Design of A Power-Assistive Robust Controller for Parkinson’s Tremor in Human

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Abstract— In voluntary oscillatory motion in muscle causes tremor in Human. Parkinson’s Tremor (PT) is one of the most common movement disorders. Without impeding the patient’s intentional motion estimating the tremor suppression in musculoskeletal level is a major challenge. To address this issue, a wearable device is designed for limb tremor could benefit a considerable number of patients, but the technology to suffer in this way is under-developed. In this paper a robust controller that can dynamically suppress pathological tremor with Raspberry-pi board is developed. Electromyogram (EMG) signal parameters are important for assessing muscle activity and fatigue. The start/stop times for each EMG burst are identified by the hand movement. Flexibility of the PT patient’s hand is identified using FlexiForce(flexible) sensor. Then the numerical values are measured and displayed in Raspbian OS with Qt creator. Finally the Simulation results are shown using LabVIEW software.

Key words: Parkinson Disease, EMG, Raspberry Pi, Qt Creator, Labview Software

I. INTRODUCTION

Involuntary oscillatory motion in muscle causes tremor in Human. Parkinson’s Tremor is one of the most common movement disorders. Without impeding the patient’s intentional motion estimating the tremor suppression in musculoskeletal level is a major challenge. Parkinson’s tremor is initially unilateral (i.e. one sided), not generally inherited, and the tremors are considered to be symptomatic, meaning they reflect known changes in the Nervous system. Pharmacologic treatment of Parkinson disease can be divided into symptomatic and neuroprotective (disease modifying) therapy. At this time, there is no proven neuroprotective or disease-modifying therapy. Thus, while the administration of drugs, stereotactic thalamotomy, or thalamic deep brain stimulation is often initially effective in controlling tremor motion, none of these treatments guarantees a permanent solution.

A. What Is Parkinson’s Tremor?

Parkinson's disease is a brain disorder that causes a gradual loss of muscle control. The symptoms of Parkinson's tend to be mild at first and can sometimes be overlooked. Distinctive signs of the disease include tremors, stiffness, slowed body movements, and poor balance. Parkinson's was originally called a "shaking palsy," but not everyone with Parkinson's has a tremor. While Parkinson's Tremor can be a frightening Diagnosis life expectancy is about the same as for people without the disease. For some people, symptoms evolve slowly over 20 years. Early treatment can provide years that are virtually symptom-free. About 5% to 10% of cases occur before age 50. Parkinson's disease is often defined as a Parkinson’s syndrome that is idiopathic (having no known cause), although some atypical cases have a genetic origin. Many risk and protective factors have been investigated: the clearest evidence is for an increased risk of PD in people exposed to certain pesticides and a reduced risk in tobacco smokers. Tremor is an early symptom for about 70% of people with Parkinson's. It usually starts in a finger or hand when the hand is at rest, but not when the hand is in use. It will shake rhythmically, usually four to six beats per second, or in a “pill-rolling” manner, as if rolling a pill between the thumb and index finger. Tremor also can be a symptom of other conditions, so by itself it does not mean someone has Parkinson's. In this paper, the tremor suppression control method is proposed for upper-limb power-assist robot. In proposed method, the vibrations of the hand and the tip of the tool are suppressed. The validity of the proposed method was verified by the experiments. When the user who suffers from the tremor uses the power-assist robot controlled based on EMG signals, the robot might assist the vibration of the tremor. In order to extract the features of the raw EMG signal, the root mean square (RMS) of EMG signal is calculated and used as an input for the controller. When the user who suffers from the tremor uses the power assist robot controlled based on EMG signals. In the proposed method, the hand position and the tool position are focused and each vibration component is extracted.[5]

II. RELATED WORKS

The purpose of this study is to examine whether the intended torque generation in this patient responds to dopamine therapy. During isometric contractions, the reported impairments were mostly in the rate of force changes, in latency, and in Maximum Voluntary Contraction (MVC) levels. The power spectra for the EMG signals of all muscles were checked for possible fatigue during the trials. Before working with the torque signals, rest torque averages were subtracted to account for gravitational components. EMG electrodes (Meditrace, center-to-center distance 2.5 cm) were used to collect the signals. Before being sampled, EMG signals were amplified 2000 times and band-pass filtered (10- 500 Hz). The EMG signals were collected from main elbow flexor and extensor muscles. [8] This paper presents the design and implementation of the first stage of the two-stage filter. Experiments on healthy subjects have shown promising results. In this paper, a novel idea is proposed to use EMG controlled FES for pathological tremor suppression. The system is designed and future plan is given. Moreover, the first stage of the filter design is accomplished. Real data from healthy subject is acquired and used to test the performance of the filter.

Electromyographic(EMG) studies have revealed that tremor activities are synchronous between agonist and antagonist muscles. Harmaline is one of the most frequently used tremor-generating drugs for experimental analysis of tremor. Systemic administration of cholinomimetics can also produce generalized tremor, and muscarinic receptors on striatal neurons are thought to be the best candidate for the tremor-generating mechanism. Rodent models of Parkinson’s disease such as those induced by dopaminergic
neurotoxins should not be regarded as an appropriate model of rest tremor in Parkinson’s disease. The purpose of the study was to develop an optimized joystick control interface for electric powered wheelchairs and thus provide safe and effective control of electric powered wheelchairs to people with severe physical disabilities. The interface enables clinicians to tune joystick parameters for each individual subject through selecting templates, dead zones, and bias axes.

**A. Force Sensor:**
The Flex sensor patented technology is made of resistive carbon elements. As a variable printed resistor, the flex sensor achieves a great form-factor on a thin flexible substrate. When the substrate is bent, the sensor produces the resistance output correlated to the bend radius; the smaller the radius the higher the resistance value. For bio-

dynamics, the sensor can be placed on a moving joint of athletic equipment to provide an electrical indication of movement or placement. A few of the sensors can be incorporated onto a glove to make virtual reality glove.

**B. Pressure Sensor:**
This circuit is designed to measure the varying pressure. The pressure is measured by diaphragm which is one type of transducer. When pressure is applied, the diaphragm is moving in the forward side. The TL 082 is the dual operational amplifier that is two operational amplifiers is fabricated in single chip. Here the instrumentation amplifier acts as differential instrumentation amplifier. The diaphragm moving is depends on the pressure. So it generates the voltage pulse depends on the movement of the diaphragm.

The voltage pulses are in the range of mV. Hence the voltage pulse is given to Instrumentation amplifier section in order to amplify the signals. When there is no pressure the diaphragm may be sliding in the forward or reverse side. Due to that instrumentation amplifier delivered some voltage at the output. To avoid this problem A4 amplifier is used for zero adjustment. Hence when there is no pressure the output is zero.

**C. EMG Circuit:**
EMG is a technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using an instrument called an Electromyograph, to produce a record called an Electromyogram.

1) **Instrumentation Amplifier Circuit:**
The instrumentation amplifier is constructed by the TL 072 operational amplifier. There are three electrodes, electrode 1 & electrode 2 are placed in hand to pick up the EMG signal and pass it to the instrumentation amplifier. Electrode 3 is placed in leg to get the reference signal from ground. The instrumentation amplifier amplify the differential signal from the both the electrodes.

2) **Filter Circuit:**
The filter section consists of high pass filter and low pass filter which is used to remove the high frequency and low frequency noise signal.

3) **PWM Circuit:**
After the filtration the EMG wave is given to pulse width modulation unit. Here the EMG waves are converted to pulse format in order to perform the isolation. Do not use the word “essentially” to mean “approximately” or “effectively.”
4) **Isolation Circuit:**
The isolation circuit is constructed by the Optocoupler. The isolation is necessary to isolate the bursts taken from the human body and monitoring equipment such as CRO, PC etc.

5) **PW Demodulation Circuit:**
Then the EMG pulse format wave is given to PW demodulation unit in which the pulse format is reconstructed to original wave. Then the wave is fed to notch filter section in order to remove the line frequency noise signal.

6) **Notch Filter Circuit:**
It is a filter that attenuates signal within a very narrow band of frequencies. A notch filter is a band-stop filter with a narrow stop band (high Q factor). Other names include 'band limit filter', 'T-notch filter', 'band-elimination filter', and 'band-rejection filter'. Here the notch filter is constructed by the operational amplifier TL074.

IV. **PROCEDURE FOR PROPOSED MODEL**
Initially Power supply is given to the board. Connect all the Components. Using the HDMI cable, connect the Raspberry pi board and the monitor. Install the Raspbian OS and Qt creator compiler. Write the Programs, Debug and Run. Install LabVIEW software. With the use of RS- 232 Serial USB cable connect to the board. Place the Electrodes on the Patients hand to know the EMG values. Force sensor is used to measure the Force from the Patient, Pressure is also measured. Switch on the power supply. Move the wrist and rotate to know the readings. Simultaneously the LabVIEW results are also analyzed.

V. **RESULTS**

A. **EMG results on LabVIEW:**

![EMG waveform during movement of tremored hand](image)

Fig. 6: The Above Results Are The EMG Waveform During The Movement Of The Tremored Hand For Parkinson’s Disease.

B. **Force results on LabVIEW:**

![No force results](image)

Fig. 7: The Above Results Shows When There Is No Force.

C. **Pressure results on LabVIEW:**

![Pressure output](image)

Fig. 8: The Above Results Show The Pressure Output.

![Respective measurements in Raspbian OS](image)

Fig. 9: The Above Figure Shows The Respective Measurements In Raspbian OS.
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Fig. 10: Respective Measurements In Raspbian OS.

Fig. 11: The Above Figure Shows The Respective Pictorial representation.

Fig. 12: The Above Figure Shows The Experimental Setup Of The Proposed Model.

Fig. 13: The Above Figure Shows The Wearable Hand Suppression Controller For Parkinson’s Tremor.

REFERENCES


