The Use of Vibration to Neutralize the Parkinson Disease Hand Tremor

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Abstract

Today there are some treatments available for Parkinson Disease. Even though there is no standard treatment for the disease, because it's progressive and has no cure, there are some technologies that help the patients with their daily routine. Early symptoms of Parkinson's disease are usually mild and generally occur gradually. As the disease progresses, it begins to interrupt daily activities. The most common symptoms are tremors, especially in the arm. In this project, a simulation of a hand tremor will be carried out, and three motors will be used in order to determine which one neglects the vibration of the hand; the Coin-type, the Bar-type and the Uxcell motor. The Uxcell motor has less angular frequency, 25 rads/sec, and was able to reduce, in a more efficient way, the vibration of the hand.

Introduction

Parkinson Disease is a degenerative disorder of the central nervous system that affects the motor system. Mostly, it's diagnosed after the age of 60. This affects people's daily routine, like walking or eating. The purpose of this project is to simulate a PD hand tremor and to test different motors to see which one is capable of reducing its vibration. Three types of motor were tested for this project; the Coin-type, Bar-type and the Uxcell motor.

Background

Companies like Google or Gyenno Technologies have picked their interest on finding a better way to help PD patients. They have created technologies using vibration that helps to control the hand tremor, which is what this project is about. Tremor (shaking) begins in the hands and arms, although it can also occur in the jaw or foot. Tremors typically involve the rubbing of the thumb against the forefinger, and is more apparent when the hand is at rest, or you are under stress. In the early stages of the disease it usually only affects one side of the body or one limb. As Parkinson's progresses, tremor may affect other parts of the body. People with Parkinson's don't have enough of a chemical called Dopamine. This is because some nerve cells in their brain that produce Dopamine have died [1]. Vibration is key to perform this project. Any vibration has amplitude and frequency and the hand tremor is no exception. Vibration is been used in many biomedical technologies not only dealing with PD, but also improving muscle strength [2].

Problem

The problem solved in this project was to control the vibration amplitude of the PD simulation. As already mentioned, many companies have created devices to help PD patients and that's why the information obtained from this project could lead to create a new medical device, that could be more practical.

Methodology

The PD simulation setup is shown in figure 1. Using a hand doll, the motor with the extra weight was attached, as shown.

Figure 1: PD simulation of the hand tremor

The setup for the motors mentioned, were as follows. Three motors for the Bar-Type (see Figure 2). Three motors for the Coin-Type (see Figure 3) and only one motor for the Uxcell motor (see figure 4).

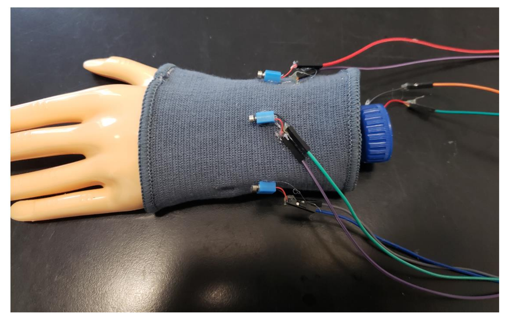

Figure 2: Bar-Type setup

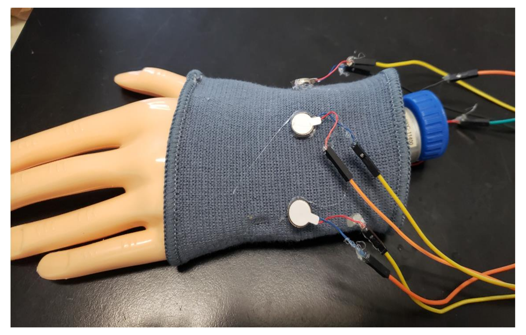

Figure 3: Coin-Type setup

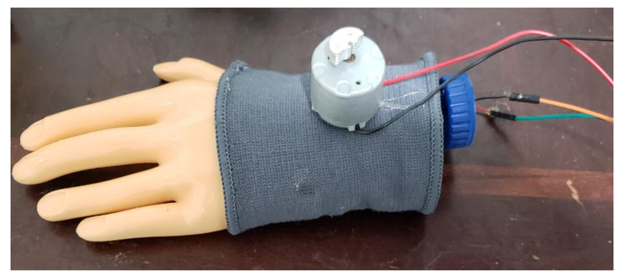

Figure 4: Uxcell motor

An Accelerometer, (see figure 5), was used to measure the acceleration of the motors since they are useful for sensing vibrations in systems. Also, a Signal Conditioner, (see figure 6), was used to amplify and convert the mechanical signal (input-signal) into an electrical signal (output-signal) easy to read.

Figure 5: Accelerometer

Figure 6: Signal Conditioner

LabView was used to acquire the motor's vibration frequencies. The block diagram is shown in figure 7.

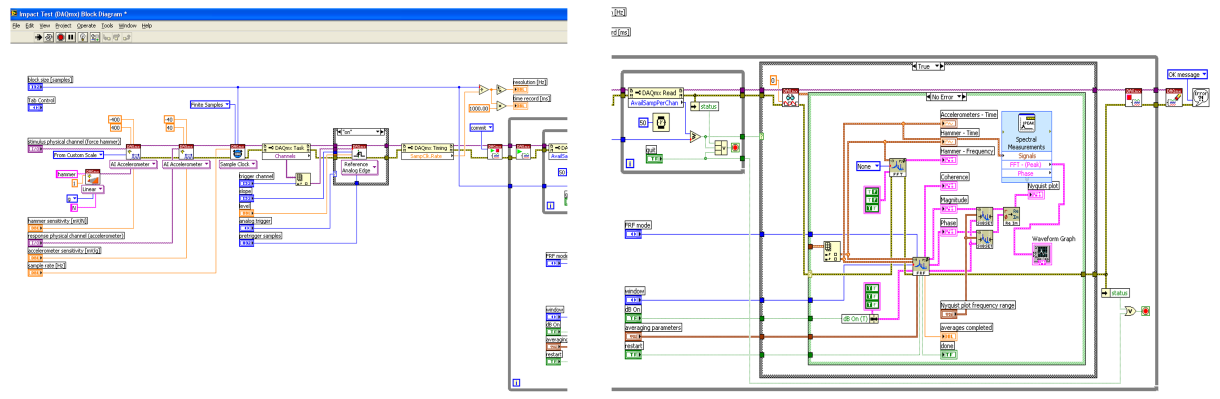

Figure 7: LabView block diagram

Results and Discussion

First is the PD simulation. Figure 10 shows that the vibration goes from -1.2mV to 1.45mV aproximately, making its amplitude 1.325mV with a vertical shift of 0.125mV. Because of the weight that was placed in the motor, little disturbance appears in the sine wave for a better simulation. The angular frequency, Figure 11, is approximately 42 rad/s which make its frequency 6.68 Hz.

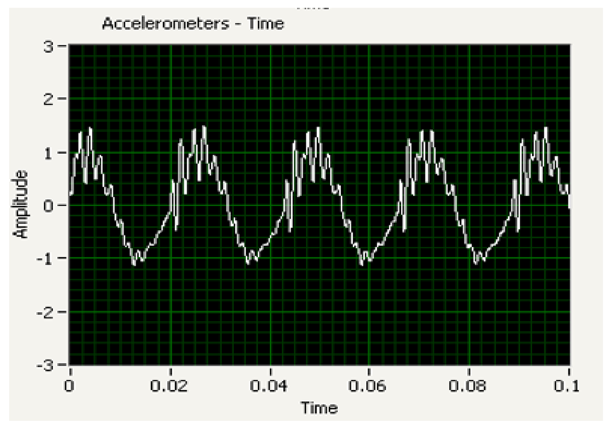

Figure 10: PD vibration reading

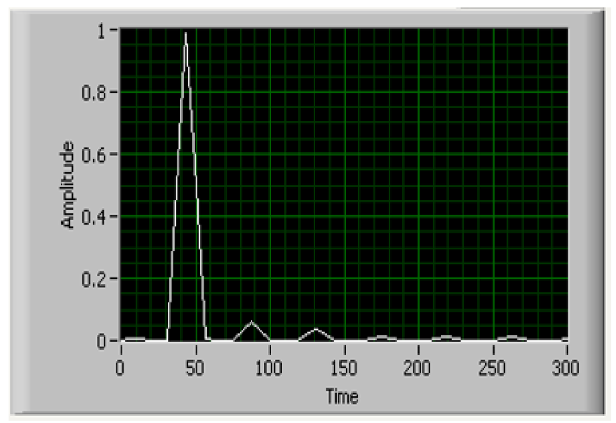

Figure 11: PD angular frequency reading

The result of the amplitude and angular frequency for the Bar-type motors are shown in Figure 12 and Figure 13.

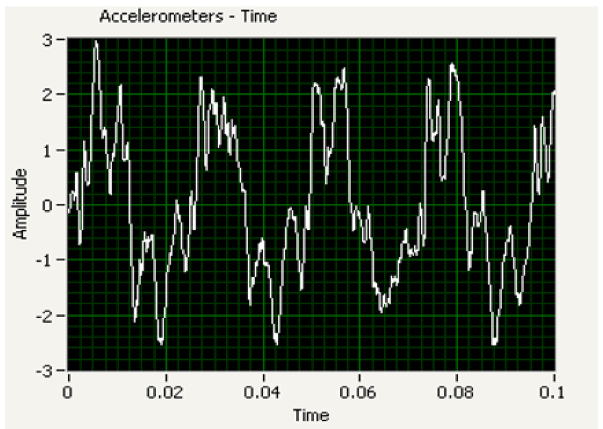

Figure 12: Bar-Type Result

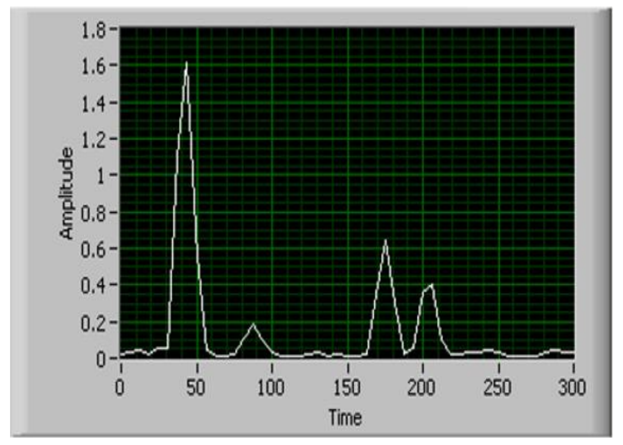

Figure 13: Bar-Type Frequency Result

The result of the amplitude and angular frequency for the Coin-Type motors are shown in Figure 14 and Figure 15.

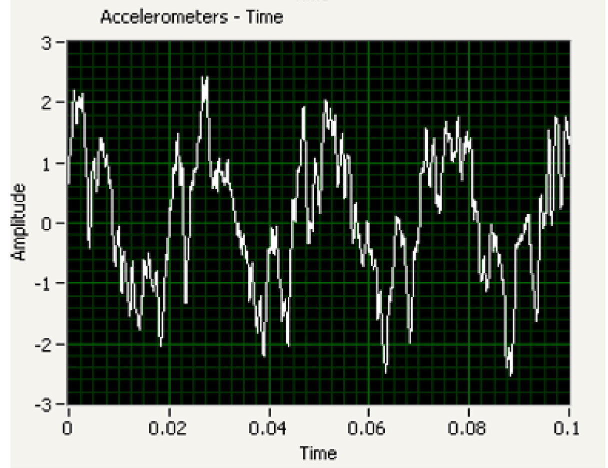

Figure 14: Coin-Type Result

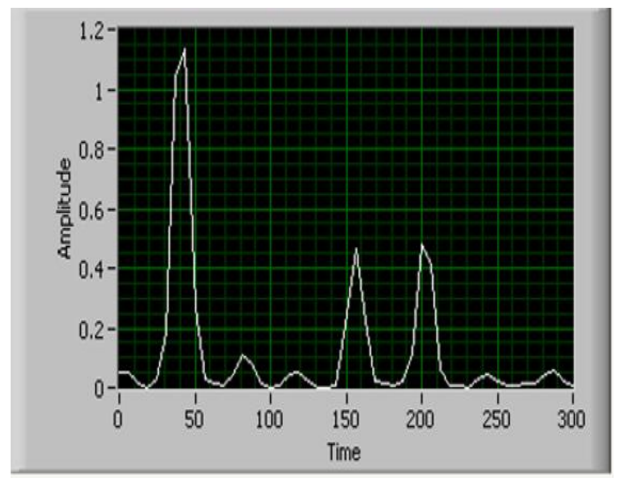

Figure 15: Coin-Type Frequency Result

The result of the amplitude and angular frequency for the Uxcell motor are shown in Figure 16 and Figure 17.

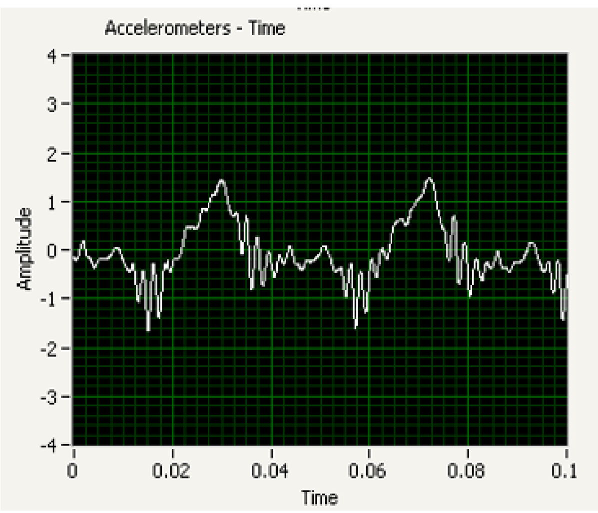

Figure 16: Uxcell Result

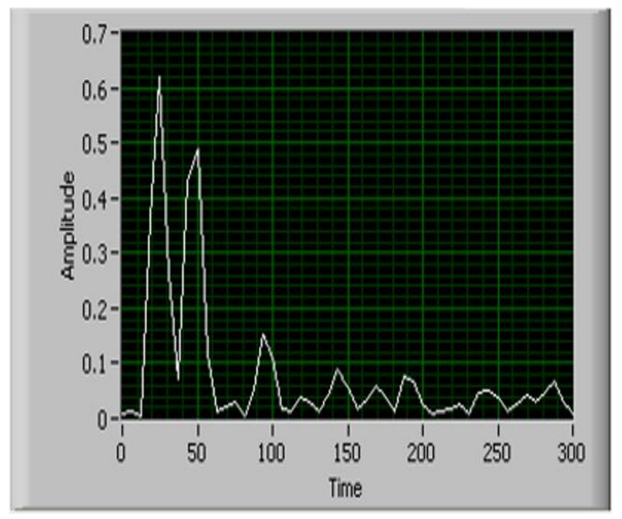

Figure 17: Uxcell Frequency Result

The Bar-type, produces a big amplitude in short time. Therefore, it barely goes opposite to the vibration of the PD producing an increase in the amplitude. The Coin-type motor does not have a weight attached to it but, same as the first motor, it barely goes opposite to the PD vibration. Therefore the amplitude still increases but not as much as the Bar-type motor.

The Uxcell vibration motor, even though it has a weight attached to it, produces a more smooth sine wave opposite to the PD simulation. As it is presented in Figure , most of the vibration amplitudes are between -0.6 mV and 0.4 mV making its amplitude 0.5 mV.

The accelerometer has a sensitivity of 10.33mV/m/s². Therefore, the acceleration for the results of the motors can be calculated using the following equation,

$$a = amplitude/accelerometer\_sensitivity \qquad (1)$$

The acceleration for the results of the motors and PD simulations are:

- PD = 0.128 m/s²
- Bar-Type motors = 0.561m/s²
- Coin-Type motors = 0.484 m/s²
- Uxcell motor = 0.301 m/s²

Conclusions

Out of the three motors, the Uxcell motor proved to be more efficient for the task. Since this is only a simulation, it is necessary to conduct a more realistic test to confirm this results. It would be more specific if tests were done on PD patients. Also, it seems to be that vibrations alone are not enough. It seems that weight must be applied.

Future Work

For future works an ANSYS simulation is recommended. ANSYS can perform load analysis indicating where the highest vibration is and could lead to a better performance given the location that needs most of the vibration.

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References

[1] Parkinson's. (2017, April 10). *Parkinson's UK* [Online]. Available: https://www.parkinsons.org.uk/information-and-support/tremor.

[2] M. Cardinale and C. Bosco, "The Use of Vibration as an Exercise Intervention," *Exercise and Sport Sciences Reviews*, vol. 31, no. 1, 2003.