GNG2101

Design Project User and Product Manual

Sportify

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December 11th 2022

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Table 2. Glossary

Term	Acronym	Definition
User and Product Manual	UPM	A document provided to to a user to help user a particular system, product or service seamlessly
User Interface	U.I.	The point of human-computer interaction and communication in a device.

1 Introduction

In the sports scene, athletes are constantly seeking new approaches to improve their overall performance to become successful in their career. For racket sports such as tennis and hockey, analysing the execution of a swing is beneficial to understand the overall execution of the athletes technique. Although there exist many cameras that are able to assist these athletes, many customers do not like the static placement of the camera and the setup required to place the camera in a strategic position.

The Sportify team was created to help these athletes by developing a new attachable and durable device that is able to accurately measure and compute relevant data. This information will be displayed in a user-friendly manner through our mobile application, to encourage an easier comprehension and promote a better analysis of the users swing and performance. The data of each user will be stored in our highly guarded database, which is controlled by our well trained cybersecurity and malware engineers. Unless given permission from the user to use their personal data to improve their performance, their personal and collected data will remain confidential and hidden from malicious activities.

This User and Product Manual (UPM) will provide all the necessary information for users to reach optimal results. The documentation addresses the functionality of the device, instructions for use, concerns, ideal users, the systems organisation, testing, troubleshooting and support. By the end of the UPM, we hope to give our users an overall better understanding on how we were able to engineer the product, and reply to any questions and concerns in relation to the product.

2 Overview

In sports,athletes and coaches in swing sports are always looking for ways to increase their performance. Devices available on the market to measure acceleration of an athlete's swing require space,money, time and skill to set up a tracker. These attributes of a device makes it difficult for swing sport athletes to track the acceleration and know the force at which they hit a ball. To solve the issue, we resulted in developing a device which measures and displays the acceleration and force of an athlete during a swing to keep track and assist athletes improve their technique.

The fundamental needs of the client was a durable,affordable and lightweight device that records real time acceleration data values, to assist and increase the performance and statistics of athletes.

Some devices used to track the velocity of force exerted by players and their swing sport equipment have attachable consoles which are fixed to the side or handle of a practice racket. Due to the positioning of such devices, it distorts the mechanical movement of the racket and disrupts the natural positioning of the athlete's form to properly hold the racket. This design causes discomfort for users of the device and due to the position of the device, reinforcement to protect the device causes the material to weigh dramatically more than the mass of the components in the device. Our device, on the other hand, acts as an extension to the bottom of the racket. The customizable 3-dimension printed case, shaped in a hexagonal prism contains the components and wiring of the device. It is enforced onto the racket with repurposed tire tubing to keep the device attached to the racket and due to the high amount of friction between the rubber and device, preventing it from moving.This design prevents the device, from not causing major restrictions to the athlete's form and does not affect the functionality of the racket as the device is centered and has a low mass.

Figure:Final design

In order for data to be easily accessible, this device transfers data via bluetooth and displays the recorded data of acceleration and force onto the display screen of the user's mobile device.

The housing of the device was 3D printed into a hexagonal prism, due to the strength of the shape caused by the angled bend in the frame. This shape also adapts to the shape of most tennis racket handles, preventing any interference of the device to the performance of the athlete. The housing protects an arduino nano, a microcontroller, which stores, runs and executes the code when commanded. The data stored on the arduino nano, is received from the MPU 9250 accelerometer, which measures the acceleration of the swing in the case of our product. With the values recorded by the microprocessor, from the accelerometer, the code written in c++, is modified to find force with the recorded acceleration using the force equation where the mass of the racket is multiplied by the acceleration. The uploaded code which is then transferred through the bluetooth module is displayed on a mobile application.

START Function
When the microcontroller is powered, data recorded by the accelerometer begins to run, continuously printing data for the recorded results for acceleration. If START is typed into the text

box, the text relays a command to the serial monitor, which becomes flag==1, indicating the command has been received, displaying the data that is recorded only after the stop command.

STOP Function

To stop the device from recording irrelevant data, the user types STOP in the text box, this relays a command to the code, changing the flag==1, to flag==0. This command immediately stops recording the values of acceleration and force.

2.1   Cautions & Warnings

WARNING
- This manual gives instructions on how to use the sportify product. If instructions and information are disregarded, you could be assuming the responsibility for damages, costs or injury caused by such disregard.
- Do not make any changes to the wiring or circuit without first contacting Sportify.

3   Getting started

3.1   Configuration Considerations

The equipment needed for configuration:

1. Sportify product (input device)
2. An electronic device with Bluetooth (output device)
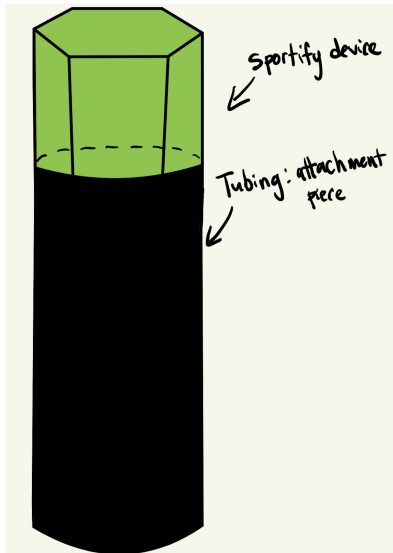3. Racket (Swing is used for input)

Figure : Sportify product

Figure : Electronic device with Bluetooth

Figure : Racket

Communications and configuration:

Once Sportify is attached to the racket with every swing…

1. The accelerometer inside the Sportify product will take note of acceleration
2. Through Bluetooth, Sportify will send the data to the Bluetooth module from Arduino
3. The Bluetooth module will output the acceleration and force to your electronic device
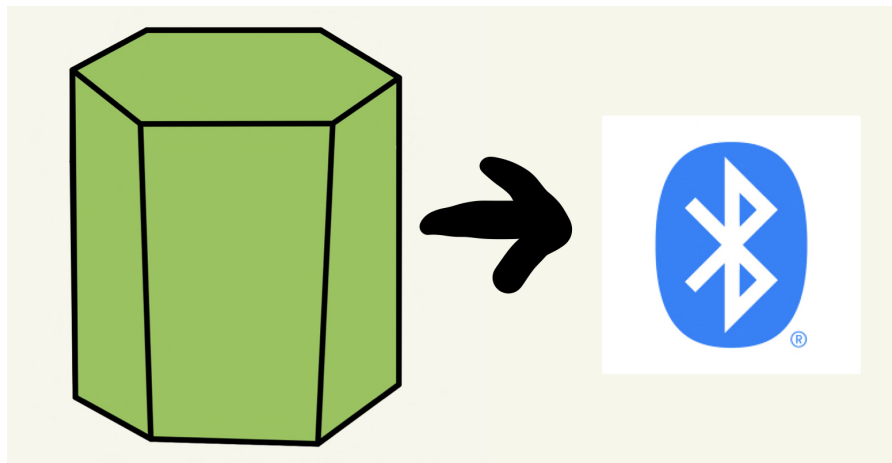   a. Force is calculated with mass multiplied by acceleration

Figure : Sportify sending data to Bluetooth module

3.2   User Access Considerations

Anyone who is interested in exercising with racket-held sports like Tennis and Badminton, and would like to improve by keeping track of their progress can use our Spotify product. To use our product to its full extent the user must have our two essential components: our Sportify physical product, and an electronic device that has Bluetooth available that has the Bluetooth module from Arduino installed. If you do not have any of our essential components you cannot keep track of your swings. Additionally, anyone with a Latex allergy should avoid using our product as rubber is in our recycled bicycle tubing. We at Sportify are interested in providing alternative materials to our product in the future.

3.3   Accessing/setting-up the System

To set up the Materials needed are a Tennis Racket, our Sportify product and an electronic device that has Bluetooth implemented.

To set up Sportify with a Racket:

1. Unwrap our product from the packaging
2. Place the round solid product labelled as "(1)" at the bottom of the Racket handle
3. Secure the product to the handle with the tubing labelled as "(2)" by wrapping the tubing around the product and the handle.
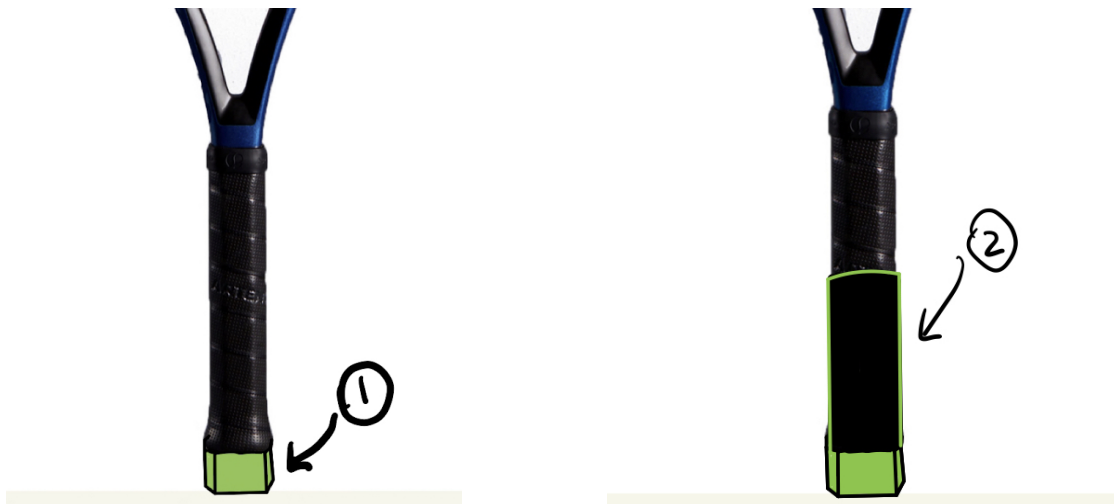
Figure : Placing the solid product to the bottom of the Racket handle

Figure : Securing (1) with (2) around the Racket handle

To set up Sportify on your device:

1. Turn on Bluetooth on your device
2. Download the Bluetooth module from Arduino
3. Connect to Sportify from the Connection page using Bluetooth
4. You are now ready to start playing with Sportify

To Start Sportify on your device:

● Enter "start" into the textbox on the main page of the Bluetooth module from Arduino

Figure : Starting Sportify on the device

There is no need for login as Sportify data from each product is private and can only be accessed by one electronic device with Bluetooth. We strive to keep your data safe.

3.4 System Organization & Navigation

3.4.1 Main page:

● The goal of the Main page is to show the data output in real-time presenting to the user the acceleration shown in km/h and force shown in N of their swing using Sportify.
● The Main page is connected to a Textbox feature allowing the user to interact with the system

3.4.2 Textbox:

● The goal of the Textbox feature is to allow the user to start and stop using the Sportify app and device
● The Text Box feature is situated on the function of the Main page where both the Textbox and Main page work together.
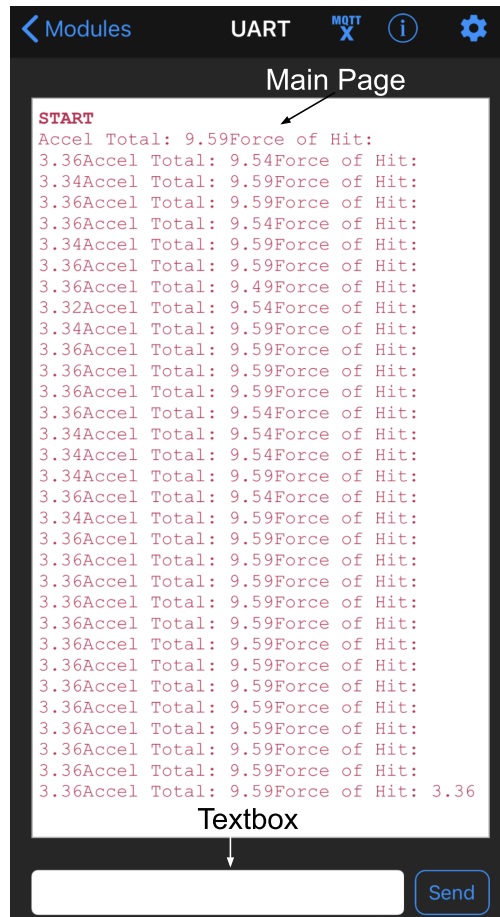
Figure : Demonstration of the Main Page and the Textbox feature

3.5 Exiting the System

To Exit Sportify on your device:

● Enter "stop" into the textbox on the main page of the Bluetooth module from Arduino

Figure : Existing Sportify on the device

To put away the Sportify:

- Put away your racket as normal by
    - Making sure the strings of the racket and the Sportify product is in place
    - Packing your racket into a racket bag
    - Store your racket bag in a cool and spacious place

4 Using the System

4.1 Steps to track athletes stats

4.1.1 Connecting the device to the app

When using the device, the first step is to connect the device to the app. To do so, we need to upload the code into the arduino using the USB mini B cable.
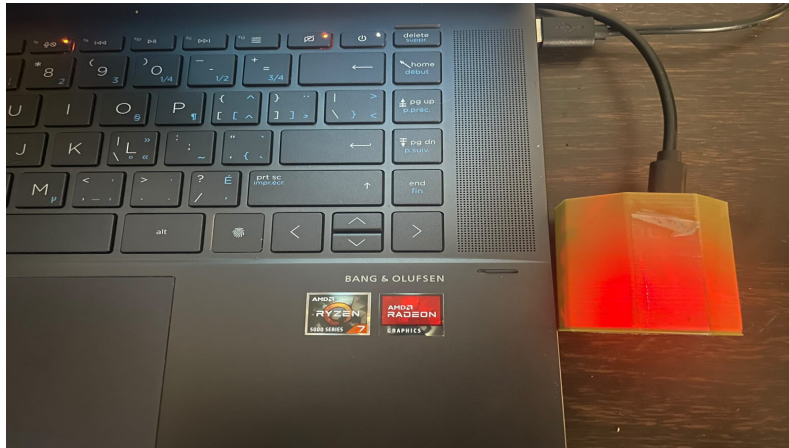
When connecting the device to the computer you have to wait for the red light to show. You can now follow the next steps to use the device.

4.1.2 Put the device into the racket

After connecting the device with the application, the next step is to put the device into the racket.

- take the bicycle tubing

- put the device on one side of the bicycle tubing

Figure : putting the device in the bicycle tubing

- attach the other side of the bicycle tubing on the racket

figure : Putting the device on the other side of tub

4.1.3 track the statistics

- **Start the code**

At this point, you only need to enter "START" in order to make the code start running.
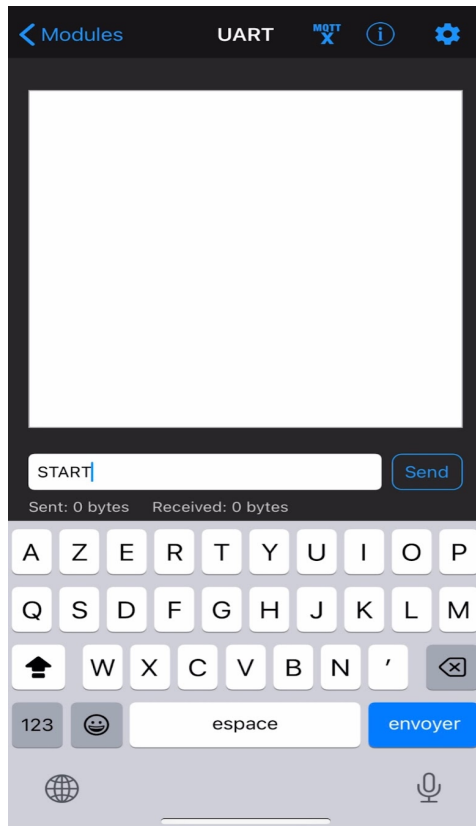
<u>Figure</u> : Starting the code

The code will start running. To test the device, just try to swing and check the app to see how the
results are given.

● See results on app

The result will display : acceleration, force of heat and magnitude of hit.

- Stop the code

5   Troubleshooting & Support

5.1   Error Messages or Behaviors

Technical errors will sometimes occur due to the age of the Arduino our device uses or the inconsistent quality of the Bluetooth module. This error might not show any output values on the Main menu due to the fact that the electronic device does not receive any data from the Sportify device due to a Bluetooth error.

If the user encounters an error, here are the steps they should take:

1. Disconnect the device by typing "stop" into the Textbox found on the main page
2. Reconnect the device by typing "start" into the Textbox found on the main page

If errors continue to occur:

1. Disconnect your device from Bluetooth by going to settings
2. Reconnect your device from Bluetooth by going to settings

If there are still errors:

1. Connect your device to power
2. Restart the Bluetooth module from the Arduino app

5.2   Special Considerations

If there are still errors, there's a possibility that the accelerometer inside the Sportify device is non-functional. This error might show strange output values on the Main menu. We suggest buying a replacement Sportify device. This is a physical error and can only be fixed by replacement. Please try all the suggestions in section 5.1 before considering buying a replacement.

5.3   Maintenance

To maintain a functioning and durable Sportify device:

1. Avoid unequipping the Sportify device from the racket
2. Keep the device in a cool and dry area
3. Store the device alongside the racket in a racket bag
4. Avoid throwing, dropping, and breaking the racket
5. Refrain from holding the racket from just the device, we suggest you hold the racket by its handle

5.4 Support

At Sportify we strive to keep your data private. Any calls made to Sportify will not be shared to the public. If you need support contact Steve at Sportify.support@sportify.com or call us at (1)123-456-7891.

If you have technical issues:
- Email: Address the subject of the email with "Tech issues"
- Phone: Press "1" when you reach the automated voice mail

If you would like to make a purchase:
- Email: Address the subject of the email with "Purchase"
- Phone: Press "2" when you reach the automated voice mail

If you have general questions:
- Email: Address the subject of the email with "General"
- Phone: Press "3" when you reach the automated voice mail

If you have questions regarding shipping and handling:
- Email: Address the subject of the email with "Shipping and Handling"
- Phone: Press "4" when you reach the automated voice mail

In the case that a security incident occurs:
- Contact us at Sportify.security@sportify.com
- Please give us full details on the security incident.

6 Product Documentation

The final prototype was made using a 3d printed case. The case is shaped in a hexagonal prism form that fits perfectly with the shape of the bottom of the tennis racket. It can allow the user to use the racket without finding that the device is put on.
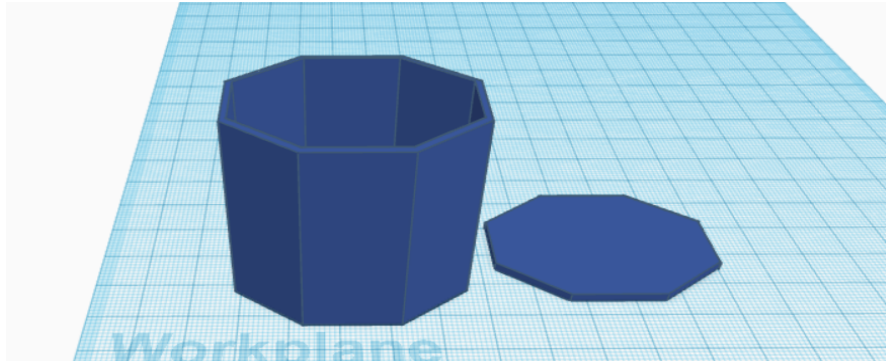
The other part is the bicycle tubing. The bicycle tubing is a recyclable component . It allowed the device to be put on the racket without falling out because of the friction it creates.

6.1 <Subsystem 1 of prototype>

6.1.1 BOM (Bill of Materials)

Item Number	Part Name	Description	Quantity	Unit Cost	Extended Cost	Links
1	Battery	button	2	$2.00	$2.00	batter
2	Arduino nano	68.6 x 53.4mm; 25g; 5v	1	$8.00	$8.00	Arduino

3	Force Sensor	6 x 3 x 0.58 cm; 20 Grams; 10kg	1	$12.19	$12.19	Force Sensor
4	Accelerometer	2 x 1.7 x 0.1 cm; 50 Grams	3	$4.33	$4.33	Accelerometer
5	resistor	1 MOhms ±5%; 2W	5	$0.05	$0.05	resistor
6	Jumper Wires	Male to male	25	$2.50	$2.50	jumper wire
7	Breadboard	16.7x5.7cm	1	$5.00	$5.00	**breadboard**
8	AA battery holder	5.8 x 3.2 x 1.4cm; 3x	1	$1.00	$1.00	**holder**
9	USB charger	USB mini B	1	$0.00	$0.00	USB
10	Bluetooth module	3.54 x 2.56 x 0.39 inches	1	$22.00	$22.00	Bluetooth

6.1.2   Equipment list

1. Soldering Iron
2. Soldering metal
3. Smoke fan
4. Soldering vice
5. 3d printer

6.1.3   Instructions
1. Connect jumper wires from accelerometer to arduino nano.

Arduino Nano	Accelerometer
VCC	5V

GND	GND
SCL	A5
SDA	A4

2. Connect jumper wires between Arduino nano and bluetooth module

Arduino Nano	Bluetooth Module
MOD	D10
CTS	D8
RXI	D6
VIN	VIN
RTS	D9
GND	GND

3. Open the Arduino IDE app.
4. Download the 12C library for an MPU 9250 as a zip.Hover over Sketch, click "manage libraries".
5. Type " MPU 9250_master" into the search box and download
6. Hover over Sketch, once the drop down menu appears, click on "Manage Libraries", then click on "Add. ZIP library".
7. After uploading the library, copy and paste the CODE attached.
8. Validate and upload your code.
9. Run your code and open the serial monitor to display the recorded values.
10. To view the the data on mobile device, download the app " Bluefruit" on the app store
11. Turn bluetooth on mobile device
12. Connect to "Adafruit BLE" listed.
13. Click on UART and type "START" when you want to receive values
14. To stop receiving values, type "STOP"

6.2 Testing & Validation

Test 1
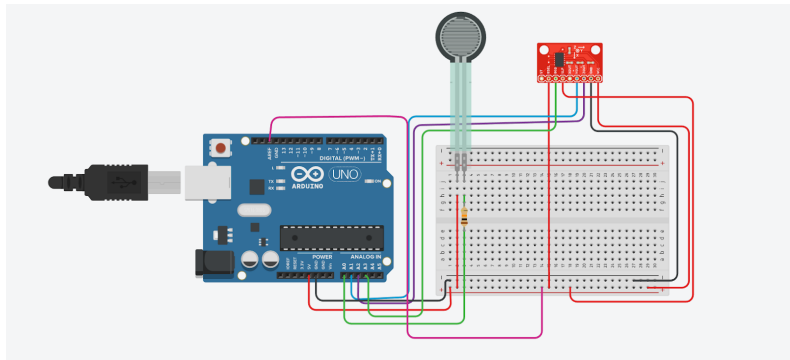

```
Force sensor reading = 0 -> no pressure
Force sensor reading = 0 -> no pressure
Force sensor reading = 154 -> light touch
Force sensor reading = 583 -> medium hit
Force sensor reading = 795 -> medium hit
Force sensor reading = 795 -> medium hit
Force sensor reading = 908 -> big hit
Force sensor reading = 908 -> big hit
Force sensor reading = 908 -> big hit
Force sensor reading = 908 -> big hit
```

```
axis :0.00              Velocity Z : 0.00           Distance  Z :0.00

Time 4.50
      Accelerationon the X axis:0.00      Velocity  X :0.00      Distance  X :0.00
      Acceration the Y axis :0.00         Velocity  Y :0.00      Distance  Y :0.00
      Acceration the Z axis :0.00         Velocity Z : 0.00      Distance  Z :0.00


Time 5.37
      Accelerationon the X axis:-0.64     Velocity  X :-3.41     Distance  X :0.01
      Acceration the Y axis :0.00         Velocity  Y :0.00      Distance  Y :0.00
      Acceration the Z axis :0.00         Velocity Z : 0.00      Distance  Z :0.00


Time 6.24
      Accelerationon the X axis:-0.64     Velocity  X :-3.97     Distance  X :-0.00
      Acceration the Y axis :0.00         Velocity  Y :0.00      Distance  Y :0.00
      Acceration the Z axis :0.00         Velocity Z : 0.00      Distance  Z :0.00
```

Figure: Results from Test 1

During the first trial of testing, an online simulation was run, to determine the values of acceleration and force using the force sensor and the accelerometer. This trial concluded that the pseudocode created, delivered the results in data that was expected individually for the accelerometer and the force sensor. During this trial, the recorded values of the accelerometer was not able to be confirmed as the accelerometer was a physical device which required the use of a physical prototype.
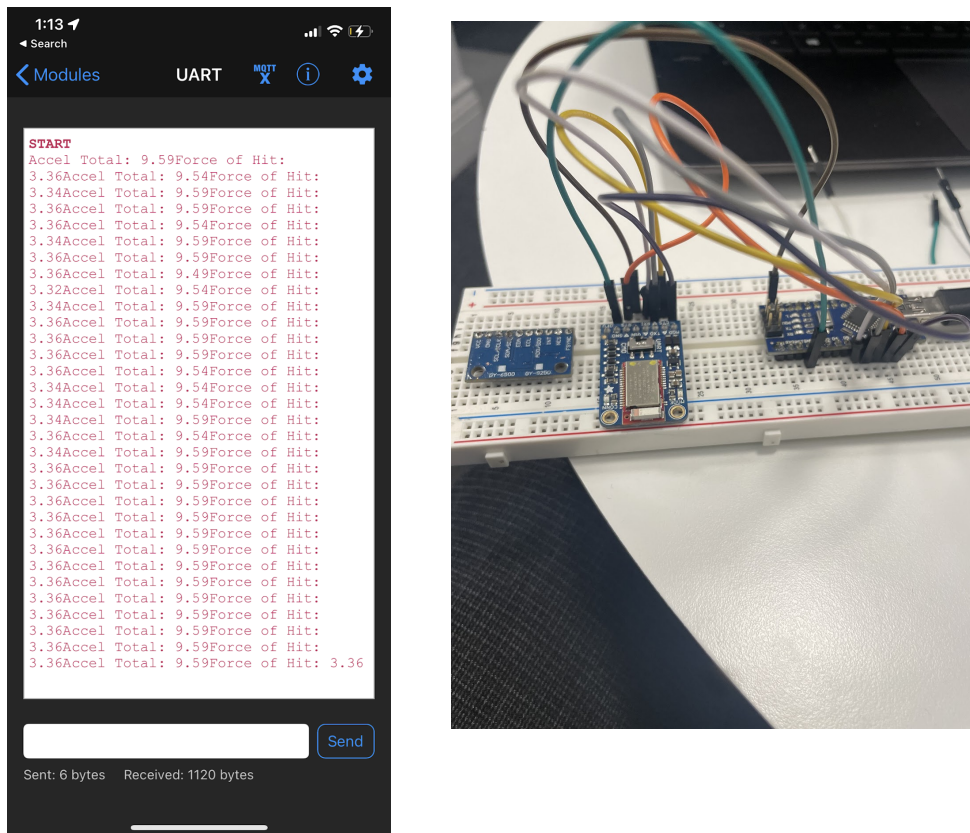
Test 2

Figure: Prototype and data from testing

For the second test trial, the components were all wired physically onto a breadboard. The device was dropped from a fixed height and the values of the device being dropped after several attempts were recorded and compared. The acceleration remained consistent when dropped at the same height, proving that the device was consistent with the data that was recorded. During this trial, the problems that were faced were due to the orientation of the accelerometer as it was initially not properly calibrated, resulting in negative acceleration values. After correction, the data recorded by the device remained consistent.

7 Conclusions and Recommendations for Future Work

Throughout this project and our work creating our prototype, we learned many important lessons. With tough due dates and a lot of tasks to complete, we had to master our time management. It was important for us to manage when we were able to meet, when we could accomplish our tasks, and how we could maximize our effectiveness. Moreover, we learned effective group skills, including communication and team work. We've learned that without proper communication, it's very difficult to accomplish anything. With that being said, good communication can make a huge difference, from better understanding each other, being able to solve problems, rescheduling meetings, and improving our creative thinking.

In order to maximize any work in the future, it is important to remember to have good communication, patience, initiative, responsibility, and leadership. Without proper communication, as mentioned previously, it is hard to understand one another, empathize with each other, and maximize your team's creative thinking. A lack of patience and sympathy with one another can lead to arguments, selfishness, and bad blood with each other, which minimize the team's productivity. Initiative and responsibility go hand in hand with each other. These are key attributes to have in a successful team environment, as there are some tasks, some challenges that most people won't want to do, yet need to get done. Having people in your team that despite their lack of interest to do the task, they will brush that aside and volunteer to get it done regardless, for the good of the team. Finally, leadership is a crucial skill to have in your team, the more leaders there are in a team, the more successful the team will be. Having people to motivate each other, set up meetings, remind each other of our tasks and goals is something priceless, and it is what keeps the gears turning towards the final prototype.

Our device itself turned out very well, it works exactly as we would want it to, and it is difficult to think of how it could yet be improved. However our software portion was a little rushed due to the time constraints we were given. If we had been given a few more months, our application and website would have been further developed. We would have improved the U.I., added graphs to display the users progress and developed an extra personalized lessons feature for users who paid extra for our membership. These were all things we initially wanted to accomplish before the end of the semester, however we had to abandon these ideas due to the lack of time. However we believe that they would have been great adjustments and would have helped users trying to improve their swinging technique a lot.

8 Bibliography

Image References

Bluetooth. (n.d.). Bluetooth [Digital image]. In *Bluetooth logo*. bluetooth. Retrieved December 9,

      2022, from https://www.bluetooth.com/

Decathalon. (n.d.). Tennis Racket [Tennis Racket Digital image]. In *Tennis Racket 280 g - TR 500*

      Blue. decathalon. Retrieved December 8, 2022, from

      https://www.decathlon.ca/en/p/8487742/tennis-racket-280-g-tr-500-blue

wikiHow. (n.d.). Bluetooth device [Bluetooth device digital image]. In *How to Use a Bluetooth*

      Device. wikiHow. Retrieved December 8, 2022, from

      https://www.wikihow.com/Use-a-Bluetooth-Device

APPENDICES

9 APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Bluetooth Digital	https://www.bluetooth.com/	
Blue decathon	https://www.decathlon.ca/en/p/8487742/tennis-racket-280-g-tr-500-blue	
wikiHow	https://www.wikihow.com/Use-a-Bluetooth-Device	