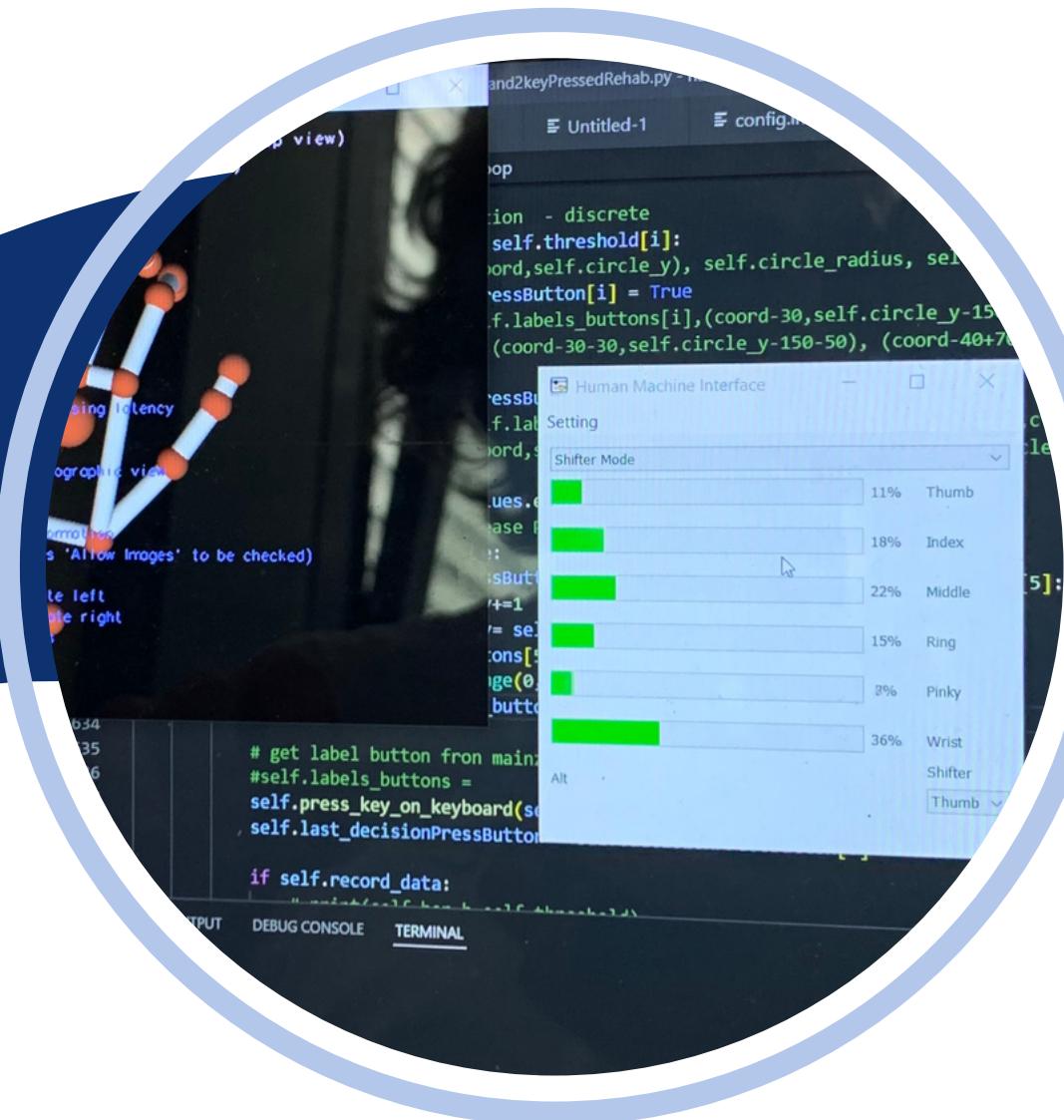


ASSISTIVE TECHNOLOGIES CHALLENGE



2022

PREPARED BY

Odile Andres

Nada Guerraoui

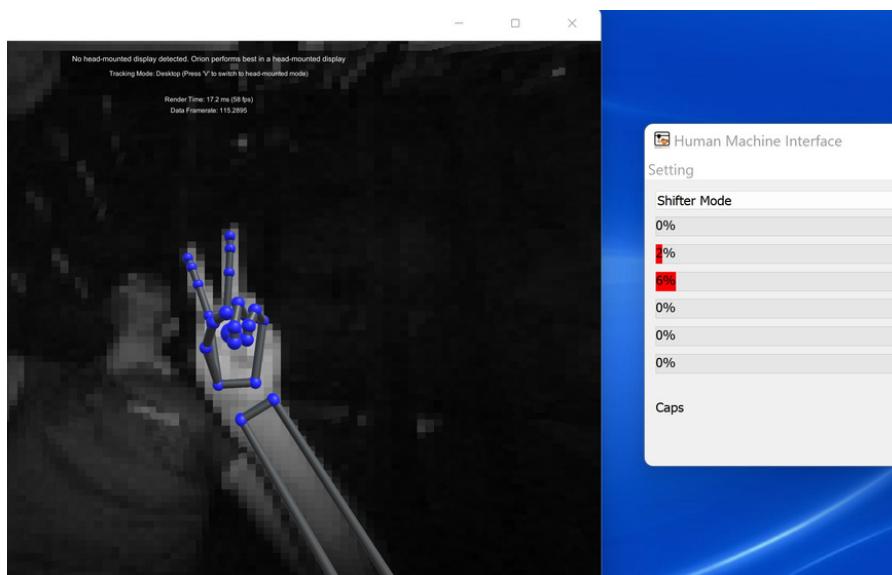
Thomas Peeters

Brahim Rejeb

HUMAN-MACHINE INTERFACE BASED ON DETECTION OF FINGERS MOVEMENTS

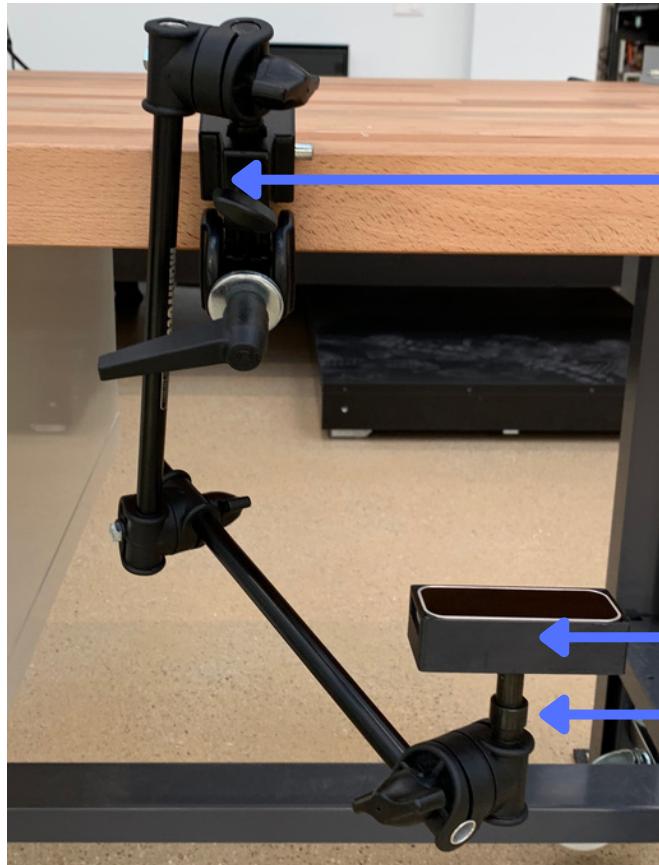
Device description:

The document describes an outline for all the information and instructions necessary to operate the device safely and effectively. "Human-Machine interface based on detection of fingers movements" was developed at the Assistive Technologies Challenge at EPFL. The product is a software that detects the residual movement of the fingers of the left hand to select keys on a keyboard using Leap Motion. The controller is attached to a positioning mechanism with six degrees of freedom. The solution has an intuitive interface and easy-to-deploy setting enabling the user to easily control the keyboard.



The prototype includes the following list of items:

- Manfrotto 196AB-2 Single Arm 2 Section
- Leap Motion
- 3D printed support for Leap Motion
- Cable extender for USB 2.0 or USB3.X



Manfrotto 196AB-2
Single Arm 2 Section

Leap Motion
3D printed support

Warnings:

- Keep the device away from liquids and make sure your hands are completely dry before touching any electrical components.
- The screws of the device might be sharp.

Instruction :

Software Installation:

Follow this github link to have acces tho the code and the tutorial to make it works:

<https://github.com/brahimrejeb/LeapOrion>

Device Installation:

The aim is to fix the Leap Motion 20 centimetres under the hand. To do this, we will attach the leapmotion to the Manfrotto 196AB-2 Single Arm.

Steps:

1.



Fix the Leap Motion to the 3D printed support. The hole under the 3D printed support is here to allow a easy removal of the Leap Motion from the support.

2.



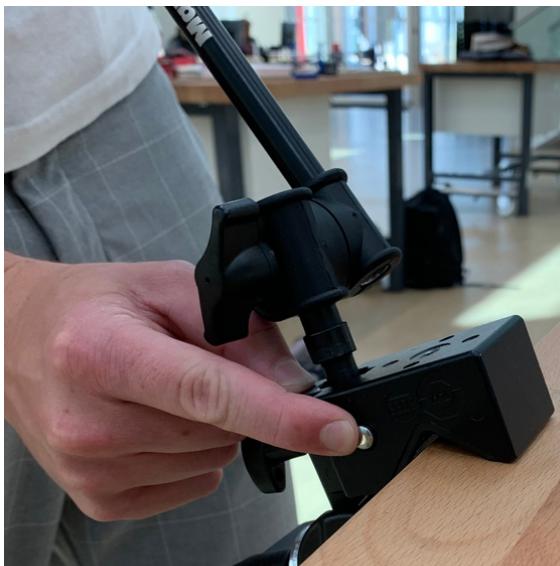
Attach the 3D support to the mechanical arm with the screw. **The cable for the Leap Motion must be on the left (adjusted in the right direction).**

3.



Attach the clamp to the desk or to a stand near the desk by turning the crank.

4.



Fix the mechanical arm to the clamp by first pressing the button on the right of the clamp to let the single arm in.

5.



Turn the screw to fix the mechanical arm to the clamp.

6.



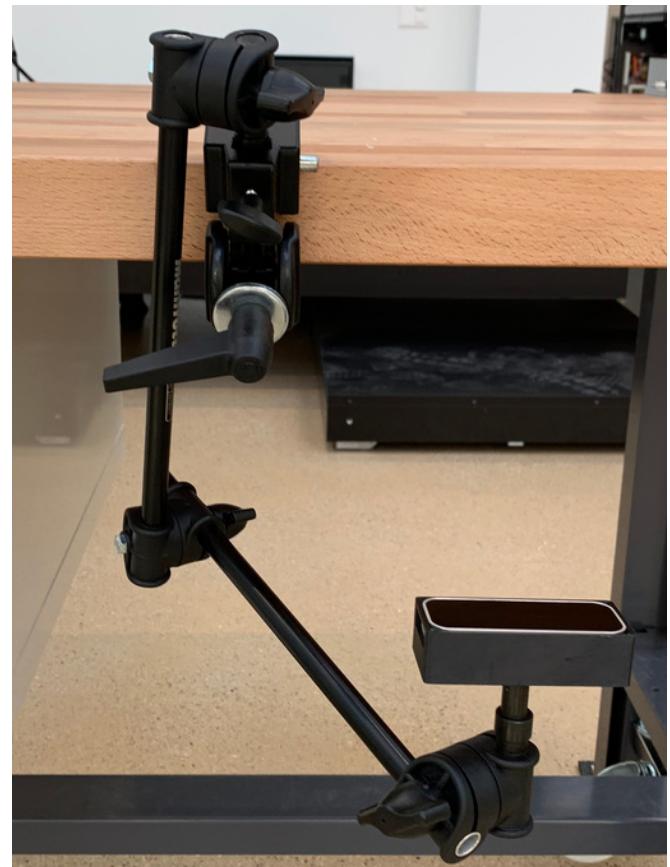
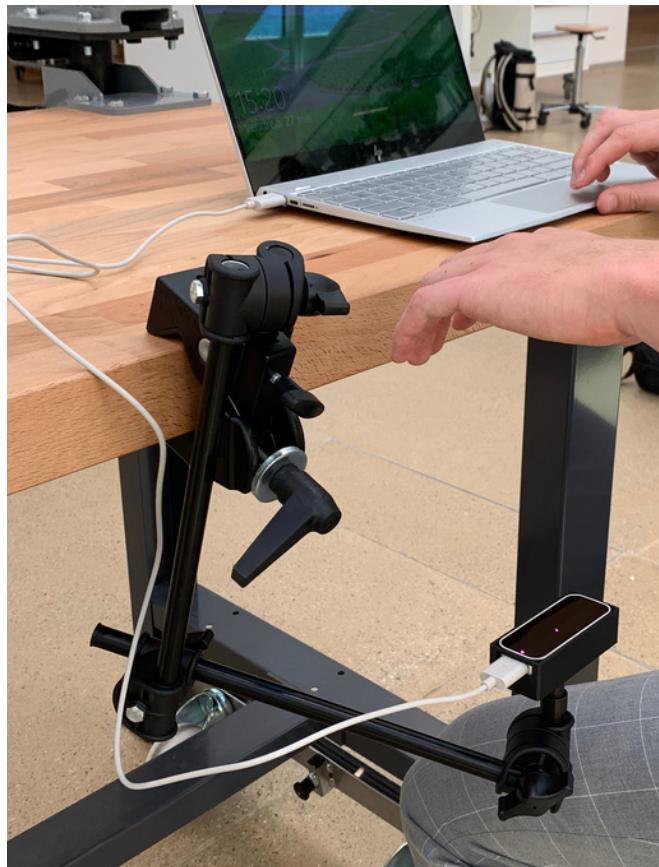
Attach the mechanical arm to position the Leap Motion 20 centimetres below the hand. To change the angle of the arm, loosen the screw on the right side of the arm, move the arm freely and retighten it when you have the desired configuration.

7.



Fix the cable of the leapmotion between the computer and the Leap Motion

FINAL SET-UP :



Features of the device :

Place your hand 20 centimetres above the Leap Motion. Make sure your hand is detected by the Leap Motion. The device will detect the specific residual movements of your finger and hand and select the keyboard keys accordingly. 2 types of movements have been implemented: simple and advanced mode. Each mode has six movements:

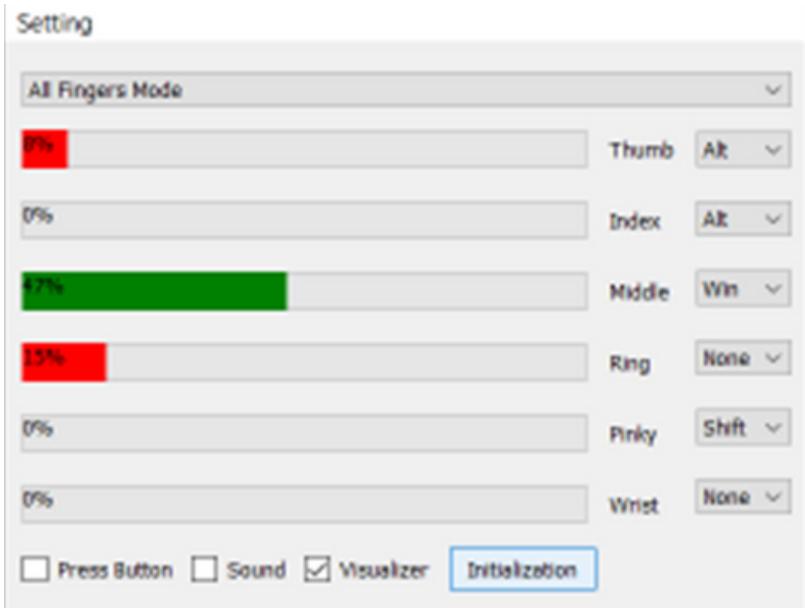
Simple mode :



1. Distance between the tip of the thumb and the palm
2. Angle between the metacarpal and the distal bone of the index
3. Angle between the metacarpal and the distal bone of the middle finger
4. Angle between the metacarpal and the distal bone of the ring finger
5. Angle between the metacarpal and the distal bone of the pinky finger
6. wrist extension movement

See Appendix for more detailed on the hand bones

Advanced mode :

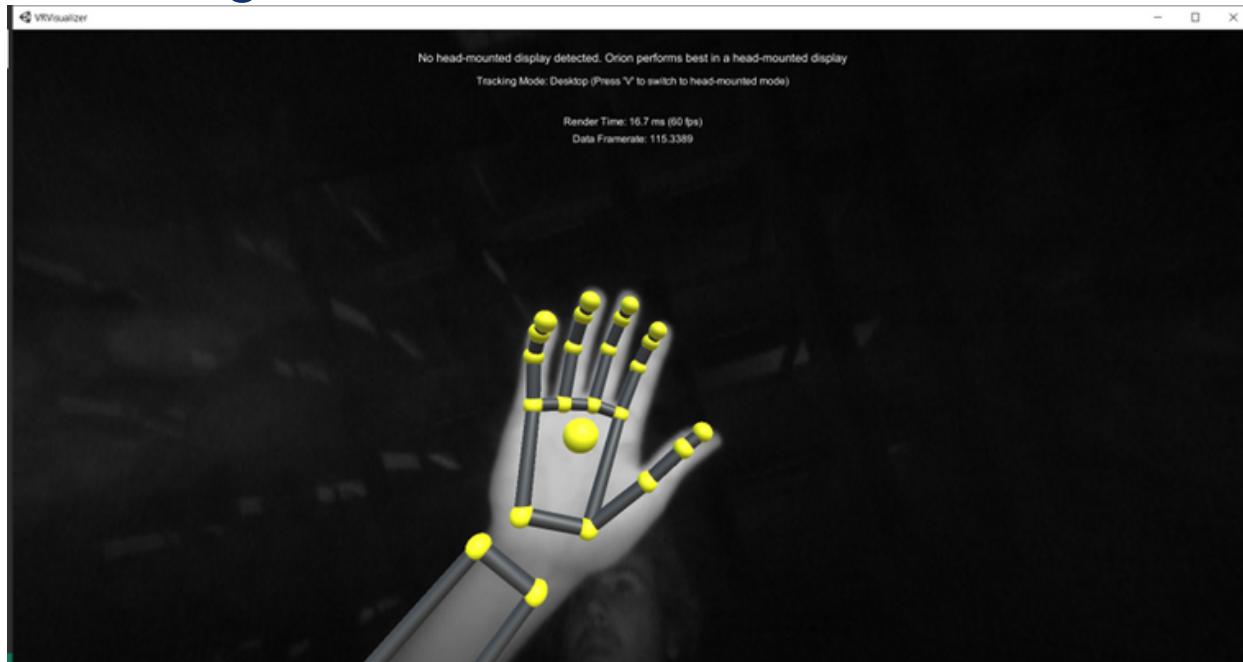


1. Distance between the tip of the thumb and the palm
2. Distance between the tip of the thumb and the tip of the index
3. Distance between the tip of the thumb and the tip of the middle
4. Distance between the tip of the thumb and the tip of the ring
5. Distance between the tip of the thumb and the tip of the pinky
6. Hand closed

As you can see from the two figures above, there are two methods of pressing a specific key: "shifter" or "all finger used": In 'shifter' mode, you can select the finger you want to use as a shifter in the bottom right corner. The movement of this finger will change the key to be pressed and the other movements will press the key. In 'All finger used' mode, you can select for each finger which key you want to press.

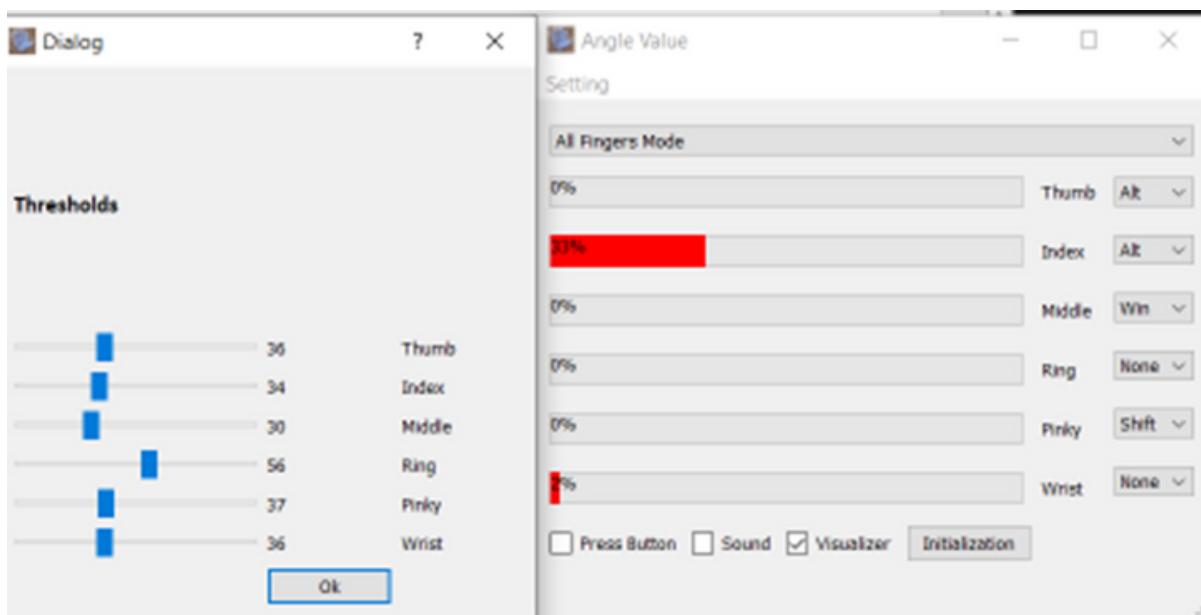
Use the device :

To use the device, run the previously installed .exe file and place your hand 20 centimeters above the Leap Motion for it to work. If you want to make sure your hand is detected, you can run the Leap Motion Visualizer. If your hand is detected correctly, you will see the specific position of your hand being tracked.



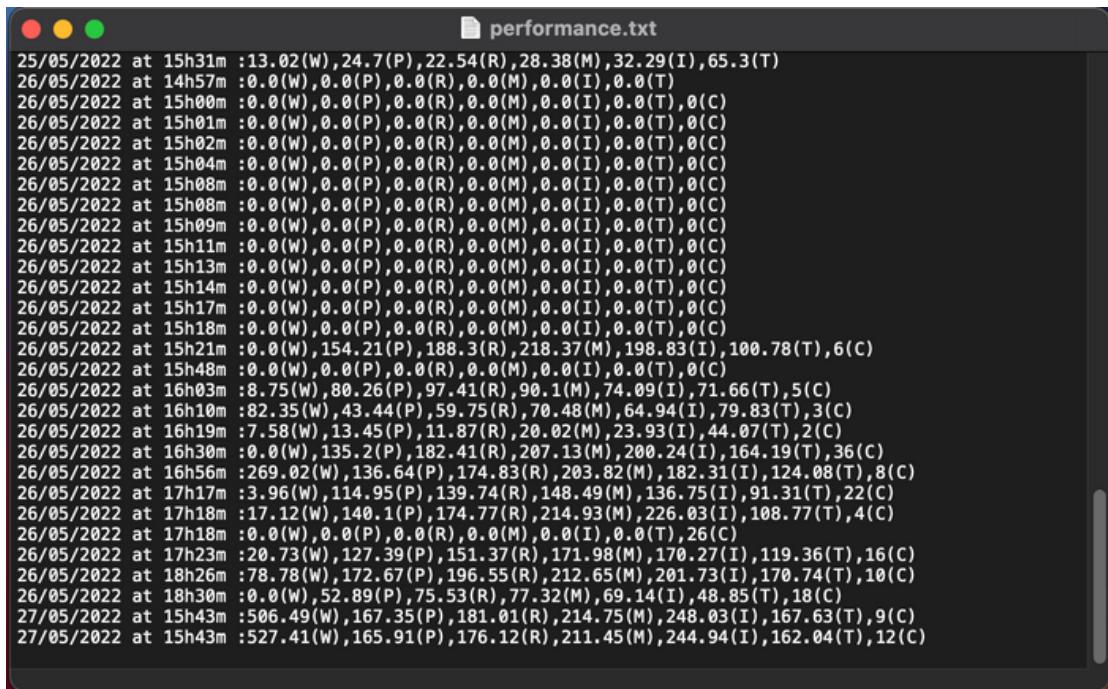
On the interface, you can see what percentage of the different movements have been performed. 0% means a resting situation and 100% means that the movement has been completely performed.

If you go to setting, acces setting, you will have access to a dialog box that you can see on the left in the image below. You can change the threshold for each movement so that you have to make movements of different magnitude to activate a key. Different checkboxes can be selected to enable different options: sound (to hear the name of the key when it is pressed), show the visualizer (to see the tracking of your hand) and Press Button to press the right key on the keyboard when the movement has been made.



Performance :

A performance.txt file is updated every time the user is using the device. In this file, we store in mm the displacement of each finger from their rest position and the number of movements made during the use of the device.



The screenshot shows a terminal window with the title bar "performance.txt". The window displays a log of sensor data entries. Each entry consists of a timestamp followed by a series of values separated by commas. The values represent displacement in mm for different fingers (Wrist, Palm, Radius, Ulna, Index, Middle, Ring, Pinky) across four categories: Position (P), Velocity (V), Acceleration (A), and Torque (T). The data shows a pattern of activity starting at 15h31m on May 25, 2022, and continuing through various times on May 26 and 27, 2022, with a significant amount of data for 15h43m on May 27, 2022.

```
25/05/2022 at 15h31m :13.02(W),24.7(P),22.54(R),28.38(M),32.29(I),65.3(T)
26/05/2022 at 14h57m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T)
26/05/2022 at 15h00m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h01m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h02m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h04m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h08m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h08m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h09m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h11m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h13m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h14m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h17m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h18m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 15h21m :0.0(W),154.21(P),188.3(R),218.37(M),198.83(I),100.78(T),6(C)
26/05/2022 at 15h48m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),0(C)
26/05/2022 at 16h03m :8.75(W),80.26(P),97.41(R),90.1(M),74.09(I),71.66(T),5(C)
26/05/2022 at 16h10m :82.35(W),43.44(P),59.75(R),70.48(M),64.94(I),79.83(T),3(C)
26/05/2022 at 16h19m :7.58(W),13.45(P),11.87(R),20.02(M),23.93(I),44.07(T),2(C)
26/05/2022 at 16h30m :0.0(W),135.2(P),182.41(R),207.13(M),200.24(I),164.19(T),36(C)
26/05/2022 at 16h56m :269.02(W),136.64(P),174.83(R),203.82(M),182.31(I),124.08(T),8(C)
26/05/2022 at 17h17m :3.96(W),114.95(P),139.74(R),148.49(M),136.75(I),91.31(T),22(C)
26/05/2022 at 17h18m :17.12(W),140.1(P),174.77(R),214.93(M),226.03(I),108.77(T),4(C)
26/05/2022 at 17h18m :0.0(W),0.0(P),0.0(R),0.0(M),0.0(I),0.0(T),26(C)
26/05/2022 at 17h23m :20.73(W),127.39(P),151.37(R),171.98(M),170.27(I),119.36(T),16(C)
26/05/2022 at 18h26m :78.78(W),172.67(P),196.55(R),212.65(M),201.73(I),170.74(T),10(C)
26/05/2022 at 18h30m :0.0(W),52.89(P),75.53(R),77.32(M),69.14(I),48.85(T),18(C)
27/05/2022 at 15h43m :506.49(W),167.35(P),181.01(R),214.75(M),248.03(I),167.63(T),9(C)
27/05/2022 at 15h43m :527.41(W),165.91(P),176.12(R),211.45(M),244.94(I),162.04(T),12(C)
```

Appendix:



The coordinates in 3D of all those green points can be computed using Leap Motion

Tutorial to fix the Manfrotto 196AB-2 Single Arm 2 Section :

[https://www.youtube.com/watch?](https://www.youtube.com/watch?v=zGuN0nZ2KTM&ab_channel=TheNightTimeEntrepreneur)

[v=zGuN0nZ2KTM&ab_channel=TheNightTimeEntrepreneur](https://www.youtube.com/watch?v=zGuN0nZ2KTM&ab_channel=TheNightTimeEntrepreneur)