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Study of Sensitivity of Muscle and Nerve Systems of Human Body with Aid of Microcontroller with Stimulation

N.Nandakumar [1], K.Shanmugasundaram [2], R.Thangavel [3]

Research Scholar[1], Assistant Professors[2], Associate professor and H.O.D [3],
Department of Electronics, Sri Ramakrishna Mission Vidyalaya College of Arts and Science,
Coimbatore-641 020, India.

Abstract

The Biomedical devices play the important key role for diagnosing the diseases sensitively and giving appropriate treatment to the patients by the Medical Professionals. The aim of this project is to design microcontroller based muscle, nerve sensitivity calculator and muscle, nerve stimulation in body, with LCD display, which calculates the initial sensitivity and maximum withstand sensitivity of muscle, nerve. The hardware of the project consists of silicon pads (electrodes) or pen electrodes, which is used to stimulate the muscle and nerve. The muscle and nerve stimulation is calculated in mA. The microcontroller based muscle, nerve sensitivity study and stimulation device is useful for the medical professionals. The calculated the sensitivity strength of the muscle and nerve through electrodes, converts the electrical signal in to the current that can be easily obtain after processing through microcontroller. All this data is manipulated through microcontroller and then the result is displayed on the LCD display**.** From this study low-cost portable and high performance stimulator is designed and implemented. For this purpose, a microcontroller is used in the design of the stimulator. The duty cycle and amplitude of the designed system can be controlled using potentiometer. The performance test of the system has shown that the results are reliable. The overall system can be used as the muscle, nerve sensitivity and stimulator under safe conditions.

Keywords: Muscle Sensitivity, Muscle Stimulation, Nerve Sensitivity, Nerve Stimulation, Microcontroller.

I. INTRODUCTION

A. Human Muscles System

Muscle tissue functions mainly as a source of power and motion in the body. Muscles' main responsibility is for changing or maintaining posture, locomotion, and movement of internal organs. The human body has about 650 muscles, which make up approximately half our bodyweight. All muscles are basically made of the same material, a kind of elastic tissue; packages of stretchable fiber-like material, similar to what goes into making a rubber band. Each muscle is made of thousands, and sometimes tens of thousands of small muscles fibers.

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Fig. 1. Skeletal Muscles

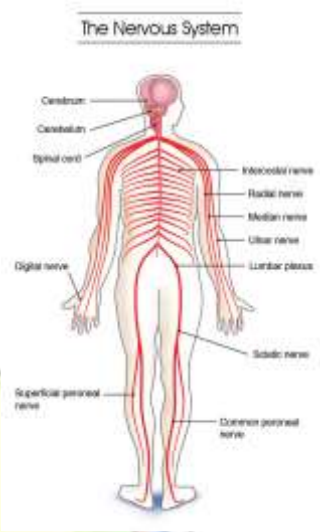

Fig. 2. Nervous system

B. Human Nerve System

The nervous system is a network of cells called neurons that coordinate actions and transmit signals between different parts of the body. The nervous system consists of the brain, spinal cord, sensory organs, and all of the nerves that connect these organs with the rest of the body. Together, these organs are responsible for the control of the body and communication among its parts.

II. MUSCEL STIMULATOR

The muscle systems of humans are complex electrochemical machines. The electrophysiological study of a muscle system treats the system as an electrical device built of very complex, non-linear elements called fibers. To understand the function of a muscles, or network of muscles, one must probe the system with pulses and record what happens. For instance, a researcher might apply pulses to a muscle and measure muscle sensitivity. The device to be described here allows a researcher to inject electrical pulses into muscle tissue.

III. NERVE STIMULATOR

Electrical nerve stimulation (ENS) is a method of pain relief that can help some people with long-term painful conditions. An ENS machine is a small, battery-operated device that has leads connected to electrodes. We attach the electrodes to our skin using self-adhesive pads. When the machine is switched on, small electrical impulses are delivered to the affected area of our body, which we feel as a tingling sensation. The electrical impulses can block or reduce the pain signals going to the spinal cord and brain, which can help reduce or relieve pain.

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IV. WORKING PRINCIPLE OF STIMULATOR

The device has been conceived to deliver constant current stimulation impulses. It allows also acquiring Electrical signal with the difference between two nerve electrodes and a reference erasing with one electrode laid on a bony point. In muscle stimulator frequency range is 3Hz standard and amplitude is 0-100 mA variables. In nerve stimulator frequency range is 0- 50 Hz, pulse with 1-250 u.sec and amplitude 0-100 mA variables. When changing the switch, we switch over one program to another.

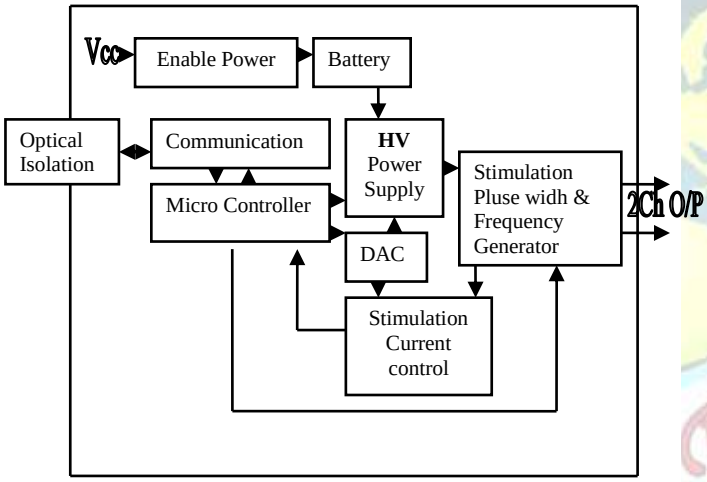

Fig. 3. Block Diagram of Muscle and Nerve Stimulator

V. DESIGN METHODOLOGY

Using 8051 Microcontroller we design the circuit. The power source is in battery or adaptor range of 9V/150m.Ah. The frequency range is 0-150 Hz and amplitude is 0-100mA.The frequency and amplitude both are manually controlled by the separate potentiometer. The output is connected with silicon pads (Electrodes). The LCD display is indicating the current range which is increasing through pot. The passing current between two electrodes can be noticed in LCD. The microcontroller chosen for our portable stimulator is a 150 Hz, low-power, 8-bit RISC chip with 128 kB of programmable flash and 4 kB of EEPROM. This microcontroller also includes an on-board, 8-channel, 10-bit, analog-to-digital converter (ADC); 32 programmable I/O lines; master/slave SPI; and two 8-bit and one 16-bit counter. Signals from the current control module, HV power supply module, and batteries are continuously sampled by the ADC and monitored for errors to ensure that the stimulator is safely operating within predefined parameters. Eight I/O lines to the digital-to-analog converter (DAC) provide the analog signals that set the stimulation current and the HV threshold, and an additional nine lines are used to control the stimulation pulse width and frequency generator. The communications module within the ExoStim is optically isolated from the controller to shield the user from potential grounding problems that could occur by touching the exterior casing of the controller while stimulating. This module includes a programmable logic device that facilitates the SPI with the controller and provides the means to shut down the microcontroller safely if the stimulator's battery output cannot maintain a nominal voltage for the microcontroller.

VI. PATIENT DATA OBTAINED WITH MUSCLE STIMULATOR

When we give the treatment for muscles with using electrical muscle stimulation we are not able to find the improvements in muscle sensitivity immediately. Using our system we are able to find the muscle sensitivity accurately. When we give the electrical stimulation using our system, the electrode is converted electrical signal in to current. In that when we feel the instill stage of current in our muscle is noted, after that we applying the electrical signal (Increases the amplitude) continuously the maximum withstanding current is noted which is shown in LCD display.

The DATA sheet is shown the First patient condition

(Muscle Sensitivity)

Patient Name: Xxx, Age: 32, Wight: 45, Gender: F,
BP: 120/80. Days – 5, Part: Right arm

TABLE I

ELECTRODES CONNECTED FOR FIRST PATIENT

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No. of Day	Insel sens (mA)	With stand Sens(mA)	Frequency (KHz)	Time (min)
1	07	17	2	10
2	08	18	2	10
3	08	18	2	10
4	09	20	2	10
5	08	19	2	10

The DATA sheet is shown the Second patient condition (Muscle Sensitivity)
Patient Name: Yyy, Age: 32, Wight: 65, Gender: F,
BP: 130/90. Days – 5, Part: Right arm

TABLE II
ELECTRODES CONNECTED FOR SECOND PATIENT

No. of Day	Insel sens (mA)	With stand Sens(mA)	Frequency (KHz)	Time (min)
1	15	25	2	10
2	16	26	2	10
3	17	27	2	10
4	16	26	2	10
5	17	27	2	10

VII. APPLICATIONOF THE STIMULATOR

Fig. 4. Placements of Electrodes for patient

Rehabilitation purposes, Physiotherapy, Beauty Industry (cleansing / nourishing the skin), Brain Stimulation Therapies, Improves the function of the cellular membrane, Acupuncture, Pregnancy-Stop the Pain and Suffering, Improvement in the Vascular and Lymphatic, Fat to be dispersed & eliminated, Cure for muscle spasms.

VIII. ACCESSORIES OF THE STIMULATOR

Electrodes (Silicon), Metal Electrodes, PEN Electrodes, Patient cable, Charger power supply, Jelly.

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stimulation in exercise of the quadriceps femoris muscle.

Fig 5: Accesses of the stimulator

IX. SAFETY OF THE INSTRUMENT

When the stimulator is connected to the patient at the time the remote is given to the patient. When the patient feels uncomfortable he presses the special key to switch off the function of the instrument.

X. CAUTIONS WHEN USING STIMULATOR

Do not use stimulator if:
Patient have a pacemaker or another type of implanted electrical device fitted, theirs pregnant, or if theirs a chance they might be pregnant – unless they are using stimulator for pain relief during labour, they have epilepsy or a heart rhythm disorder (check with their GP), they experience an allergic reaction to the electrodes (it's possible to get hypoallergenic electrodes), they have broken skin, varicose veins or recent scarring in the area where they want to place the electrodes, their driving or operating machinery, they are in the bath or shower.

XI. CONCLUSION

A microcontroller based electrical muscle and nervous stimulation make the operation easy, System cost reduced, Output results become accurate, it make the system user friendly one.

XII. FUTURE DEVELOPMENT

Multiple waveforms can be analyzed, Multiple Channels (More than two) can utilized, Connectivity with PC , Automatic stimulation (Using Remote).

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AUTHORS BIOGRAPHY

Mr.N.Nandakumar, received B.Sc Electronics and M.Sc Applied Electronics from Bharathiar University, Coimbatore, 1996 and 1998. PGDDI (Post Graduate Diploma in Digital Instrumentation) from Alagappa University Karaikudi, 1999. 17 years of experience in Bio-Medical Equipments Installation, Sales and Servicing. Currently he is working as Senior Biomedical Engineer in Prime Bio Medical Systems, Tirupur, since 2002. Currently pursuing his M.Phil Electronics in Bharathiar University from 2013. His areas of interest are Electronic Instruments, Digital Electronics and Biomedical Instrumentation.

Mr.K.SHANMUGASUNDARAM, received M.Sc Applied Electronics from PSG College of Arts and Science, Coimbatore, 1993. PGDCA from Bharathiar University, Coimbatore, 1996. M.Phil from Bharathiar University, Coimbatore, 2001. Currently pursuing his Ph.D Electronics in Bharathiar University. Currently he is working as an Assistant Professor in the Department of Electronics in SRMV College of Arts & Science, Coimbatore. His areas of interest are Biomedical Instrumentation, Digital Electronics, Linear IC's & Instrumentation, Microprocessors.

Dr. R. Thangavel , received his M.Tech (EST) from SRM University 2010. Ph.D. from Bharathiar University 2011. Currently pursuing his MBA. Currently he is working as an Associate professor and Head, Department of Electronics in SRMV College of Arts & Science, Coimbatore. His areas of interest are Embedded System, Instrumentation. Other activities are Board of Studies Member in Various University/College. He has published more then 10 papers in National and International conferences and Journals.