DESIGN AND IMPLEMENTATION OF EMG TRIGGERED - STIMULATOR TO ACTIVATE THE MUSCLE ACTIVITY OF PARALYZED PATIENTS

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1. **ABSTRACT:**

A simple Electrical stimulator is used to give the current stimulations to the muscle of paralyzed patients manually by the doctor during treatment of paralysis. We proposed the Electromyogram (EMG) triggered stimulator which is used for paralyzed patients to activate their muscle activity and relearn the lower limb movements. The different time domain features are extracted using MATLAB Tool from the EMG signal to study the muscle contraction level and contraction force applied on the muscle. The innovation consists in using EMG sensor for sensing electrical signal from a thigh muscle that is action potential which is used as Triggered EMG level to drive the stimulator.Hence when patient thinks or tries to the lower limb movement the triggered EMG level is generated and when it reaches above threshold level stimulations are given. We used microcontroller as PWM generator to apply stimulations of fixed frequency which stimulates the muscle.

KEYWORDS: Electromyography (EMG), Electrical Stimulator

2. INTRODUDUCTION:

Many stroke patients suffer from a paralyzed lower extremity, including functional limitation of the affected leg and limitations in their activities of daily living. Recovery of function in the paretic lower limb is noted in fewer than 15% of patients after stroke. Patients often compensate for their paretic lower limb by using their intact limb in the performance of everyday tasks. Paretic muscles due to central nervous system impairment such as spinal cord injury or stroke can be externally contracted by electrical stimulation (FES: Functional Electrical

Stimulation) and functions of the paretic limb can be restored. One of the FES techniques employed to facilitate motor restoration in chronic stroke patients is electrical stimulation. Inthis method the different electrical stimulations are given by doctor manually to the target muscle. The paper proposes the electromyogram EMG-triggered Electrical stimulator. This method requires the patient's voluntary muscle contractions to exceed a target threshold for the onset of electrical stimulation. If the EMG activity exceeds the threshold, the muscle contractions are augmented by electrical stimulation that assists the patients to achieve joint movements. And using this patient can relearn their voluntary movements again and on its own.

3. REIVEW OF LITERATURE:

Yoshihiro Muraoka, Shigeo Tanabe, Tomofumi Yamaguchi, and Kotaro Takeda, [1]proposed stimulator for upper limb functional recovery which can stimulate target muscles in proportion to the amount of voluntary EMG of the identical target muscles. And also it can facilitate the contraction of paralyzed muscles by electrical stimulation at sub threshold intensity level. In this study the device specification is described, especially its electrical circuits and signal processing that detect voluntary EMG and stimulate from the same electrodes. Stimulator uses two DIACs for detecting voluntary EMG from stimulating electrodes. The DIACs switch passively between the stimulation circuit and the EMG amplifier circuit. Anirban Dutta, Rudi Kobetic, Ronald Triolo [2] Studied the FES-assisted stepping triggered by a manual switch (switch-trigger) and by an electromyogram-based gait event detector (EMG-trigger) to the two subjects with incomplete spinal cord injuries (iSCI) during ten trials over two alternate days. The results suggest that less user effort was needed when walking with EMG-triggered stepping than with manual switch trigger.

4. SYSTEM ARCHITECTURE:

Fig. 1 Illustrate the general functional block diagram of electrical stimulator. It is functionally divided into 3 blocks, a input stage, a controller stage and a driving stage. In the input stage the rectified EMG that is pre-processed EMG is given to the microcontroller. Then according to the threshold parameters micro-controller generates the PWM output, and in driving stage the output is converted into current which is given to the patients through electrodes.The PWM wave is generated by PIC Microcontroller, the frequency of the PWM is 3175Hz which is fixed. At the output of controller, the voltage is converted into current then one Optocoupler is used to isolate the output.

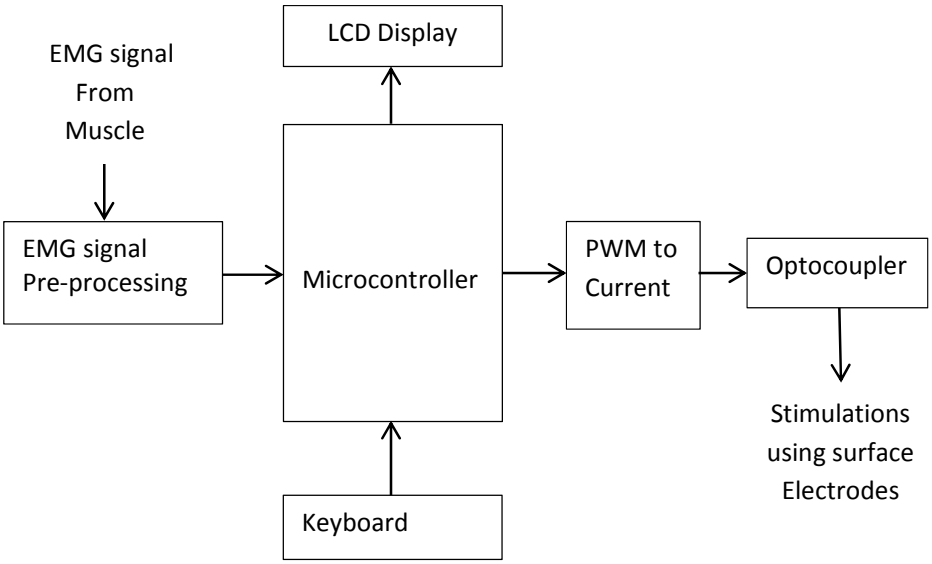


Fig. 1 Block diagram of EMG-triggered Stimulator using PIC Microcontroller

A. Keyboard :

It is used to set current and provide stimulations modes which are required to stimulate the target muscle. Facility is also provided for incrementing and decrementing the current to be set. It has a facility to maintain a repetitive stimulation over duration of time.

B. Surface Electrodes:

These are disc electrodes specially designed for EMG signal acquisition and stimulation. The impulse delivered by the proposed PNS is applied to skin via these electrodes to stimulate the motor nerve.

C. EMG sensor with pre-processor:

The design of pre-processor consists of preamplifier which is most critical aspect of this device. It is desirable to obtain an EMG signal that contains maximum amount of information from EMG electrodes and minimum amount of contamination from electrical noise. For this purpose INA106 instrumentation amplifier which acts as a differential amplifier is used with gain 110. In order to eliminate the potentially much greater noise signal from power line sources, a differential detecting configuration is employed. The signal is detected at two sites by two EMG electrodes which are placed on the muscle belly. The preamplifier circuit subtracts the two signals and then amplifies the difference. As a result any signal that is “common” to both detection sites will be removed and signals that are different at the two sites will have a “differential” that will be amplified which are usually in the range of mV. Fig, 2 shows the circuit and design of instrumentation amplifier.

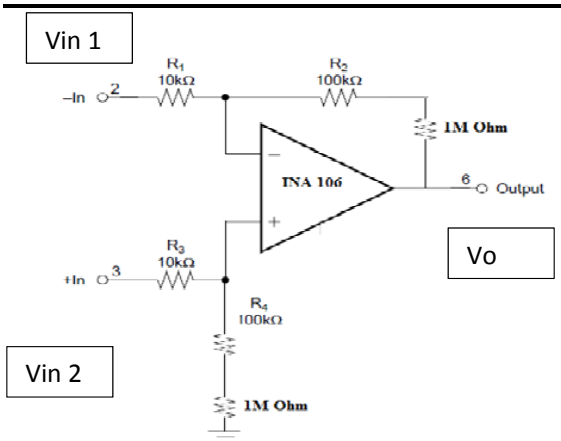


Fig 2 Circuit diagram and design of Instrumentation amplifier

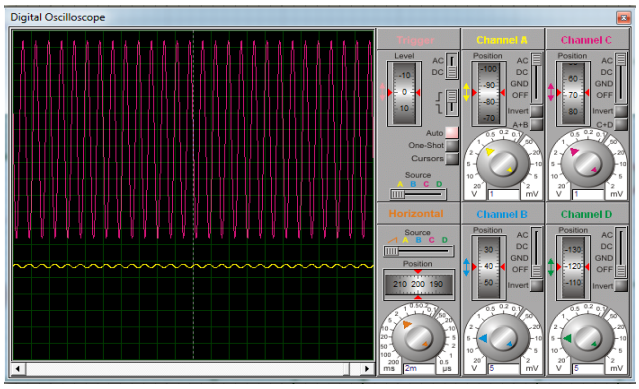


Fig 3 Design and output of Band pass filter with proteus software

D. Circuit Design:

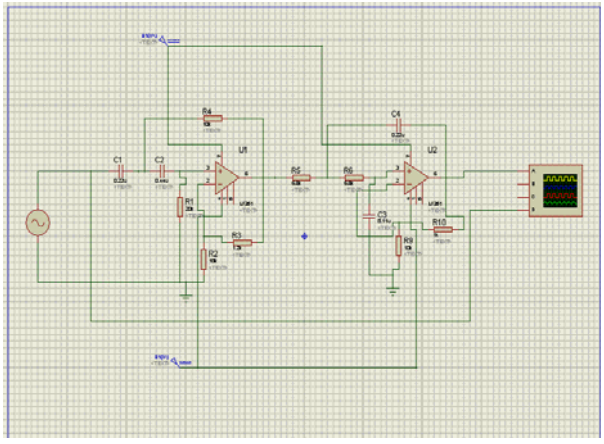
1) Rf = 100K + 1M = 1100K Ohm, R1 = 10K Ohm

2) Gain = Rf / R1 = (100K + 1M) / 10K = 110

3) VO = Gain (Vin1 – Vin2)

4) VO = 110 (Vin1 – Vin2)

To remove the noise, the second order Butterworth band pass filter is used. The design of band pass filter is shown in fig.3. As the frequency of the EMG signal is present in between 50 Hz to 200 Hz , the band pass filter is designed for 50 Hz to 150 Hz.



E. PIC Microcontroller

PIC18F458 Enhanced Flash 16 bit Digital Signal Controller is used since it has features like 1kb of on chip RAM, 10bit ADC. The following points describe the function of PIC microcontroller in the proposed work.

1) It generates PWM with the help of PWM driver circuit based on selection of different modes of stimulation.
2) It acquires the EMG signal from EMG sensor that is action potential in the form of
   voltage, and sets the threshold EMG level to drive the stimulator stage.
3) It displays the input EMG level voltage.
4) It checks for various failures associated with this device.
5) It displays the amplitude of current applied to the muscle to stimulate it, it also displays the frequency of stimulation pulses.

E. LCD Display

16x2 LCD display displays current to be used, Frequency of stimulation selected and pulse width duration of stimulations.

5. RESULT:

Here we carried out test with proposed instrument on paralyzed patient. The surface electrodes are placed on the target muscle which is rectus femoris muscle. When patient tries to do the movement, the triggered –EMG level is generated, and stimulations are given to the thigh muscle.

Fig. 4 Proposed Instrument

6. CONCLUSION:

In PIC microcontroller based EMG-triggered Stimulator, PIC microcontroller enables to make easy, fast and flexible design and implementation. It generates PWM depending on selection of pulse width for stimulation which stimulates the target muscle. The action potential obtained from a little muscle contraction when patient tries to do a movement is sensed by EMG sensor, amplified and used as a triggered level EMG signal. When trigger level goes high than threshold level, the stimulations gets started for the specified duration with specified current level. The current level, duration of stimulation is displayed on LCD.

REFERENCES:

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