جامعة الأمير محمد بن فهد
PRINCE MOHAMMAD BIN FAHD UNIVERSITY

College of Engineering

Department of Mechanical Engineering

Fall 2019/2020

Senior Design Project

Designing Tremor Watch

Team# 18

Team Members

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Abstract

A tremor is a muscle contraction which leads to constant patterned cyclic movement in a human body. It is common for tremors to occur in hand or wrist but in some cases it also affects head, chest and even voice. The effects of tremor can be partial or permanent depending on the body. These can be Parkinson's tremor, action tremor, resting tremor etc. The diagnosis were mainly surgeries in the past which reduces the tremor but can cause more weakness.

The tremor watch is able to measure the dynamics of the body which includes acceleration and other components. This will allow the team to compare the dynamics of the patient with a normal body. The components will be set to a normal body so that it can resist tremors and reduce the cyclic movement of the patients wrist. The project consists of vibration motor, haptic motor driver , Arduino and other various electronic and mechanical components.

Acknowledgments:

Dr. Nassim Khaled (PMU):

- Project advisor.
- Micro-controls experience.
- MATLAB experience.

Oumour Hamza (Morocco):

- Arduino Programmer.
- 5 years of experience in programming and circuit design.
- "M-DuinoCore" inventor.

Mr. Aalim Mustafa (PMU):

- Expert in control systems.
- Continuous support through the project development & testing.

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Chapter 1: Introduction

1.1 Project Definition

This project is about designing and manufacturing a tremor prevention watch, where the watch consists of different sensors that will be able to detect the motion of the body and give readings. The watch has multiple layers of parts that are assembled. It also has Bluetooth module in order to change the parameters through a phone app. Apart from that, there will also be a LiPo battery to run the device. A microchip SD card is also installed in order to read the results on a plotted graph through MATLAB. The device will detect the patient's tremors and generate a series of haptic signals through micro-motors located on the wrist band. These motors vibrate to counter the tremors and help the patient do normal tasks.

1.2 Project Objectives

The objectives of this project are:

- Improving mobility and function
- Contributing to the research of Parkinson disease
- Helping patients with Parkinson disease
- Experimenting with real time data and tuning a reactive device based on it.

Chapter 2: Literature Review

2.1 Project Background:

Parkinson's disease is a progressive nervous system issue that influences movement. Symptoms start step by step, sometimes beginning with a barely noticeable tremor in only one hand. Tremors are normal, however, the disorder additionally regularly causes stiffness or slowing of movement. In the beginning periods of Parkinson's disease, your face may indicate little or no expression. Your arms may not swing when you walk. Your speech may turn out to be soft or slurred. Parkinson's disease symptoms worsen as your condition progresses over time. In Parkinson's disease, certain nerve cells (neurons) in the brain gradually break down or die. Many of the symptoms are due to a loss of neurons that produce a chemical messenger in your brain called dopamine. When dopamine levels decrease, it causes abnormal brain activity, leading to symptoms of Parkinson's disease. Actually, the causes for Parkinson’s disease still not yet finalized or known but there are several factors to play a role including the genes, and environmental trigger. In addition to that, there are risk factors that may lead to this disease such as the Age, actually most of the patients who suffered from this disease are 60 years old and older. The Sex is another risk factor since the men are most likely to face this disease. Parkinson's disease signs and symptoms can vary from one to another. Early signs might be gentle and go unnoticed. Symptoms frequently start on one side of your body and generally stay more worst on that side, even after symptoms start to influence the two sides. Parkinson’s sign may include: slow movement, Rigid muscles, Loss of automatic movements, Loss of balance while standing, and the Tremor. Tremors typically occur during rest whereas people with essential tremor mostly have tremors during times of activity. the tremors of Parkinson’s disease and essential tremor also differ in frequency and magnitude. Tremors related to Parkinson’s disease usually occur more frequently over time and are more forceful than those related to essential tremor. Individuals with essential tremor may see a fluctuation in the frequency of their tremors throughout. Because of this tremor, The main goal of this senior project is to create a device will help and give the patient the required support to let him move his/her hands in better shape and try to reduce the tremor as much as possible. Finding a patient, testing and tuning the device, buying and choosing parts for the device, and finding an electrical engineer cooperate to give us some support during some connections.

2.2 Previous Work

World Intellectual Property Organization (WIPO) did a great work to solve the same issue which is the tremor of Parkinson's disease, Embodiments of their invention relate to Systems and Methods for Controlling the Effect of Tremor. In the first embodiment of their disclosure, a system of treatment of involuntary muscle contraction includes a wearable interface having an internal contact surface, the wearable interface configured to at least partially encircle a first portion of a limp of a subject, and an energy applicator carried by the wearable interface and configured to apply energy of two or more types to the limb of the subject (Fig 1). In some embodiments, the system for treatment of involuntary muscle contraction further comprises a control unit configured to control the operation of the energy applicator [3].

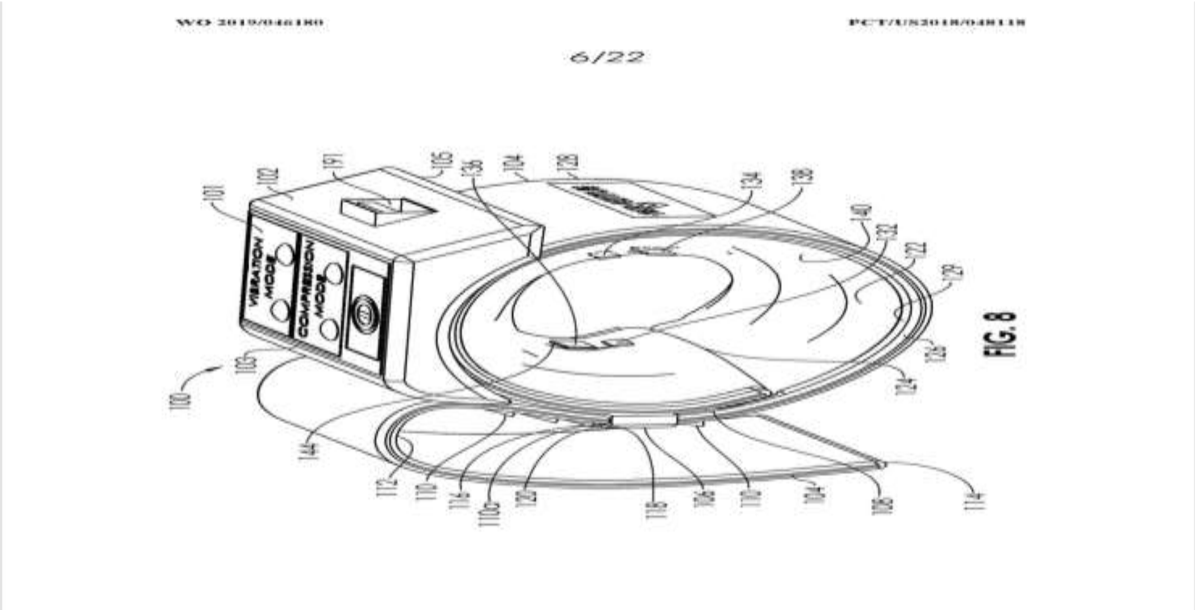
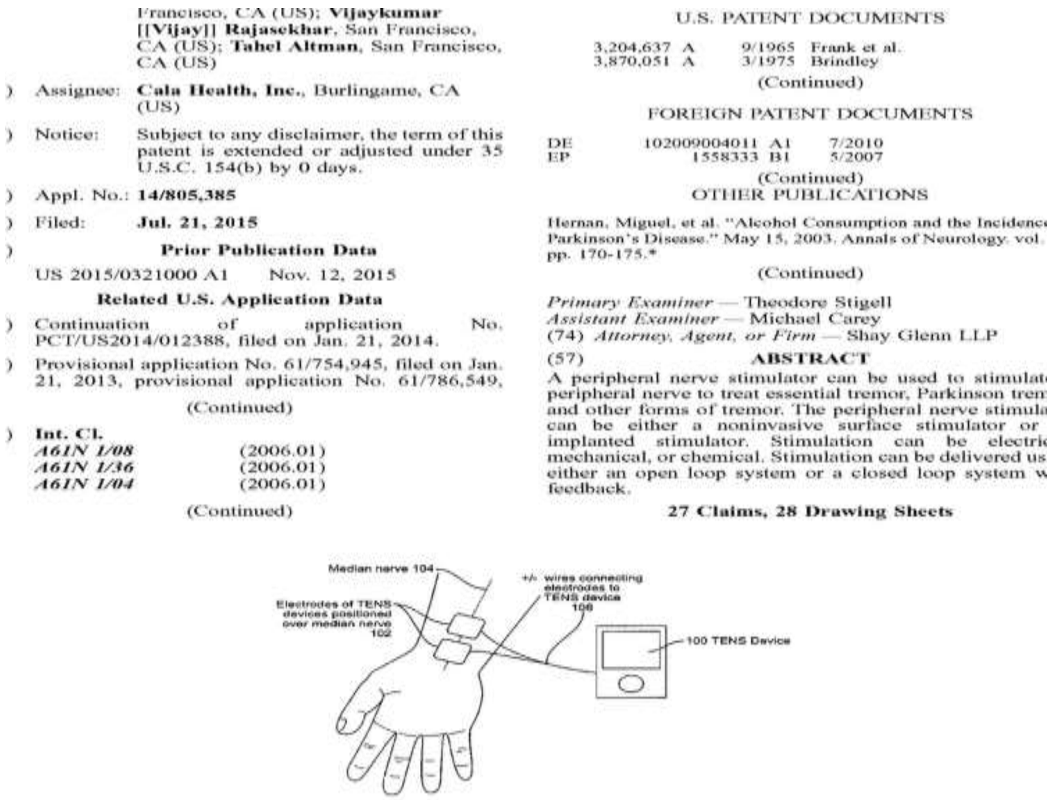


Figure 1: Wearable tremor control system configured for placement on the wrist of a patient

Another application is a continuation of the above application (Devices and Methods for Controlling Tremor) which is the Peripheral nerve simulator (Fig 2). They used the Peripheral nerve to treat essential tremor, Parkinson’s tremor, and another types of tremor. It can be either a non-invasive surface simulator or an implanted stimulator. This stimulation could be chemical, mechanical, or electrical. Simulation can be delivered using either an open loop system or a closed loop system with feedback.



Francisco, CA (US); **Vijaykumar [[Vijay]] Rajasekhar**, San Francisco, CA (US); **Tahel Altman**, San Francisco, CA (US)

) Assignee: **Cala Health, Inc.**, Burlingame, CA (US)

) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

) Appl. No.: **14/805,385**

) Filed: **Jul. 21, 2015**

) **Prior Publication Data**

US 2015/0321000 A1 Nov. 12, 2015

Related U.S. Application Data

) Continuation of application No. PCT/US2014/012388, filed on Jan. 21, 2014.

) Provisional application No. 61/754,945, filed on Jan. 21, 2013, provisional application No. 61/786,549,

(Continued)

) **Int. Cl.**

A61N 1/08	(2006.01)
A61N 1/36	(2006.01)
A61N 1/04	(2006.01)

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(Continued)

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(74) *Attorney, Agent, or Firm* — Shay Glenn LLP

(57) **ABSTRACT**

A peripheral nerve stimulator can be used to stimulat peripheral nerve to treat essential tremor, Parkinson trem and other forms of tremor. The peripheral nerve stimula can be either a noninvasive surface stimulator or implanted stimulator. Stimulation can be electri mechanical, or chemical. Stimulation can be delivered us either an open loop system or a closed loop system w feedback.

27 Claims, 28 Drawing Sheets

Figure 2: Peripheral Nerve Simulator

Deep Brain Stimulation (DBS) is a surgery also can be used to solve the tremor. Surgeons implant electrodes into a specific part of your brain. The electrodes are connected to a generator implanted in your chest near your collarbone that sends electrical pulses to your brain and may reduce the tremor and another Parkinson Symptoms.

2.3 Comparative Study:

The Emma

A computer scientist called Haiyan Zhang who works at Microsoft along with a group of engineers and technicians grouped together to help a graphic designer called Emma. She suffers from Parkinson's disease which resulted in her not being able to do her work anymore. Parkinson's disease caused her to lose the ability to control her hand and she began having tremors. These tremors are unpredictable and they minimize the tasks that the patient can do properly. In order to help Emma gain back control of her hand and perform daily tasks as she once did, the team designed a wrist band with small motors that vibrates and countered the tremors. The wrist band was named "The Emma", after the patient who the device was designed for.

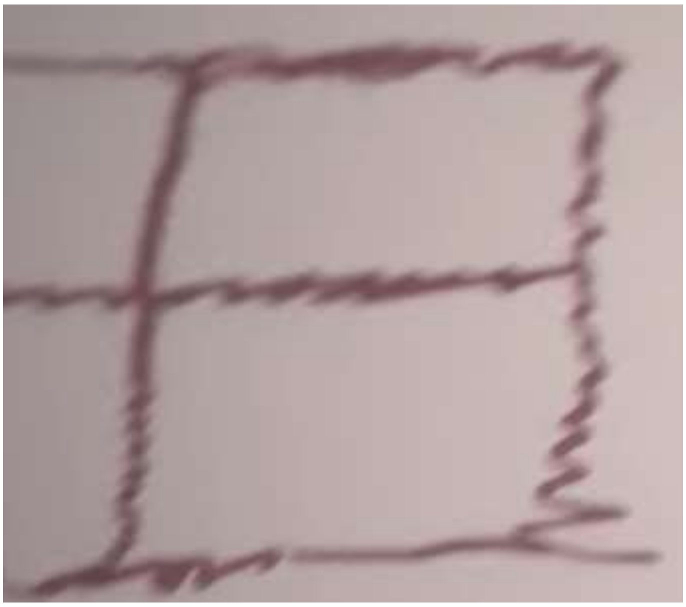

Figure 3: Emma's drawing before

Figure4 : Emma's drawing after

Gyrogear Glove

Fall Ong, the founder of Gyrogear who are a group of volunteer graduates and students have designed a glove that uses the same idea of a *gyroscope* but on the glove itself. This glove forces the hand to stay stable by countering the instabilities. This glove covers almost half of the forearm but it keeps the fingers free to move.

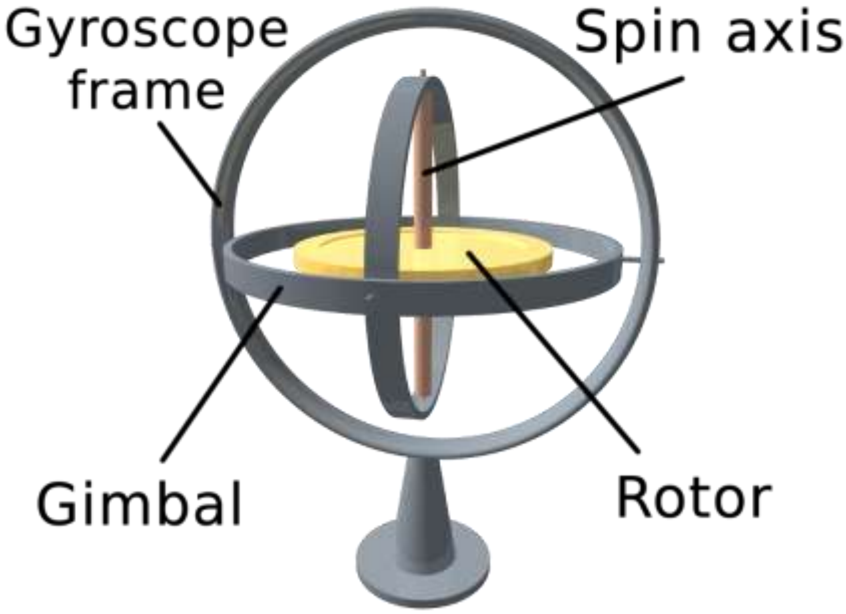

Figure 5: Gyroscope

Figure 6: Gyrogear tremor's gloves

Our project shares the same objective but a using a different approach. Both of these projects (The Emma & Gyrogear Glove) are reactive devices meaning that these devices wait for the tremor to happen which will move the gyro, then react to the tremors and keep the hand stable. Our project however, is a proactive device which will prevent tremors all together to prevent shaking. We are aiming to disturb the signals that cause the tremor in order for the brain to completely ignore the tremor signals and therefore the tremors disappear.

Chapter 3: Initial Design

3.1 Brainstorming

Our team have decided to meet and start a brainstorming session, where we would come up with ideas regardless of how realistic or impossible they might be. The main scope of this approach is to initiate the minds of the team members and start the imagination process in order to come up with a good understanding of the project.

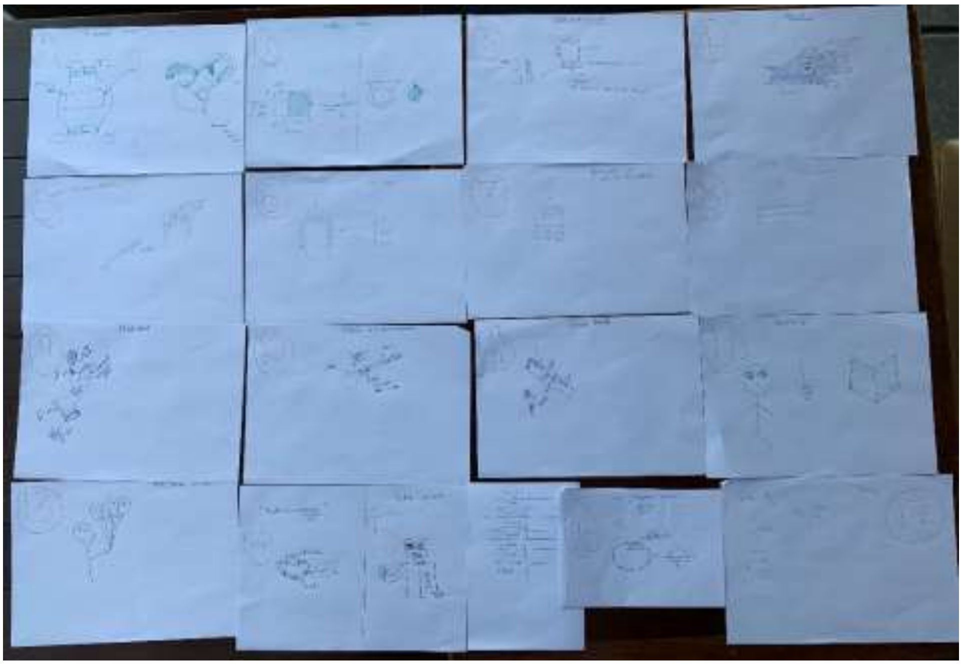

Figure 7: Brainstorms

Then we created a criteria to evaluate the ideas based on a number of rules that were obtained through all of our group members.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Weight	x	x				x		x	x	x	x		x				x
Size		x						x	x	x	x		x				x
Real	x		x	x	x		x	x	x		x			x		x	
Manuracturing	x		x	x	x	x	x		x	x	x		x	x	x	x	x
Cost			x			x	x						x				
Material (availablity)	x	x	x	x	x	x	x		x	x	x		x	x	x	x	x
Noise (not)		x			x	x		x					x				x
Durability										x	x		x		x		x
Comfort		x								x	x	x	x	x	x		x
Choice			Yes								Yes						

Table 1: The Evaluation Criteria

The Two winning ideas were both realistic, approachable, and possible candidates to begin with. However the team decided to for the alternative of the “Watch Design”.

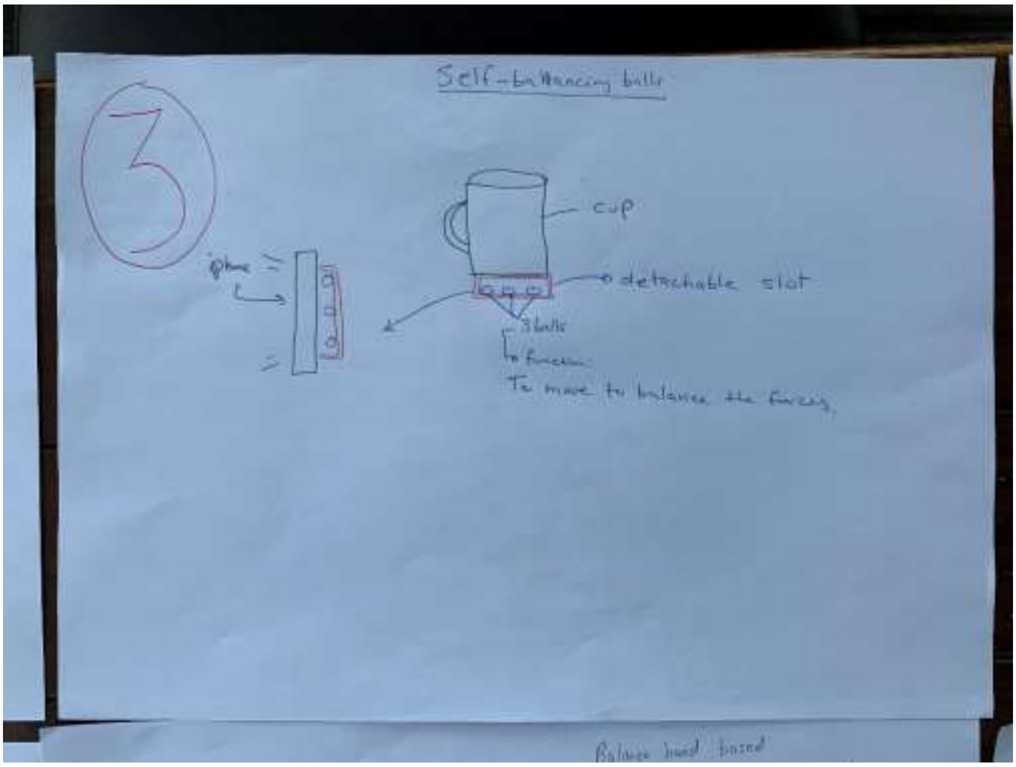

Figure 8: Choice No.1 (Self Balancing Balls)

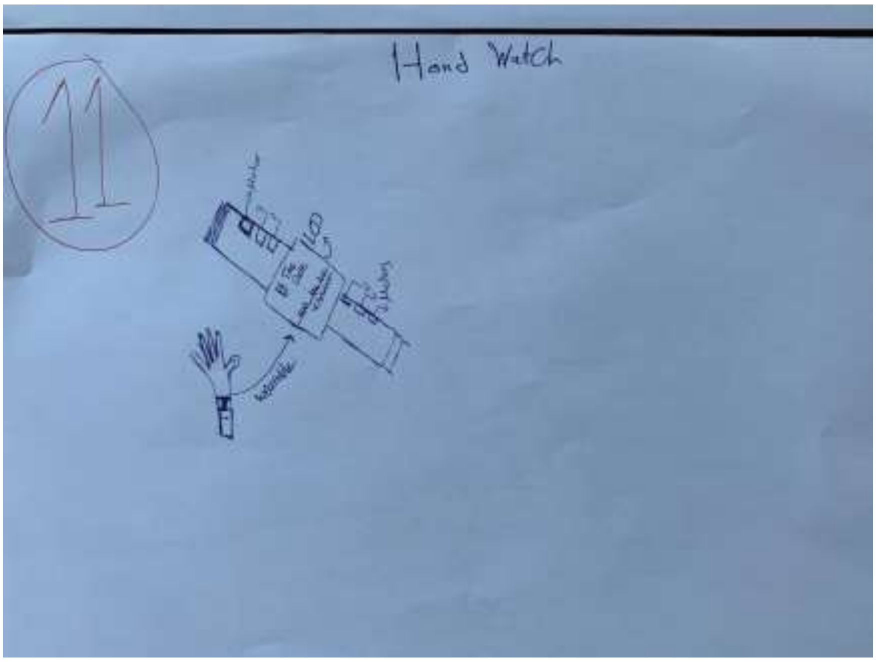

Figure 9: Choice No.2 (Hand Watch)

3.2 Planning

Our team began with the idea approach. What was needed? What are the possible shapes? Could it be easily designed?

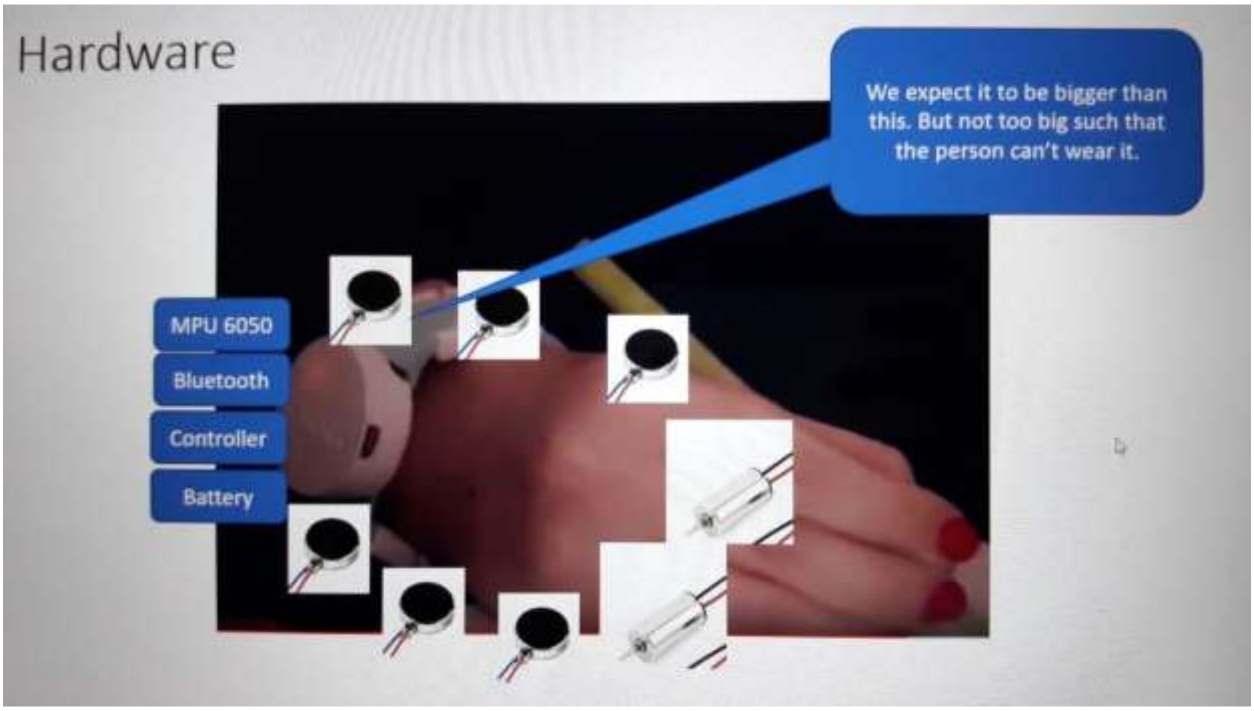

Figure 10: Initial needs of the project

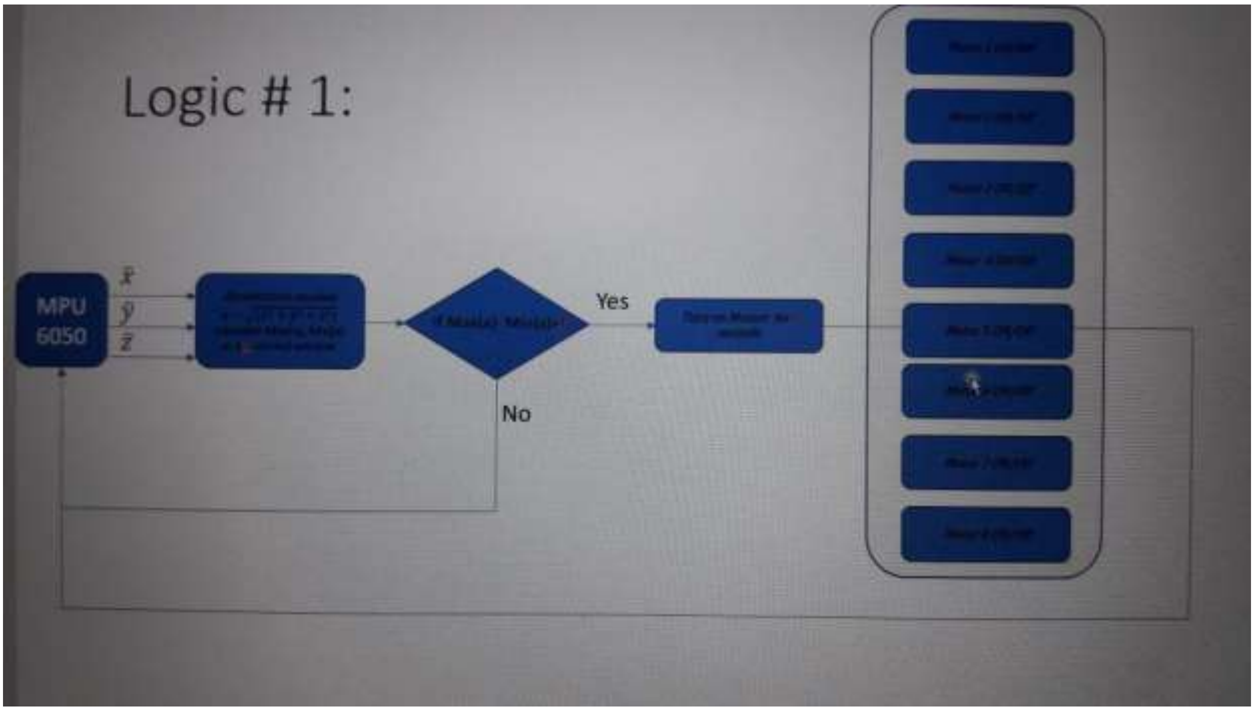

Figure 11: Logical approach to the project

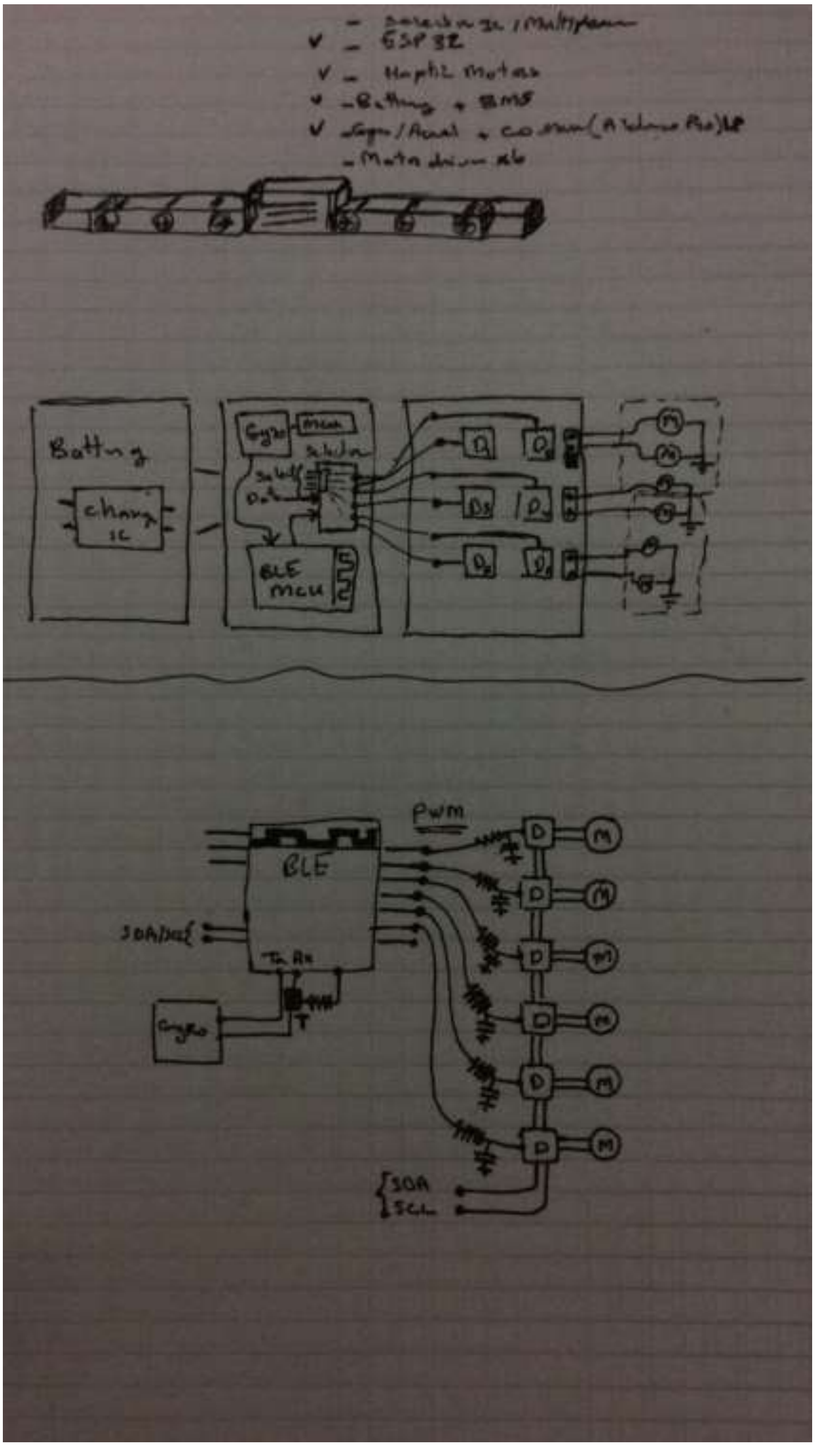

Figure 12: The initial sketch

3.3 Sketches and Requirements

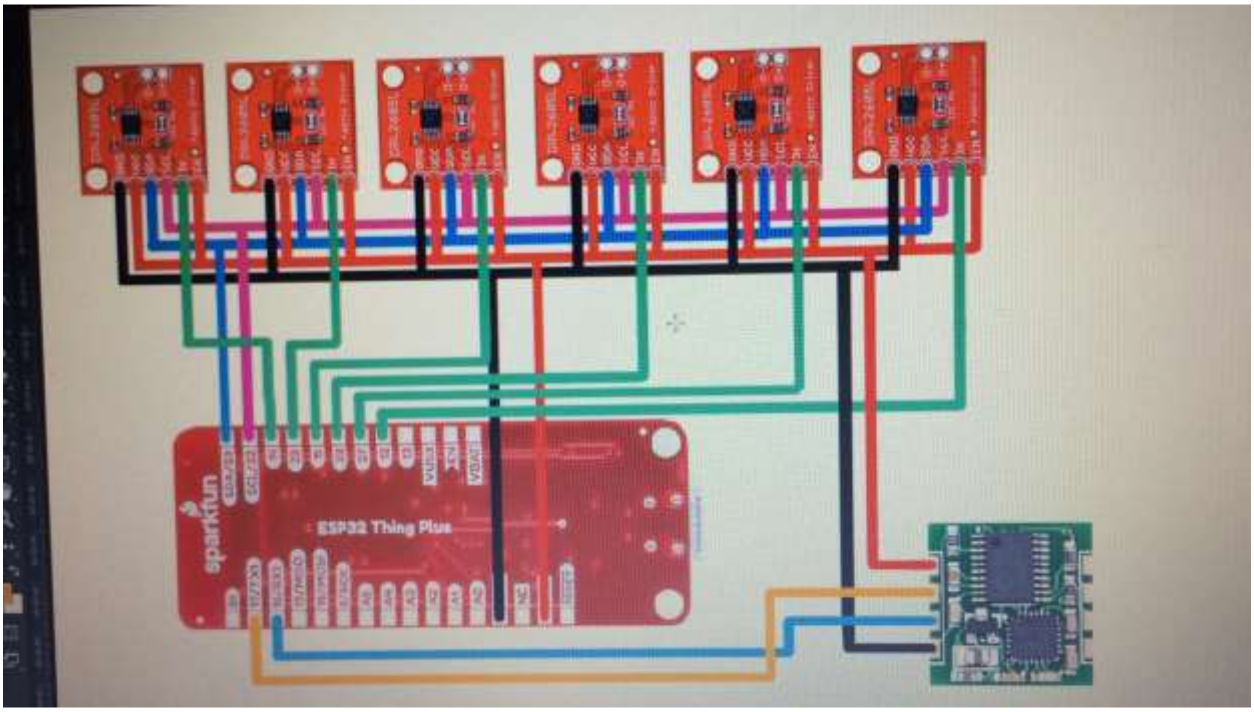

Figure 13: an improved sketch idea using a Fizz model

3.4 Design Constraints and Calculations

Bluetooth

Comfort

Phone App

Wearable

Lightweight

Battery

Reactive

ESP32, ULN

Chapter 4: Designing and Prototyping

4.1 Prototype 1

This Unit is Called the Acceleration Data Logger. It is an Arduino based unit that can measure acceleration in the XYZ directions with high accuaracy, and will collect the data on an Excel file saved on an SD card in the unit. It requires Four AA batteries to operate.

Figure 14: Components of Prototype 1

This device is useful as a prototype 1 because it will help us interact with the code and start some testing before we start working with our real project. The main idea is to get familiar with testing and coding. While also tackling the issue of first hand interaction with electronic devices.

4.2 Specifications

1- Arduino Mega.
It is a Microcontroller board that can connect to USB and operate smaller compnents such as a gyro sensor and an SD card slot to log data.

2- SD card Reader module,

3- MPU6050 sensor
It helps us to measure acceleration, velocity, orientation, displacement and many other motion related parameter of a system or object in XYZ directions.
4- 16 GB SD card

5- Arduino Case with battery holder.

4.3 Prototype 2

This prototype is the main prototype that will achieve our goal to tackle Parkinson's tremors as it contains the acceleration unit and the micro motors that will be controlled based on the data obtained from the gyro sensor. This prototype will be fully reactive and will hold the ability to analyze input based on values of tests conducted by healthy people compared to others with Parkinson's deasese.

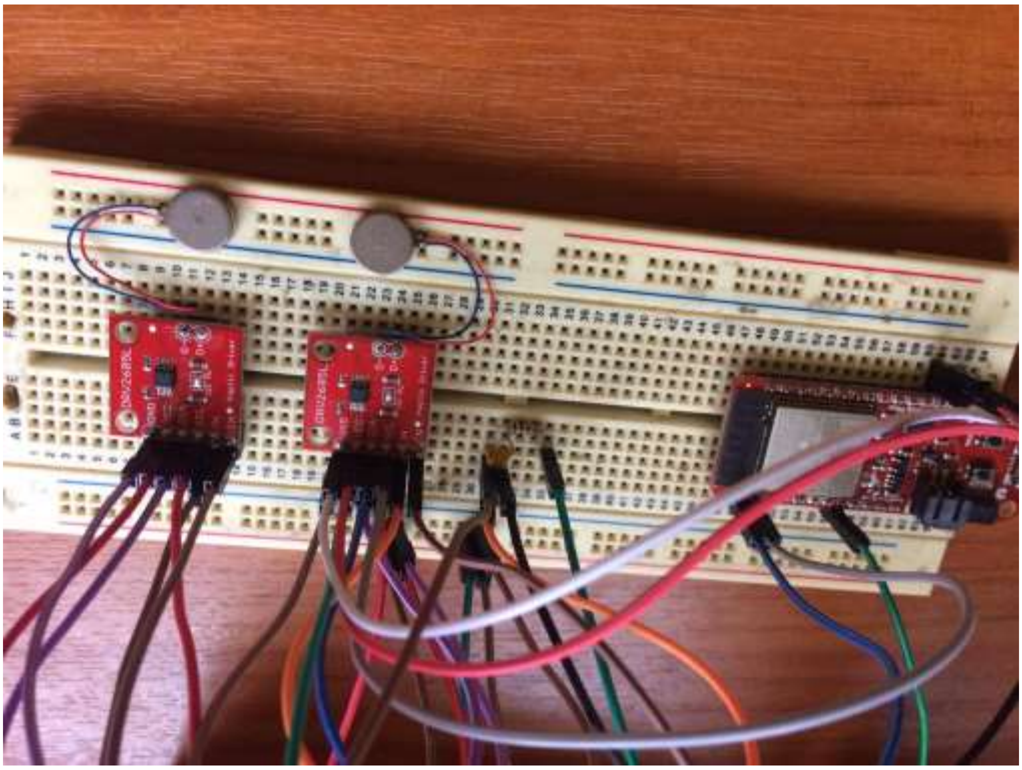

Figure 15: Prototype 2 Initial testing with motors

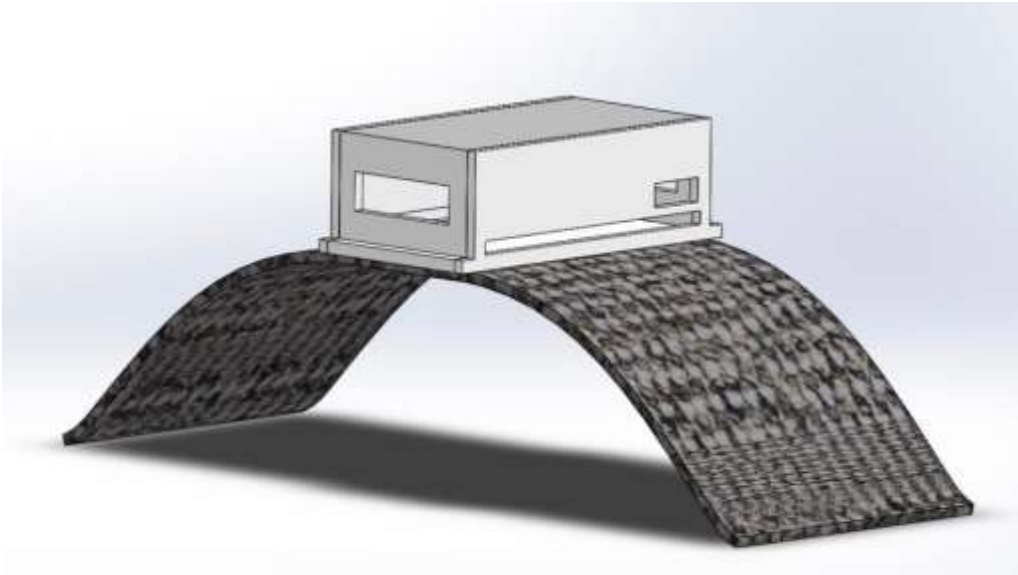

Figure 16: Prototype 2 CAD Model

4.4 Selection of Components

1- x6 Haptic Motor Drivers.

It will operate the drivers and communicate back with the micro controller unit.

2- x6 Vibration Motors.

The motors are the actuators required to send the signals to the patient hand and initiate disturbance to the signals of Parkinson's tremors.

3- Arduino Pro Mini.

It is a micro controller unit

4- x2Analog/Digital MUX Breakout.

Used to convert signals and operations inside the system from Analog to Digital.

5- x3 Logic Converter

It is useful to step up or step down Voltages to operate components inside of the circuit board.

6- ESP32 VROOM

This is the main component in the design. It will send and receive the signals, it includes a built in Bluetooth module and can operate the gyro sensor and the components of the haptic motors drivers with ease.

4.5 Specifications and Design Standards

Arduino Pro Mini:

Type	Arduino Pro Mini 328 - 3.3V/8MHz
interfacing circuitry	3.3V devices and modules (GPS, accelerometers, sensors..)
USP connection	USB connection off board
Analog Pins	8 pins
DC Input	DC input 3.3V up to 12V
Protection	Over current protected
Dimensions and Weight	0.7x1.3" (18x33mm)- 0.8mm Thin PCB - less than 2 grams!
Regulator Voltage	3.3V

Table 2: Engineering Standards (Arduino Pro Mini)

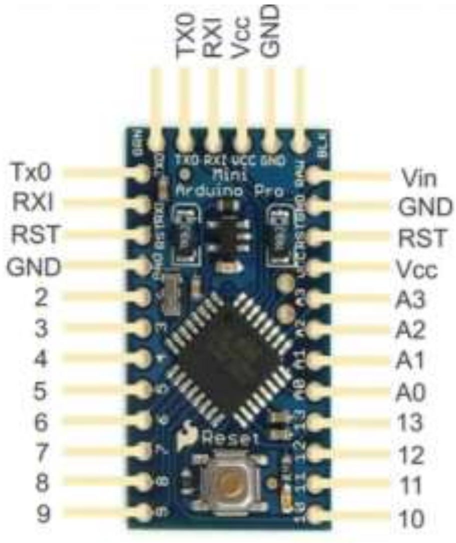

Figure 17: Arduino Pro Mini

ESP32 WROOM:

Type	SparkFun Thing Plus - ESP32 WROOM
Storage capacity	16MB of flash storage
WIFI	YES-Integrated 802.11 BGN WiFi transceiver
Bluetooth	YES-Integrated dual-mode Bluetooth
Operating Voltage Range	3.0 to 3.6V
Number of GPIO	21
Deep Sleep Current	2.5 µA
Frequency	Up to 240MHz clock frequency

Table 3: Engineering Standards (ESP32 WROOM)

Figure 18: ESP32 WROOM

Vibration Motors:

Motor Construction	10mm Coin Type Vibration Motor
No. of Magnet Poles	4 Poles
Coil Construction	Flat Coreless Coil
Rated voltage	3.0 V DC
Operating Voltage	2.3 ～ 3.6V DC
Rated Current	60mA (max)
Rated Speed	13000±3000rpm /min
Operating Environment	-30 ～ 60℃ 10 ～ 90% Relative Humidity
Mechanical Noise	50dB (A) (MAX)/AT Rated Voltage

Table 4: Engineering Standards (Micro Motors)

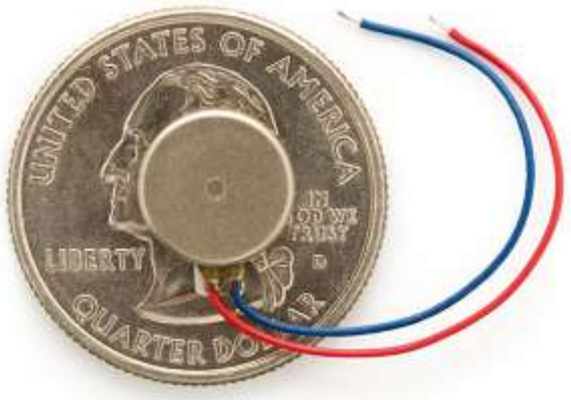

Figure 19: Vibration Motor

Chapter 5: System Testing and Analysis

5.1 Experimental Setup, Sensors and data acquisition system

Gyrosensor

For our first experimental setup, we used a gyrsensor. The main objective of the gyrosensor is to measure and maintain the orientation and the angular velocity of an object. We need to measure the angular velocity of the watch that will be on the patient's wrist to understand the extremes of the tremors that the patient has. We installed the gyroscope in the watch compartment in order to ensure that the results are accurate and precise. We chose this model due to its compact size, ability to measure three different parameters (acceleration, angular velocity, angle), low current consumption, compatibility and the ability to measure in 3-Axis (XYZ).

<u>Specifications:</u>

- Output: Time, Acceleration, Angular Velocity, Angle.
- Size: 15.24mm X 15.24mm X 2mm.
- Measurement: 2 Axis Tilt Angle 3-Axis, XYZ, (Roll, Pitch, Yaw) Acceleration.
- Output Frequency: 100Hz (baud rate 115200)/20Hz (Baud Rate9600).

- Input Voltage: DC Input Voltage
- Consumption Current: Typical 10mA
- Compatibility: All Compatible(PC/Android/MCU).

Figure 20: Gyrosensor

Vibration Motors

After getting the data from the gyrosensor on the acceleration, angular velocity and the angle, we need a respond mechanism. We attached the 6 motors on the strap of the watch, 3 on each side. The motors will vibrate gradually until they reach the required vibration. We chose this model due to its size which is relatively small.

Specifications:

- Size: 10mm Coin Type Vibration.
- Phases: Single Phase.
- Magnet Poles: 4 Poles.
- Coil Construction: Flat Coreless Coil.
- Rated Voltage: 3.0 V DC.
- Operating Voltage: 2.3-3.6V DC.
- Rated Current: 60mA Maximum.
- Rated Speed: 13,000 ±3000 rpm/min.
- Operating Environment:
    - 1)-30 to 60 °C.
    - 2) 10 to 90% Relative Humidity.
- Mechanical Noise: 30db Maximum.

Figure 21: Vibration Motor

Arduino Pro Mini

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button and turn it into an output - activating a motor, turning on an LED. On our first prototype, we used Arduino Mega but we changed the model to Arduino Mini on our second prototype. We changed the model to the mini due to one of the major constraints we faced on our first prototype. The size of Arduino Mega was big and bulky which was an obstacle because this device will be worn by the patient on his wrist. This adjustment ensured that the patient is comfortable and that our device does not limit the patient's movement while performing daily tasks.

Specifications:

- Size: 18x33x0.8 mm.
- Weight: Less than 2 grams.
- Analog Pins: 8 pins.
- DC Input: 3.3-12V.
- Protection: Over current protection.
- Regulator Voltage: 3.3V
- Interfacing Circuitry: Low-voltage board needs no interfacing to 3.3V devices (accelerometer, sensors).

Figure 22: Arduino Pro Mini

5.2 Overall Results, Analysis and Discussion

Testing Parameters

Our testing parameters were set to clearly understand how the patient's tremors are and if the tremors are constant in magnitude and direction or completely random. This was done by setting up two different tests and from the outputs we concluded the behaviour of the tremors.

Tests:

- Moving a bottle of water from one point to another.

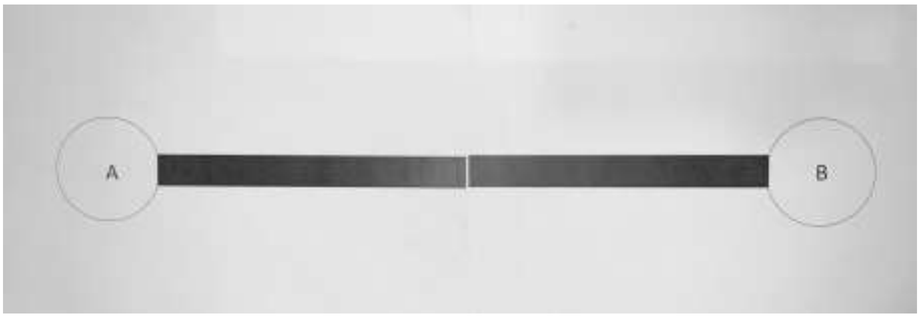

Figure 23: Bottle Movement Test (A to B)

- Drawing multiple straight lines.

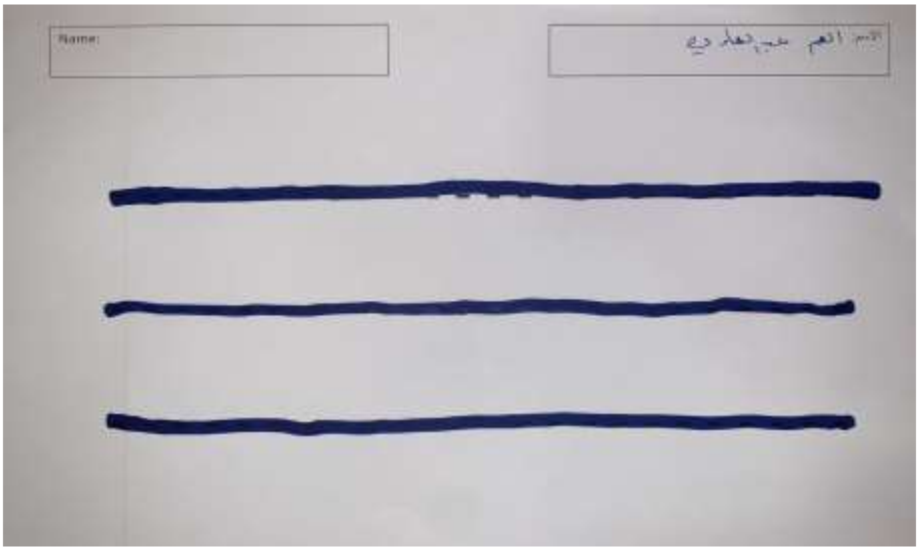

Figure 24: Line drawing test.

These tests were first carried out on our team members multiple times to have the needed data to then compare it with the patient's tremors. Moreover, Our team members have experimented with the Two Tests mentioned above and carried them individually to record and determine the data acquired and to determine the most significant variables during these tests. Our team measure the data using prototype 1, as well as the Physics Toolbox Sensor Suite Application on the iPhone to read live data.

Live Data Acquisition

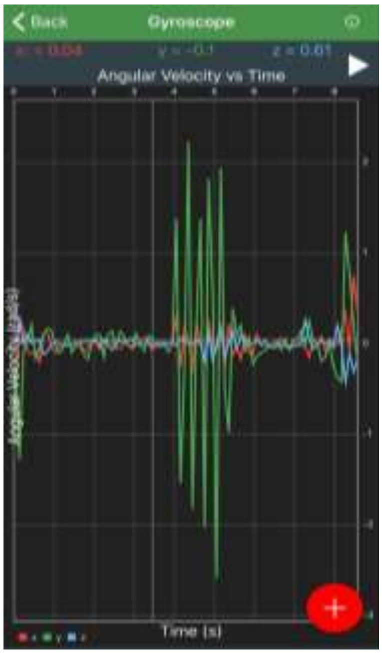

Figure 25: Gyro sensor live data

The live data readings shown in (Figure 25) clearly show that the main contributing factor to tremors is the y-axis value of the gyro sensor readings. This finding helped us to eliminate the other non-contributing data to the motion of Parkinson's patient tremors. Also, by using this data on a healthy person in comparison with the readings of a patient tremors we could clearly observe the difference and fine tune our prototype tremor watch.

In most cases, live data assists the investigation of a phenomena with many variables such as the tremors movements data. These data values consist of many parameters such as the x,y,z components of linear acceleration, the x,y,z components of angular acceleration, and the gyro readings in the x,y,z axis of the gyro sensor itself. Our team was unlucky during the beginning of the research journey until during one of our meetings we proposed to analyse life data readings to achieve a better understanding of the research at hand and how to handle the immense amount of collected data. This approach was far from simple, since we had to go through many live data applications and experiment with the results of both a healthy person and a person with tremors in the hands. Finally, our team was able to use the application "Physics Toolbox Suite" to obtain a better understanding as seen in Figure 25 above.

Healthy Testing and Results

As seen here the data obtained from motion testing of two healthy participants who performed the line drawing tests.

Time (Sec)	GyroY (Deg/Sec)
0	-5.18
0.1	-1.41
0.2	8.9
0.3	-36.52
0.4	-45.42
0.5	-10.38
0.6	-1.48
0.7	-1.88
0.8	-0.61
0.9	-4.17
1	-3.55
1.1	-1.27
1.2	2.16
1.3	4.41
1.4	4.62
1.5	4.13
1.6	1.94
1.7	2.93
1.8	4.67
1.9	1.75
2	2.93
2.1	5
2.2	-3.42
2.3	7.71
2.4	5.65
2.5	0.87
2.6	3.83
2.7	1.28
2.8	4.88
2.9	6.16
3	4.42
3.1	3.78
3.2	5.32
3.3	10.5
3.4	9.69
3.5	4.76
3.6	2.67
3.7	8.74
3.8	6.65
3.9	3.97
4	7.52
4.1	6.41
4.2	5.78
4.3	3.83
4.4	6.23
4.5	6.97
4.6	6.23
4.7	3.28
4.8	4.03
4.9	4.06
5	1.05
5.1	-8.86
5.2	-3.82
5.3	-19.21

Table 5: Healthy Testing (Abdullah)

Time (Sec)	GyroY (Deg/Sec)
0	-7.51
0.1	-10.2
0.2	-23.14
0.3	-31.17
0.4	-7.77
0.5	18.75
0.6	12.35
0.7	-0.65
0.8	7.8
0.9	26.99
1	13.28
1.1	15.13
1.2	14.77
1.3	14.72
1.4	19.82
1.5	20.9
1.6	25.5
1.7	22.28
1.8	18.84
1.9	20.08
2	21.7
2.1	19.62
2.2	21.07
2.3	16.67
2.4	14.57
2.5	17.02
2.6	18.6
2.7	19.25
2.8	15.83
2.9	11.18
3	17.16
3.1	17.07
3.2	16.72
3.3	16.11
3.4	17.28
3.5	15.67
3.6	14.77
3.7	16.35
3.8	17.74
3.9	13.41
4	14.58
4.1	11.28
4.2	8.03
4.3	8.25
4.4	5.97
4.5	12.08
4.6	1.48
4.7	5.74
4.8	4.46
4.9	4.32
5	2.61
5.1	4.32
5.2	3.97
5.3	0.69
5.4	-19.31

Table 6: Healthy Testing (Abdulaziz)

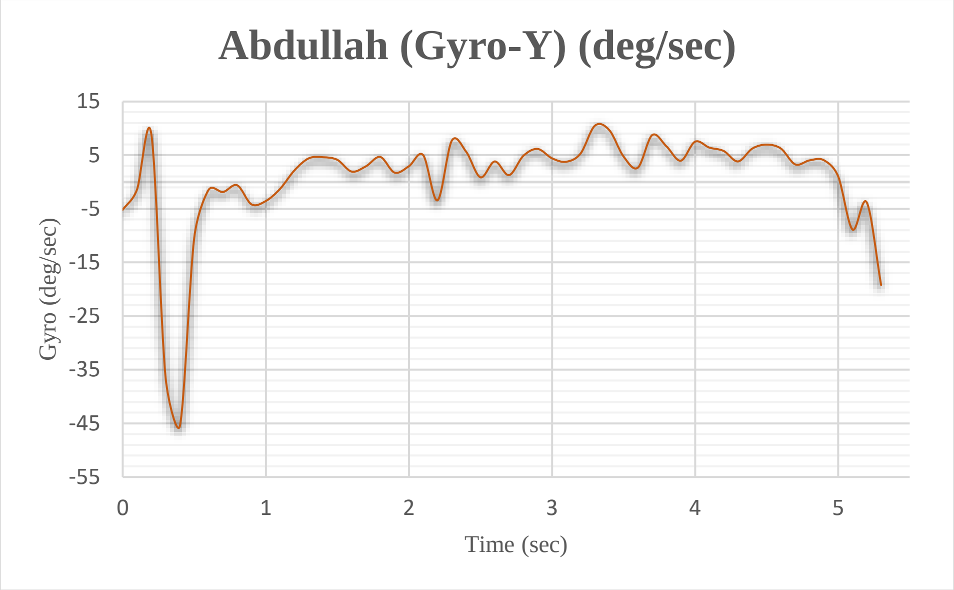

Figure 26: Healthy Results (Abdullah)

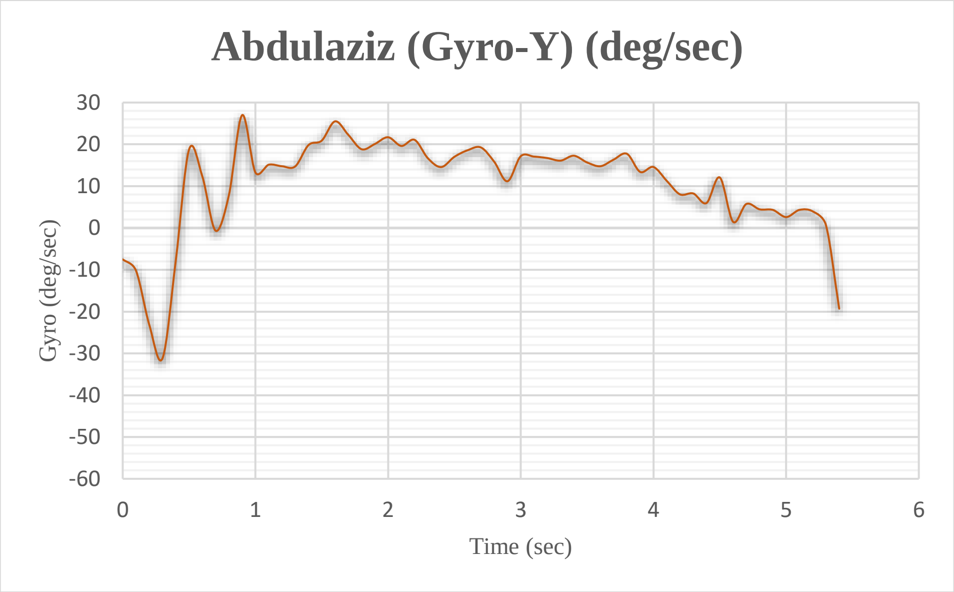

Figure 27: Healthy Results (Abdulaziz)

As observed in the results above the variations in Gyro-Y values for healthy participants performing the line drawing test vary between -20 (deg/sec) to 20 (deg/sec) for a scale of 40 (deg/sec) range of values tested in about 6 seconds of time intervals.

Patient Testing and Results

At first our team got in contact with a university student named Qassim Al-Zaiyed who offered to help us get to a volunteering patient. Then, our team made a trip to Al-Ahsaa to meet with our volunteering patient Mr. Abdulhadi Alhajji, who is a 55 years old Aramco employee experiencing tremors related to Parkinson's disease. Our team attempted to do Six tests to observe and analyse the data collected from Mr. Abdulhadi, and so we found the following Results:

Time (Sec)	GyroY (Deg/Sec)
0.1	1.15
0.2	1.04
0.3	1.61
0.4	1.79
0.5	0.82
0.6	2.95
0.7	22.86
0.8	28.51
0.9	-12.31
1	-42.51
1.1	-21.72
1.2	-18.71
1.3	-122.04
1.4	-194.62
1.5	-496.33
1.6	-496.33
1.7	-244.74
1.8	-0.91
1.9	97.52
2	-48.41
2.1	-157.17
2.2	-304.97
2.3	-109.73
2.4	56.28
2.5	131.55
2.6	-8.57
2.7	-82.63
2.8	22.07
2.9	123.99
3	191.73
3.1	-18.88
3.2	30.36
3.3	-18.02
3.4	-1.98
3.5	54.63
3.6	81.72
3.7	11.37
3.8	-7.87
3.9	-0.31
4	-15.22
4.1	-19.06
4.2	19.35
4.3	-16.47
4.4	-6.97
4.5	-1.67
4.6	-20.97
4.7	-7.76
4.8	39.93
4.9	-10.42
5	-40.38
5.1	-102.65
5.2	-144.91
5.3	-46.96

Table 7: Patient Testing

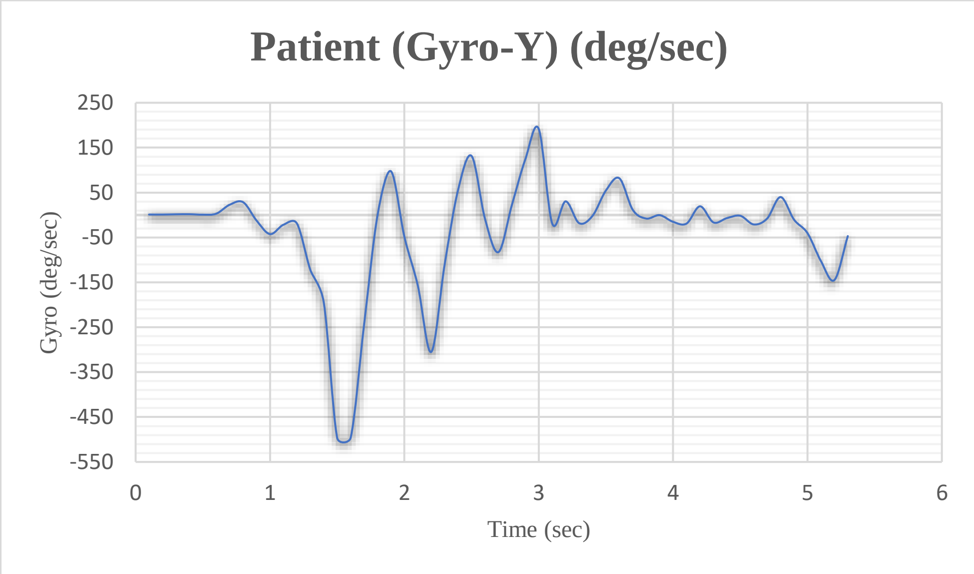

Figure 28: Patient Results

As observed in the results above the variations in Gyro-Y values for Our volunteering patient Mr. Abdulhadi Alhajji vary between -250 (deg/sec) to 150 (deg/sec) for a scale of 400 (deg/sec) range of values tested in about 6 seconds of time intervals. These valuable data numbers were acquired randomly as Mr. Abdulhadi was having a conversation and exhibited obvious tremors in the wrist of his right hand. Prior to these tremors, during the Six testing session tremors failed to show on the patient due to the random nature of Parkinson's patients tremors.

Chapter 6: Project Management

6.1 Planning

Throughout the project our team have followed the approach of engineering analysis.

Our management scope of the planning criteria was “divide and facilitate”:

1- Big problems
2- Deep analysis
3- Dividing the big problem to smaller problems
4- Each team member works individually on a problem
5- The problem is finally tackled through smaller solutions joined together

6.2 Decision Making

An example of collective decision making was the team moving from the previous idea of “Submarine Design” to the “Tremor Watch” Design:

1- Team meeting
2- Full description of current case
3- Full Co-Analysis of alternatives
4- Full Study of consequences
5- Voting
6- Final decision

6.3 Challenges

Our team encountered many challenges including:

- Coding and implementation of device codes:

  - New Arduino library installed

  - System port changing to program the device

  - The team chemistry

Many of these challenges were tackled through the approach of individual team members.

6.4 Budget

The project budget contained expenses of development, 1st prototype, 2nd Prototype parts and design.

- 1st prototype 156$
- 2nd prototype:
  - Parts (466$)
  - Development (800$)

Total= 1422$ (divided on 5 team members)

6.5 Bill of Materials

The project materials consisted of Three main components:

- Circuit board
- Cloth (Wrist band)
- Plastic (3D printed box for the watch)

Figure 29 : Materials of Wrist Band & Box

Chapter 7: Project Analysis

7.1 Life-long Learning

This project was useful in developing high level of skills. It had an impact on every individual which reflected on the whole group and helped to succeed in every way possible. The skills involved are the following:

Software Skills

The software skills developed were from the coding of the gyro and esp32 The software used was Arduino. There are 3 main variables which requires which required tuning.

These consist of :

- Acceleration a (m/sec^2)
- Angular Acceleration ω (rad/sec^2)
- Gyro readings (θ/sec)

The understanding of the codes in the software was beneficial in order to tune these variables.

Hardware Skills

Since the project is very unique it has some new hardware parts in order to collect the data. Arduino is the main hardware which does not act only as a software but it the main core of the tremor watch. It is activated by a battery and a gyro that sends signals to the Arduino, where the Arduino activates the gyro and ESP32 which activates the motors. Nevertheless, when these components are set to work, the device will not work without the Android App that has to be connected by Bluetooth. When they are connected, the App is programmed in such a way it will show all the parameters varying on a graph.

Teamwork Skills

Working in a group helped the team in reaching the same level of understanding. Every idea was accepted in brainstorming and delivering the work in a different manner. This encouraged the team members in putting more effort and building more confidence. The communication and weekly meeting gave a positive output. Everyone shared the responsibility and delivered the work on time. There were tasks divided among the members and a proper plan and goal was set to be done at the due time.

Project Management

The project was well managed and all the team members were involved in every task. Every task was divided among the members. In every meeting, timeline was created to finish the tasks and to keep the project on track. In addition a separate meeting of 2 members is done with the advisor in order to keep him updated and get feedback regarding the project before proceeding.

7.2 Impact of Engineering Solutions

The project was useful in several ways when it comes to society, economy and environment.

Society

The advantage of Tremor Watch on the society is that it will bring happiness to many lives. It will start to give hope to people who are suffering from Parkinson's Disease. People will be able to do normal things of their lives.

Economy

This project will help people financially as people will spend on the less on the project rather than medicines. The project is useful in anywhere in the world so it is an advantage that more people can find cure instead of limited societies. According to Lewin Group the estimated cost on the medicines are $25000 while this project budgets $1500-$2000 approximately.

Environmentally

This project will help people suffering from Parkinson's Disease worldwide. The drugs involved in the medicines makes a human body weaker and weaker. It will create a healthy environment once people start to use this project.

Contemporary Issues Addressed

In 2015 there was a study shows that Parkinson's disease affected around 6.2 million people and resulted in about 120,000 deaths globally. This huge number has really knocked the bell to inform that we are facing a real issue that resulted a huge number of deaths. Parkinson's disease normally appear in patients over the age of 60, and unfortunately, males are more often affected than females at a ratio of around 3:2. In addition to that, it worth to mention that the people who responded to the survey made by the tremor group were from Saudi Arabia which make this disease also a local problem. The symptoms that the Parkinson disease causes are really effect on the patient negatively, such as shaking, rigidity, slow in movement; moreover, the symptoms includes sleep, emotional and sensory problems which really encouraged us as a team to create something that may help these patients to have better life.

Chapter 8: Conclusion

To conclude, our team is very pleased with the work done and the progress achieved. The main objective of this project and the key reason we were constantly motivated to learn more about this topic is the possibility of changing someone's life. Knowledge is only valuable if used and harvested. We are still motivated and invested in this project to cause a change in a patient's life and enable him to carry out simple daily tasks that he currently cannot do. The smile we witnessed on the patient's face that we met and tested the device on was priceless. Although we did not stop the tremors he has, the mere fact that someone cares about the patients and their struggles made him smile. We as a group have learned a lot from this project, from the work and from each other. Our two prototypes were very useful and helpful, and we believe that the third prototype is needed. The first two made us very familiar with the problem and we now can clearly see the problems and how to approach them.

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