Nerve Conduction Velocity Detection for a Set of Subjects under Constrains Using PIC16F877

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Abstract—Nerve conduction velocity (NCV) is a very common parameter to diagnose neuromuscular and neurodegenerative diseases. The main objective of this project is to measure the nerve conduction velocity. We are measuring the NCV based on the electrical conductivity of the nerve. Electrical pulse is stimulated and given using a sensor and detected by another sensor. The PIC is programmed to measure the nerve conduction velocity by dividing the distance between the sensors by the time delay. The PIC used is 16F877 by Microchip Corporation. The normal value of NCV is 40-60 m/s. The NCV test is useful in detecting diseases like multiple sclerosis, peripheral neuropathy, carpal tunnel syndrome, ulnar neuropathy, spinal disc herniation.

Keywords- Data Accquisition Board, Myelin Sheath, Nerve Conduction Velocity,PIC 16F877,Statistical Analysis, Stimulator Circuit ,Ulnar Nerve,

1 introduction

A nerve conduction study (NCS) is a test commonly used to evaluate the function, especially the ability of electrical conduction. Nerve conduction velocity is the speed at which an electrical stimulus signal passes through the nervous system. Surface electrodes are designed to give information about the whole of a muscle stimulated, giving data for the time taken for the fastest axons to conduct an impulse to the muscle and the size of the response. Needle electrodes for NCS give very accurate conduction time information, but because they record from only a small area of muscle or nerve, they give poor or, in the case of the latter, more complex information making numerical analysis difficult. The speed at which the action potential travels down the length of the axon is referred to as its conduction velocity, and can be calculated by dividing the distance an action potential travels by the time it takes the action potential to travel that distance.

The conventional method of measuring nerve conduction velocity is a technique that essentially consists on the application of an electric stimulation on the skin, over the path of a nerve, what evokes the generation of an action potential that spreads bidirectional along the excited nerve fibers. That action potential is then recorded on another point and shown on the oscilloscope. In order to do that, a system composed of two fundamental parts is necessary: a stimulator and a detector , electrically isolated from each other.

The stimulator circuit [1] consists of a monostable pulse generator implemented with the Timer LM555, to which a NPN bipolar transistor in the common-emitter configuration amplifier is cascaded. It generates a rectangular simple (unipolar) voltage pulse, with duration of 0.1 ms and variable amplitude ranging between 10 and 60 V. The instrumentation amplifier INA114 was used as first stage of the detector, because of its high CMRR (*i.e*. larger than 115 d B) and high input impedance of 108 Ω [11]. After the instrumentation amplifier, a first order passive high pass filter and a first order active low-pass filter were cascaded. Since the stimulator and detector circuit is isolated the hardware formed is bulky. The use of oscilloscope increases the cost. Some conventional methods are invasive due to the use of needle electrode. Application of high voltage causes a twitch feeling in the human. In this paper we present a new non invasive method to measure NCV using low voltages.[1]

2.Objective

Nerve conduction velocity is the speed at which an electrical stimulus signal passes through the nervous system. Conduction velocities are often used to measure the relative health of the nervous system. A disease that affects the nervous system by damaging myelin sheaths, or destroying membranes and membrane transport, or constricting nerves can be indicated by changes in nerve conduction velocity (NCV) of the patient.NCV tests are performed when the following diseases or conditions are suspected: carpel tunnel syndrome, traumatic damage, poliomyelitis, diabetic neuropathy, chronic inflammatory polyneuropathy and multiple sclerosis.

In this paper we aim at introducing a new non invasive method of detecting nerve conduction velocity under some constraints for a number of subjects from different age group. We present the statistical analysis of the data collected using this electrode. We also pre-

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sent the proposal for future study in this area.

3.methodology and working

The methodology includes the following steps. The ulnar nerve is located on the left hand. This process involves moving the little finger and thereby locating the ulnar nerve .The hair from the place where the electrodes are going to be placed is removed. The area is then cleaned with alcohol strip to properly make the region antiseptic. Then place the stimulating and receiving electrode. Measure the distance between the electrodes using suitable scale and record it. The circuit is then powered on and the message "ATTACH ELECTRODE" appears.

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Fig. 1 Display 1

The electrodes are now attached to the appropriate places. The message appears on the LCD module "SENSOR INTERFACE" and "DISTANCE 20".

Fig. 2 Display 2
The distance default is changed from 20 to the required value by using the up and down switches

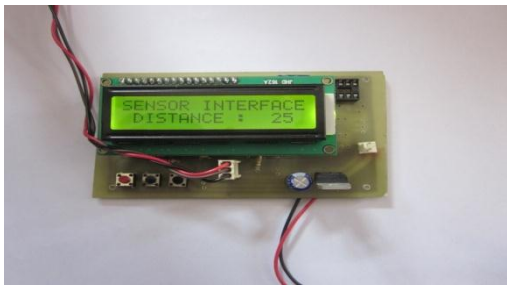

Fig. 2 Display 2

The pulse on switch is then pressed to trigger the PWM from pin C2. Then the LCD display shows the messages "TIME" and " VEL" along with the values of time delay and nerve conduction velocity.

Fig. 3 Display 3

The following process occurs in the device while measuring the NCV. When the microcontroller is powered by the battery, it asks the user to attach the electrode. When the electrodes are attached the distance between the electrodes is entered to the microcontroller through the incrementer and decrementer push button switches. Then the pulse ON switch is pressed to give the stimulating pulse. The pulse is a 800Hz PWM with 200microsecond ON time. This pulse is given out through C2 pin and received at D0 pin after a delay has occurred. The microcontroller is programmed to calculate this time delay using interrupt function, and then the distance between the electrodes is divided by this value which gives the nerve conduction velocity.

4.programming the PIC16F877

The program for the PIC16F877 is written to the memory

using the PIC programming board using its software. The basic logic of the program is the use of timer module for calculating the time delay. After the stimulating pulse is given by the microcontroller, the timer is configured and the timer starts counting at this instant. When the receiving pulse is detected at the detecting electrode, the timer is stopped. The value of timer is counted and the delay is calculated. The distance entered in the microcontroller is divided by this time delay to obtain the NCV. The value of time delay and the NCV are displayed on the LCD module.

5. Statistical Analysis

The statistical analysis includes the significance test. The significance test is described in the below given explanation. If the normal distribution of a particular quantity is known and the quantity is measured again under somewhat changed condition, the mean value is unlikely to be the mean of the original distribution. If the difference in mean is small, it would be reasonable to assume that the distribution is from the same population. On the other hand, if the difference is considerable, then it would be reasonable to assume that the changed circumstances have altered the values and the result is significant. In other words, we can say that the original data and the subsequent data taken under somewhat changed conditions are not from the same population.

To test whether there is a significant change in the original and subsequent data, we use a signifi-

cance test based on the difference of means. The statistician's criterion of significance test is that if the mean values of samples deviates 1.96 times the internal standard error of the difference of means, then the change is significant. An example for the statistical analysis for a number of ten subjects in the age group 20-30 years is given below

TABLE I
DATA FOR ANALYSIS

constrain	*VALUES OF NCV (m/s)*				
constant distance	*44.44*	*45.54*	*44.70*	*44.80*	*44.51*
	45.71	*45.50*	*44.67*	*45.52*	*45.71*
varying distance	*45.70*	*45.33*	*46.29*	*45.85*	*44.40*
	45.74	*44.44*	*46.29*	*44.45*	*45.79*

TABLE II
ANALYSIS OF DATA

mean ncv	*stand-ard devia-tion*	*nter-nal esti-mation of uncer-tainty*	*nter-nal stand-ard error*	*range of varia-tion of mean*	*allow-able range*
45.428	*0.4965 56*	*0.165*	*0.1847*	*0.318*	*0.362*
45.11	*0.2491 3*	*0.0830 6*			

From the above figure, it could be observed that the difference in mean R(X) lies within 1.96 times the combined internal estimate of uncertainty $U_{R(X)}$. Hence, we can say that there is no significant difference in the determination of the NCV in the two different constrains or that the measurement is taken from the same population.

3.conclusion and future scope

A non invasive method to measure nerve conduction velocity was developed. The device is a cost effective one as the cost of fabrication is very low compared to the conventional machine for this purpose. The device is highly robust due to its small size. The device is portable due to the small size. The entire function of stimulation and detection is carried out by the microcontroller itself and hence is a very useful device. The future scope of this project includes the use of a DAQ (data acquisition board) for the processing of data or the waveform obtained from the nerve. Another development that could be accomplished is the inclusion of the amplifier section in the detecting part especially for patients in whom the voltage is quite low. The project could be extended using the animal model that is a mice model. This is done to further study the effects of nerve conduction in mice models and thereby indirectly in human.

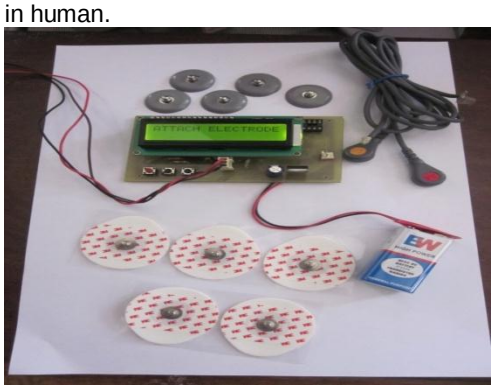

Fig 6 Final hardware setup

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