan-safety and tolerability. 2013 AstraZeneca. All rights reserved. 829806-2848509 Last Updated 8/13

[9] Sampath Kumar, Mohan Rajesh Elara, Edgar A., 2011, Mexico-Development of hand held device for assessment and assistive purposes during post stroke therapy, Martínez García Instituto de Ingenieria Tecnologia Universidad Autonoma de Ciudad Juarez, 978-1-4577-2119-9/12/$26.00; IEEE :139.

A Brief Author Biography

B.Subha, she has received the Under Graduate degree in Biomedical Engineering at Velalar College of Engineering & Technology, Thindal and Post Graduate degree in Applied Electronics at PSNA College of Engineering & Technology, Dindigul, in 2009 and 2013 respectively. From 2009 to 2015 (till date), she is working in the department of Biomedical Engineering, PSNA College of Engineering & Technology, Dindigul. Where she is an Assistant Professor. Her interests are in Diagnostic and Therapeutic Equipments. She has published 3 International Journal papers.

Ms.V.Janani, has received the Under Graduate degree in Biomedical Instrumentation & Engineering at SRM University, Chennai and Post Graduate degree in Control and Instrumentation Engineering at Kalasalingam University, Krishnankovil, in 2010 and 2012 respectively. From 2013 (till date), she is working as Assistant Professor in the department of Biomedical Engineering, PSNA College of Engineering & Technology, Dindigul. Her research interests are in the field of Biomedical Instrumentation. She has published 2 International Journal papers.