3rd National Conference on Enhancement in Biomedical Engineering and Healthcare
Organised by Department of Biomedical Engineering,
Adhiyamaan College of Engineering, Hosur, Tamil Nadu, India

Computational Analysis of Neuro Muscular Rehabilitation Using Labview

K. Uma[1], V. Sangeetha[2], A. Mahalakshmi[3]

[1, 2]Assistant Professor, Department of Biomedical Instrumentation Engineering, School of Engineering, Avinashilingam University, Coimbatore, Tamil Nadu, India

[3]Research Scholar, Department of Biomedical Instrumentation Engineering, School of Engineering, Avinashilingam University, Coimbatore, Tamil Nadu, India

ABSTRACT

Physical disabilities which caused by impairment due to muscle spasticity, osteoporosis, muscle atrophy affects the person's quality of life. As a result, physical rehabilitations are essential to be performed for the restoration of lost functions as a core treatment for such disabilities. On the other hand, the physical rehabilitations are too labour intensive due to the nature of one-to-one attention in healthcare sectors. To overcome the above mentioned problems, this paper presents the development of analysis of intelligent upper limb rehabilitation system to close the gap in shortage of therapists. The system is designed especially for user motivation to perform the exercise longer and be used with minimum therapist supervision at home. The physical rehabilitation aims to work out the increase in upper limb range of motion, and strengthen the associate muscles. The user's sEMG signals will be attained and the system detects the defined sEMG threshold level to display and analyse the active muscle's EMG signal in real time during performing exercises. These signals are extracted as live data and imported to LabVIEW platform. These live data were used as an input for real-time muscle activation module. Analysis and display of real-time muscle activation is performed in LabVIEW. The effectiveness of the proposed system is being evaluated by performing usability test. Since the system is user friendly the participants can interact with the rehabilitation exercises easily.

Keywords : sEMG , upper limb rehabilitation, analysis in LabVIEW.

I. INTRODUCTION

Rehabilitation is the re-integration of an individual with disability into society by enhancing existing capabilities or by providing alternative or substitute. The principle of rehabilitation is to assist individuals with disabilities and aid the recovery of physical functions lost because of disease or injury. Rehabilitation engineering is the use of systematic application of engineering technological solutions to assist the individuals confronted with disabilities. Functional areas addressed through rehabilitation engineering may possibly comprise mobility, communications, hearing, vision and cognition activities related with employment living, education, and integration into the independent community. The goal of the rehabilitation engineering regarding clinical practice and education is to focus on the applications for different impairments and disabilities.

Electromyography (EMG) is a technique that deals with the detection, analysis and measurement of electrical signals obtained from the skeletal muscles.

The field of electromyography is studied in Biomedical Engineering and prosthesis that use electromyography comes under Biomechatronics. During the exchange of ions across the muscle membranes, an electric impulse is produced during the muscular activity. The surface electrodes which are used to acquire this signal is known as myoelectric signal. The instrument used to obtain the EMG signal is known as electromyograph and the resultant recorded form is called electromyogram. The movement of the human body is possible by coordination of muscles with the brain. Whenever the muscles get excited through the Central Nervous System (CNS), they are innervated in groups called 'Motor units'.

Electromyography is getting used as an assessment tool in applied research, physiotherapy, rehabilitation, medicine and training, biofeedback, ergonomics research, and biomechanical research. In the recent past, EMG has also being used in rehabilitation of patients with amputations in the form of robotic prosthesis. EMG has proved to be a valuable tool as it provides a natural way of sensing and classifying different body movements. Recent advances in electronics and microcontroller technology has improved control options for robotic mechanisms.

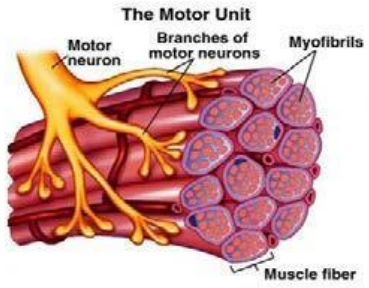
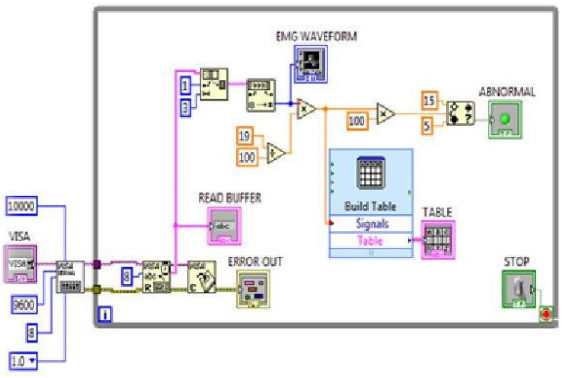


Fig.1 Motor unit of the muscle

Electromyogram (EMG) is an electrical impulse produced by skeletal muscles during muscular activity. It can detect the abnormalities and activation levels of human movement through analyzing the shape are required for a certain activity, the brain sends size, and frequency of muscle activation. It gives very important information in many clinical and biomedical applications. There are numerous applications of EMG signals used for controlling of prosthesis or orthotic device movement, detection of user intended movement, controlling of virtual models, etc.

II. Methodology

In this rehabilitation system, surface EMG electrodes are used to extract the signals. The real-time muscle simulation module in this system employs the sEMG signals to detect the activation level of muscle performance to trigger the muscle simulation. This module provides very useful information to user as a motivational tool and therapists to monitor and track the patient's muscle performance. The system consists of one main module and six sub modules in-built namely initialization, setups, read data, plot data, muscle animation and close connections in LabVIEW to exhibit as real-time muscle activation. The display of muscle activation is compared with the threshold value of sEMG live value with the predefined sEMG value.



The threshold value of sEMG signals is variable and can be defined by therapist according to the user performance. The sEMG signal is initially acquired by the needle and surface electrodes and amplified for

further process. Frequently more than one amplification stages are needed, it must be processed to eliminate low or high frequency noise, or any other factors that may affect the outcome of the data. The amplitude of the signal which is the point of interest can range between 0 to 10 millivolts (peak-to-peak) or 0 to 1.5 millivolts. The frequency of an EMG signal usually ranges between 0 to 500 Hz. However, the usable energy of EMG signal is dominant between 50-15 Hz.

The sEMG electrode will acquire some threshold value and gives to the amplifier unit. The amplifier then amplifies the sEMG signal and sent to the microcontroller ADC segment. This section converts the analog signal to digital signal. Controller sends the signal to LabVIEW platform PC. PC monitors and analyse the sEMG signal using LabVIEW.

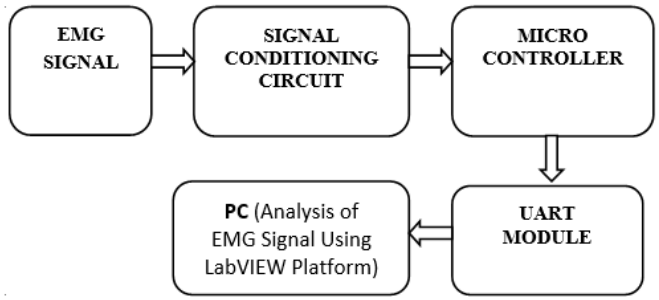


Fig.2.1 Block diagram

A. Hardware

The hardware unit consists of power supply, signal conditioning unit and PC. The power supply circuit is built using filters, rectifier and voltage regulator, typically 230V rms, is connected to a transformer, which steps down the AC voltage to the level of 12V. A diode rectifier then provides a full wave rectified voltage and converts 12V AC to 12V DC. This resulting DC voltage usually has some ripple or AC voltage variation. Filter or smoothing capacitors are used to remove the ripples. A regulator is used to provide a DC voltage that has much less ripples and maintains the same DC value even if the DC input varies.

The most fundamental function of the signal conditioning unit is to filter the noise ripple signals. The spectrum includes some invalid signal frequency data too. There are several concerns regarding the appropriate acquisition of EMG signal. Once the electrode is properly placed, the signal is extracted. For the transmission of pure EMG, the high and low frequency noise should be deleted and only a specific band of frequency should be carried forward. In order to achieve this, a band pass filter can be used. A band pass filter can be designed by connecting a low pass and a high pass filter in series. A band pass filter response is shown in Fig 2.2

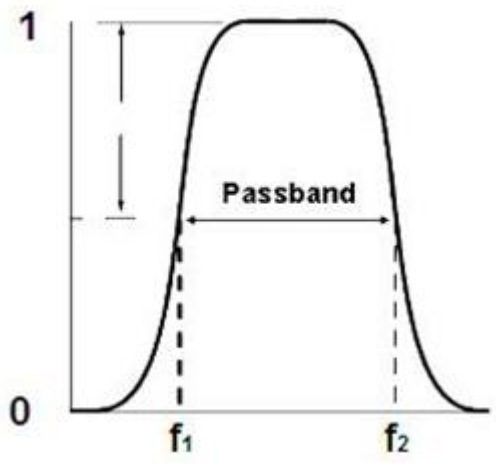


Fig. 2.2. Bandpass filter response

The frequency region where the response of the EMG signal is '1' is called the 'passband'.

III. Software using labview platform

LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) is a platform and development tool for a visual programming language [2]. It contains a comprehensive set of tools for

analyzing, acquiring, storing data, displaying and to troubleshoot the code[2].

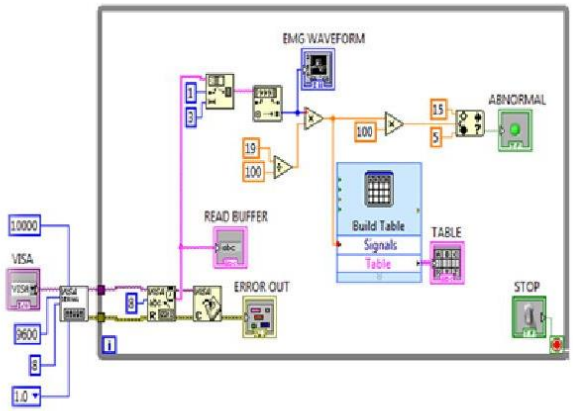


Fig.3.1 LabVIEW Block diagram

It also includes built-in support for NI hardware platforms such as Virtual Instrument Software Architecture (VISA) toolsets, Measurement and Automation eXplorer (MAX), etc.

VISA Open

Opens a session to the device specified by VISA resource name and returns a session identifier that can be used to call any other operations of that device.

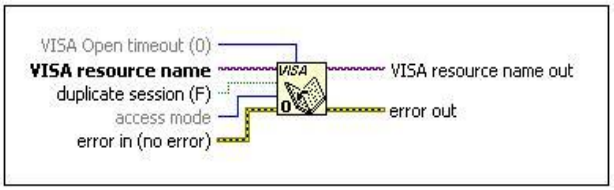


Fig. 3.2 VISA Open

VISA Read

This function might return less than the number of bytes requested if the function reaches the end of the buffer, reaches a termination character, or if a timeout occurs [3]. The output error cluster indicates if a timeout has occurred. Whether the data is read synchronously or asynchronously is platform-dependent[3].

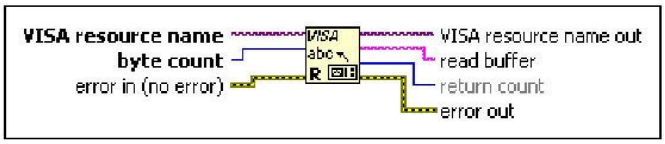


Fig.3.3 VISA Read

C. VISA Close

Error I/O operates uniquely in this function. The function closes the device session regardless of whether an error occurred in a preceding operation [3]. For each VISA session that is opened, the session should be closed when it is completed. Depending on the speed of the transfer, this can hinder other processes that require the calling thread [3].

Fig.3.3 VISA Close

IV. RESULTS AND DISCUSSION

The main objective of this research work is to rehabilitate patients with neuromuscular disorders like muscle spasticity, muscle atropy, osteoporosis, etc., EMG signal carries valuable information regarding the muscular system. The sEMG signals are usually not repeatable and contradictory in nature. Therfore to analyze such signal, LabVIEW platform is uesd. LabVIEW software serves as the valuable diagnostic and supportive tool for the analysis of sEMG signals obtained. The patients can interact with the system and they can monitor their trained muscle performance in real time.

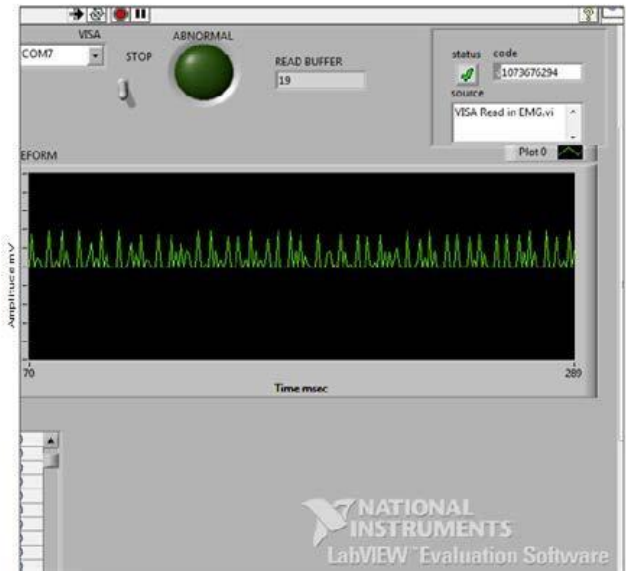


Fig.4.1 Output EMG signal

The test has been conducted with healthy subject in order to compare with the patients with neuromuscular disorders. Therefore the developed system is not only for adult rehabilitation but also for children with disabilities. In future, detailed information about sEMG signals can be obtained which can be used to rehabilitate patients with ease and the system can be made compact and portable.

V. REFERENCES

[1]. Joseph D. Bronzino, "The biomedical engineering handbook", Second Edition, Volume II, CRC Press, Springer, IEEE Press, 2000.

[2]. https://www.ni.com/getting-started/labview-basics/environment

[3]. https://zone.ni.com/reference/en-XX/help/371361R-01/lvinstio/visa_read/

[4]. Yee Mon Aung, Adel Al Jumaily "Neuromotor rehabilitation system with real-time biofeedback", International Journal of Computer Information Systems and Industrial management Application, Vol. 5, pp. 550-556, 2013.

Cite this article as :

K. Uma, V. Sangeetha, A. Mahalakshmi, "Computational Analysis of Neuro Muscular Rehabilitation Using Labview", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 5 Issue 5, pp. 73-77, March-April 2020.