NYU

Robots for disability

Prototype project

Fernando Okigami, Olzhas Nariman
December 13, 2017

Aim: Assessment and Rehabilitation tool

- Millions of people survived after stroke attack
- 9 out of 10 require rehabilitation courses
- *Multiple Sclerosis, Parkinson’s Disease, Brain Injury, etc.*

PROTOTYPE

- Measurement system for upper limbs performance
- Leap Motion Controller + Python + QtDesigner + Medical inputs (Prof. Raghavan)

Advantages

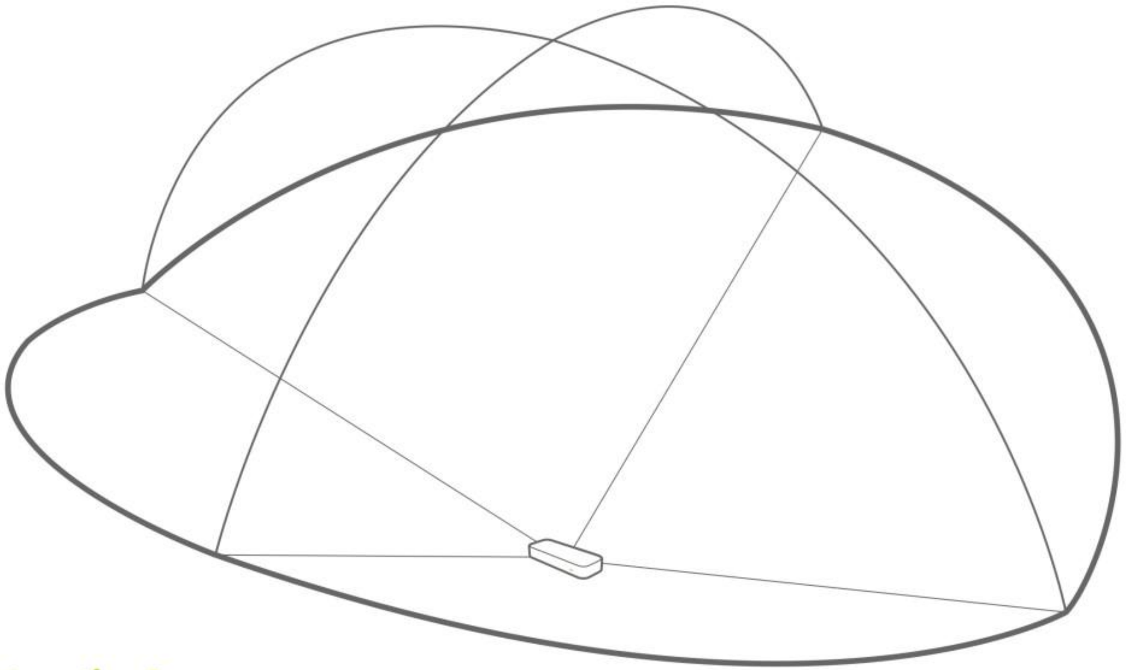
- Low-cost: only $60
- Recording performance: 110 frames per second
- High accuracy

Hardware

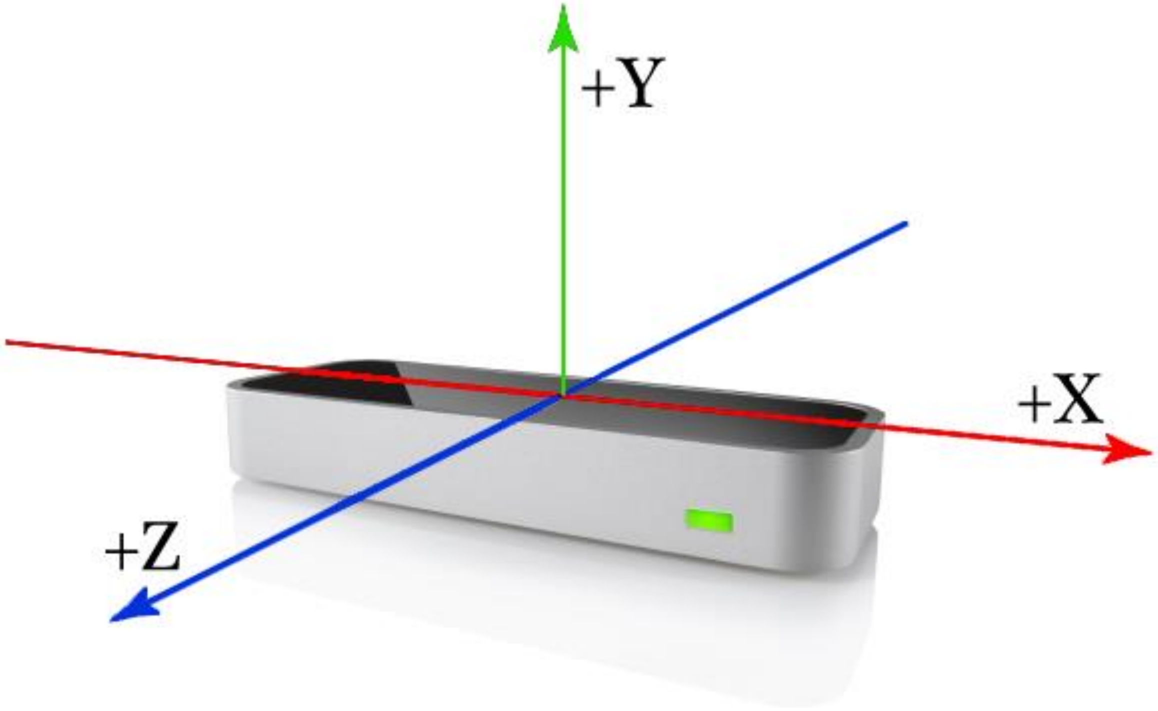
- 2 cameras
- 3 infrared LEDs
- 850 nanometers wavelength

Interaction Area

R = 2 ft (almost hemisphere)



Interaction Area
2 feet above the controller, by 2 feet wide on each side (150° angle), by 2 feet deep on each side (120° angle)



About precision and tracking: what literature says

An Analysis of the Precision and Reliability of the Leap Motion Sensor and Its Suitability for Static and Dynamic Tracking

Jože Guna,* Grega Jakus, Matevž Pogačnik, Sašo Tomažič, and Jaka Sodnik

1. In the static scenario, the standard deviation was less than 0.5 mm.
2. The results of the dynamic scenario revealed the inconsistent performance of the controller, with a significant drop in accuracy for samples taken more than 250 mm above the controller's surface.
3. The results show a deviation between the desired 3D position and the average measured positions below 0.2 mm for static setups and of 1.2 mm for dynamic setups.
4. The standard deviation of the noise for the static marker was measured for each individual coordinate: std*x* = 0.018 mm, std*y* = 0.016 mm and stdz = 0.029 mm.
5. The lowest standard deviation (0.0081 mm) was measured on the *x* axis 30 cm above the controller, while the highest standard deviation (0.49 mm) was measured on the *y* axis at the leftmost and topmost positions. (STATIC)
6. The mean sampling frequency was 39.0 Hz. The standard deviation was 12.8 Hz.
7. this paper also shows: Distance deviation distributions in *x*-*z* plane at (**a**) *y* = 150 mm; and (**b**) *y* = 250 mm. (DYNAMIC)

Conclusion:
In the static scenario, the standard deviation was shown to be less than 0.5 mm at all times, in the best cases less than 0.01 mm. In addition, the high accuracy (below 0.2 mm) reported in [15] combines with our results to evaluate the controller as a reliable and accurate system for tracking static points.

About precision and tracking: what literature says

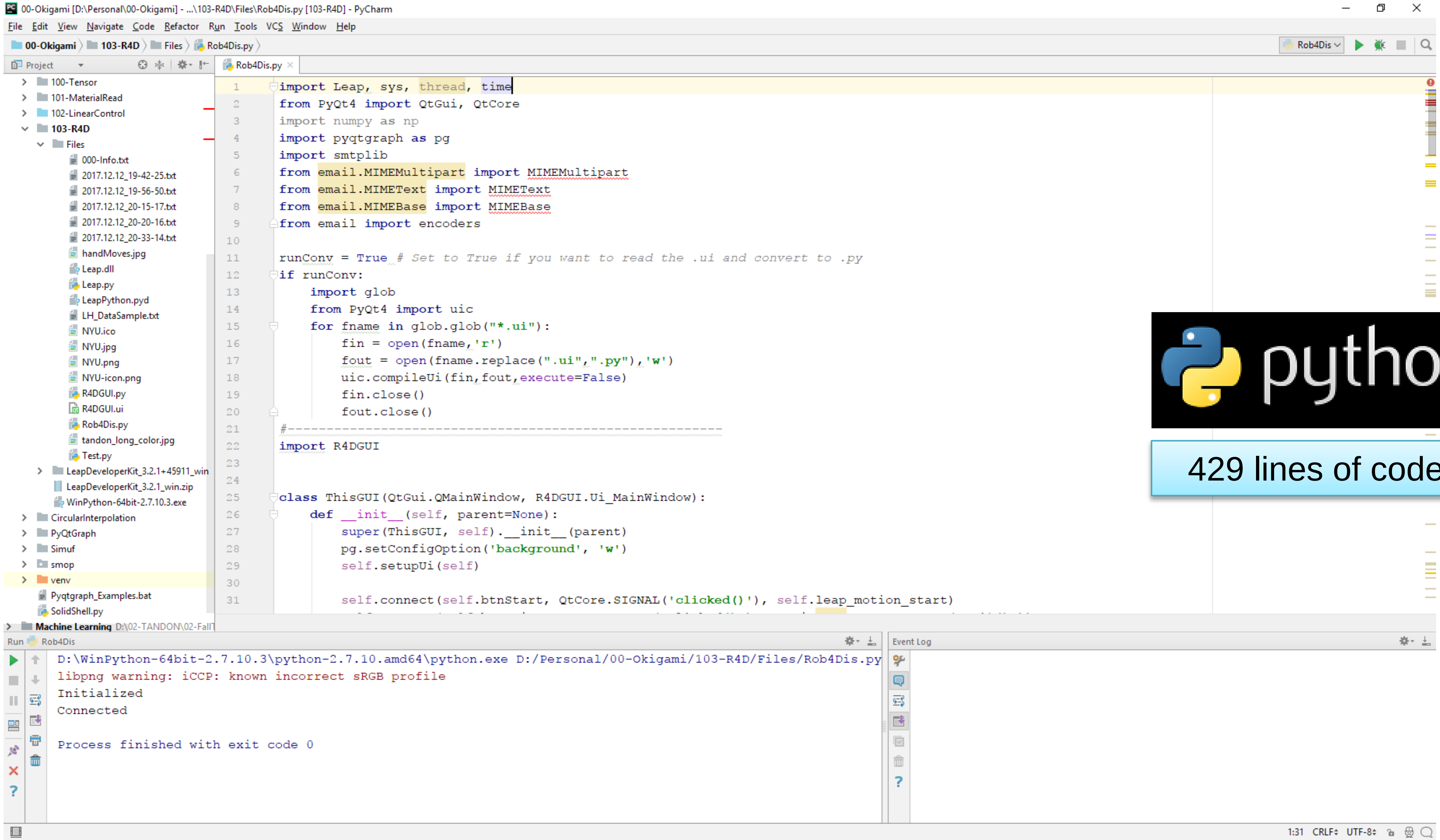
Leap motion controller three dimensional verification and polynomial correction

Yajaira-IlseCuriel-Razo[a]OctavioIcasio-Hernández[ab]GabrielSepúlveda-Cervantes[c]Juan-BautistaHurtado-Ramos[a]José-JoelGonzález-Barbosa[a]

1. The results demonstrated an axis-independent deviation for static setups between the desired 3D position and the measured position of less than 0.2 mm. For dynamic situations, independent from the plane, the accuracy was less than 2.5 mm. Repeatability averaged less than 0.17 mm. They concluded it was not possible to achieve the theoretical accuracy of 0.01 mm under real conditions but it did provide high precision (0.7 mm).

2. For static measurements, a plastic arm model simulating a human arm was used, and showed a **standard deviation less than 0.5 mm**.
3. However, while the palm was properly recognized within 300 mm of the LMC, palm coordinates were very unstable during the process when **the palm touched the surface**.
4. These errors are the deviation of LMC tracked data from a desired 3D position **measured by the CMM**. The mean error of the four trajectories was 9.550 mm, significantly larger than the quoted manufacturing accuracy, 0.01 mm [13]. The uncertainties also exceed 0.01 mm, the smallest being 0.136 mm in the first trajectory. Other researchers [14,16] have commented previously regarding the manufacturing accuracy. When [14] moved a sharp pen mounted on the robotic arm over discrete positions on a path, the standard deviation was slightly less than 0.7 mm per axis, implying it was not possible to achieve the nominal manufacturing accuracy of 0.01 mm under real conditions.

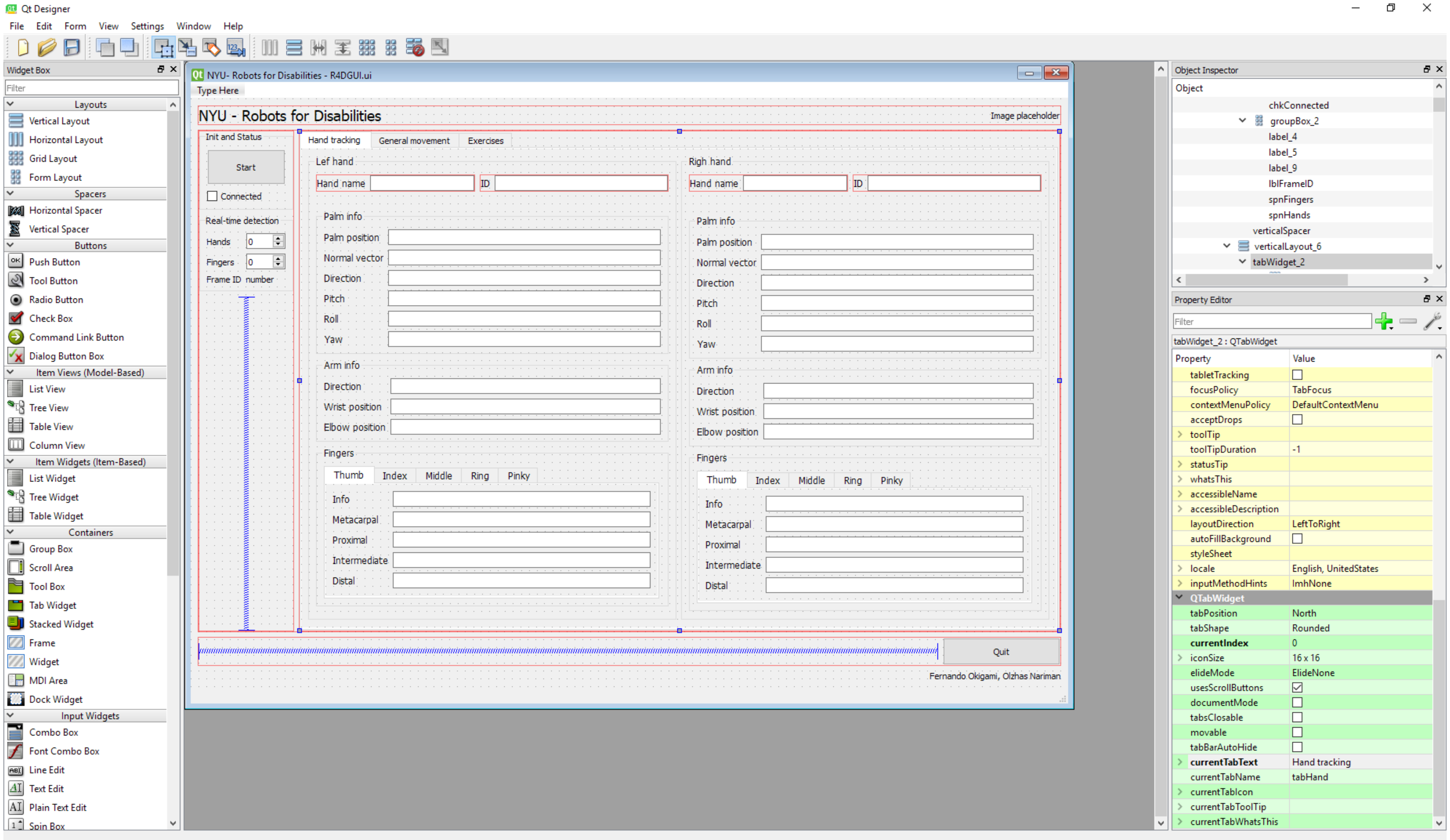
PyCharm – Python IDE



python™

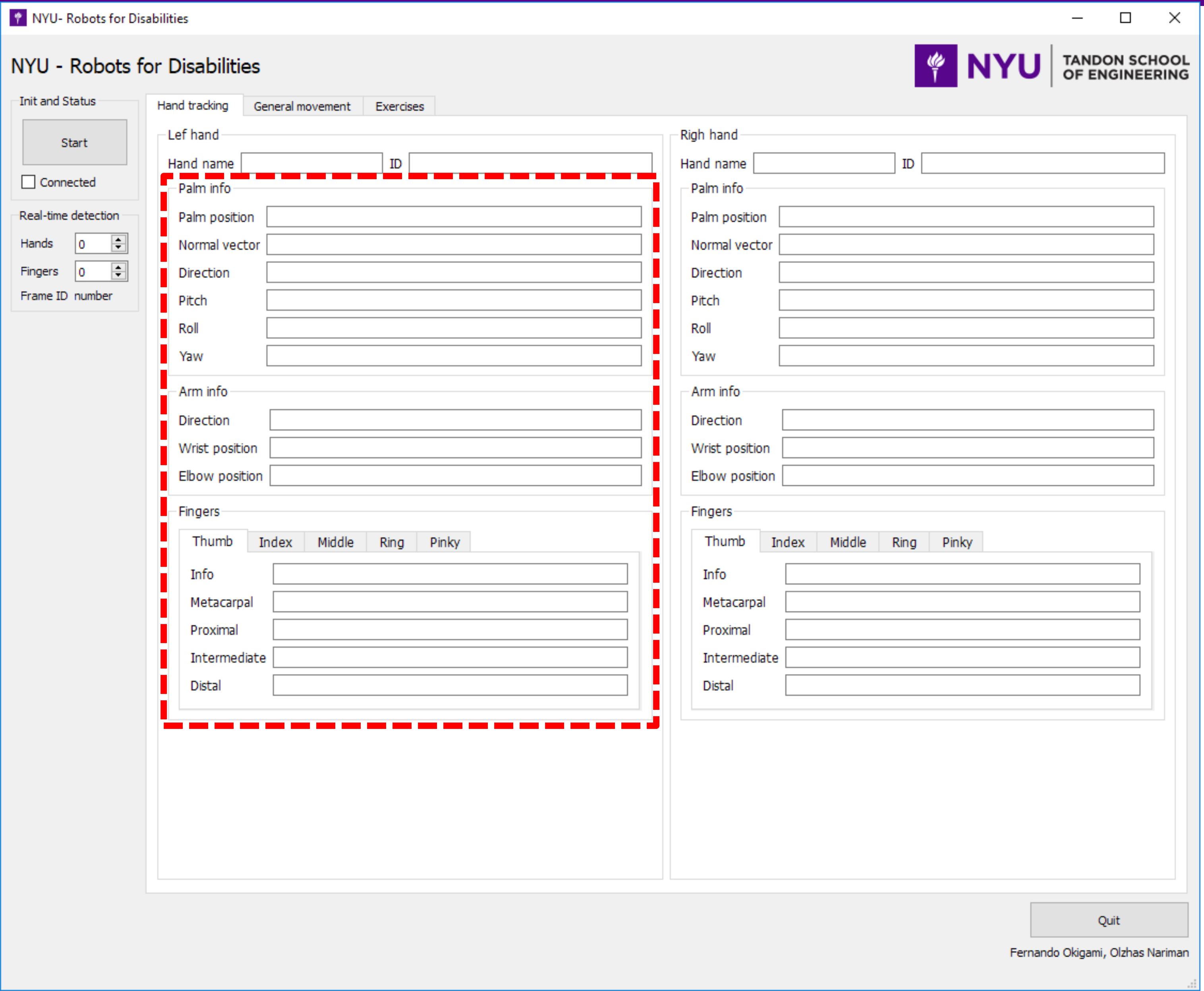
429 lines of code only!

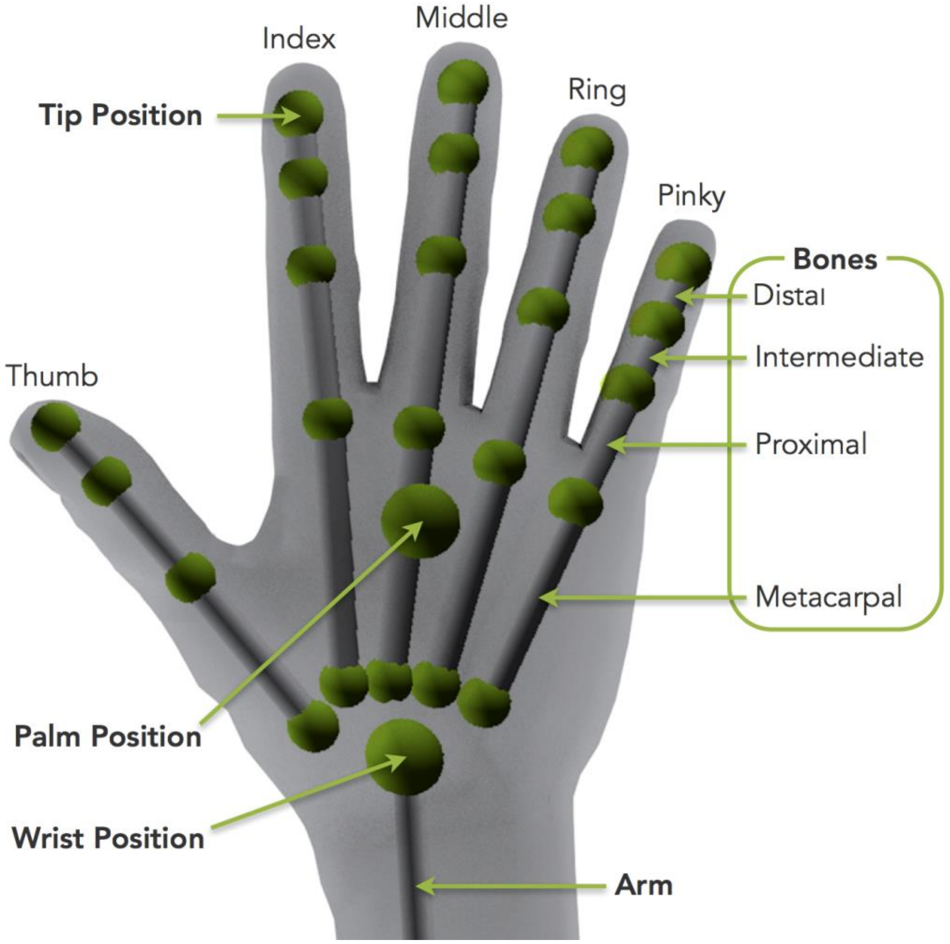
PyQt – Qt wrapper



NYU

Main tab

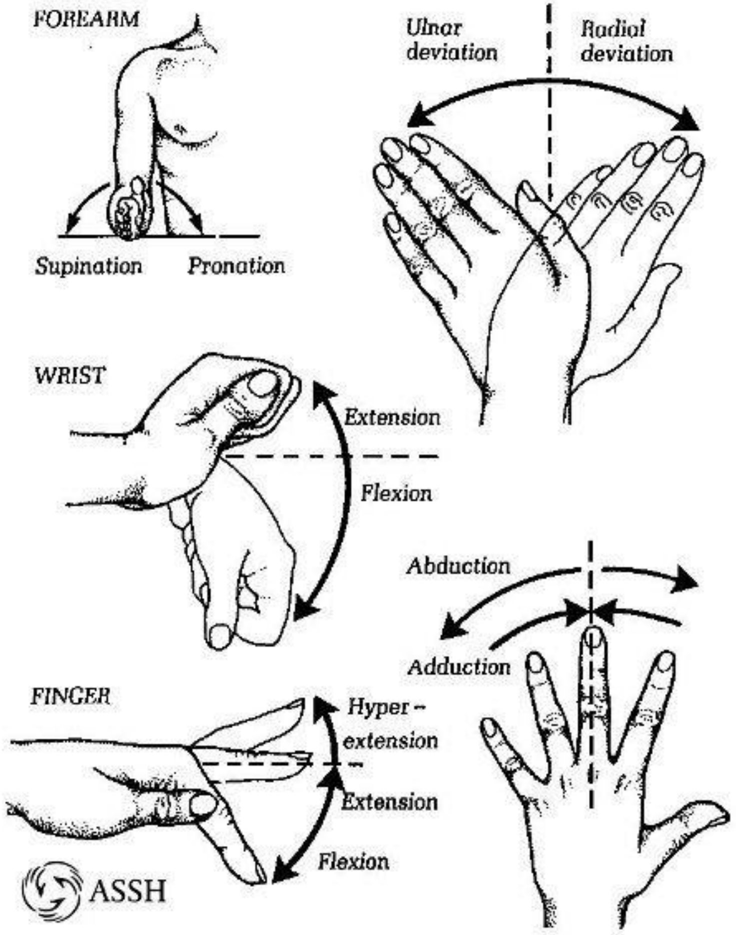

NYU- Robots for Disabilities
NYU - Robots for Disabilities
NYU TANDON SCHOOL OF ENGINEERING
Init and Status
Start
Connected
Real-time detection
Hands 0
Fingers 0
Frame ID number
Hand tracking
General movement
Exercises
Lef hand
Hand name
ID
Palm info
Palm position
Normal vector
Direction
Pitch
Roll
Yaw
Arm info
Direction
Wrist position
Elbow position
Fingers
Thumb
Index
Middle
Ring
Pinky
Info
Metacarpal
Proximal
Intermediate
Distal
Righ hand
Hand name
ID
Palm info
Palm position
Normal vector
Direction
Pitch
Roll
Yaw
Arm info
Direction
Wrist position
Elbow position
Fingers
Thumb
Index
Middle
Ring
Pinky
Info
Metacarpal
Proximal
Intermediate
Distal
Quit
Fernando Okigami, Olzhas Nariman


Index
Middle
Ring
Pinky
Tip Position
Thumb
Bones
Distal
Intermediate
Proximal
Metacarpal
Palm Position
Wrist Position
Arm

- **Through a user-friendly interface:**
  - Accurately track movements
  - Measure travel distance
  - Count number of cycles for exercises
  - Determine session times
  - Exchange data with doctors
  - Traceability of patients' data
  - Analyze hidden trends in sub-movements

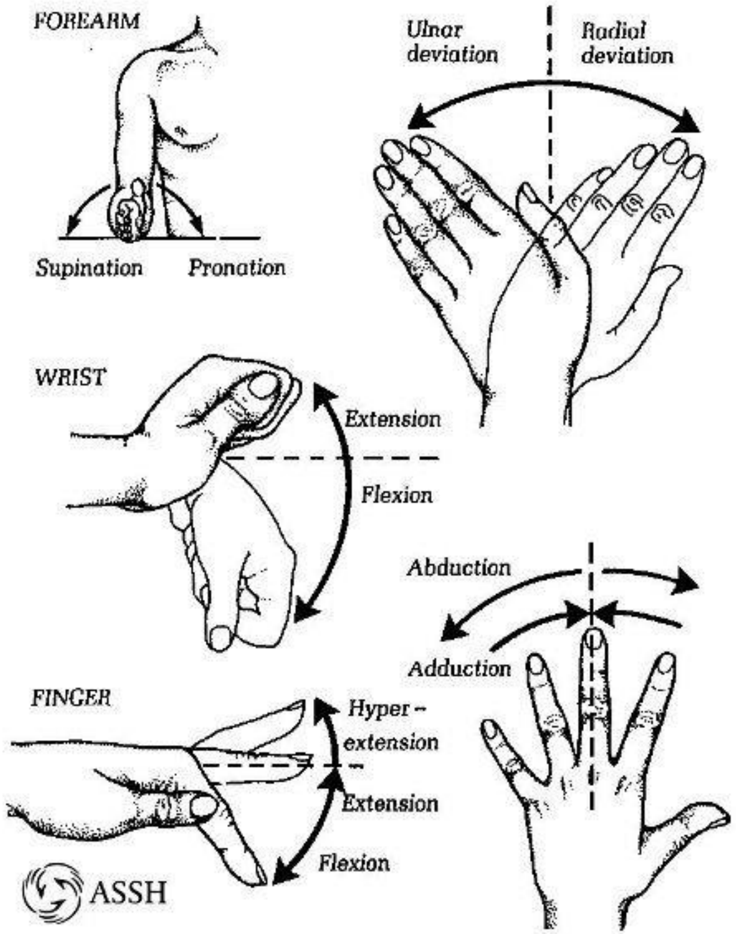
- **We can assess:**
  - Range of motion
  - Smoothness of movement
  - Frequency of tremors

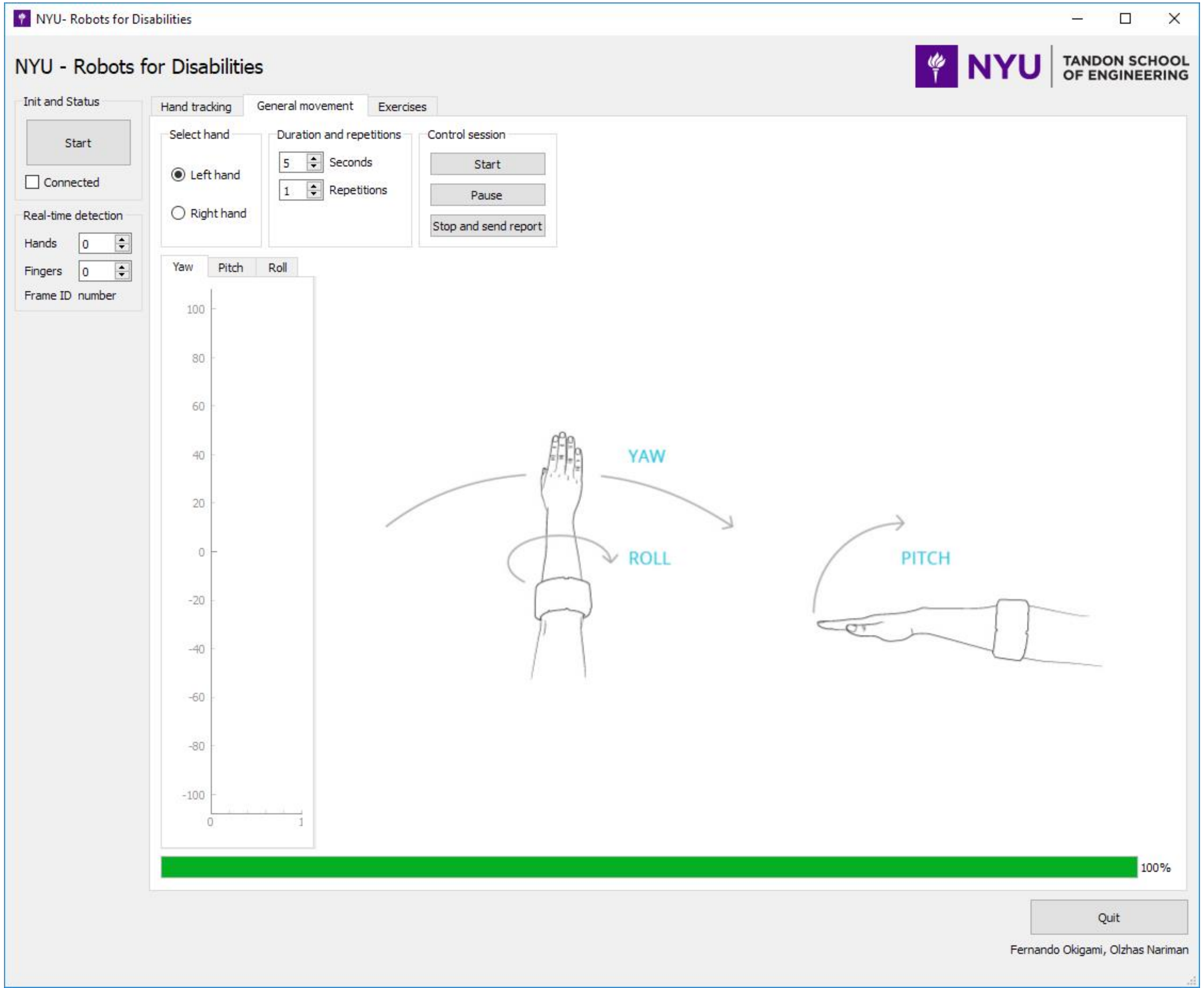
This way we can reveal early symptoms



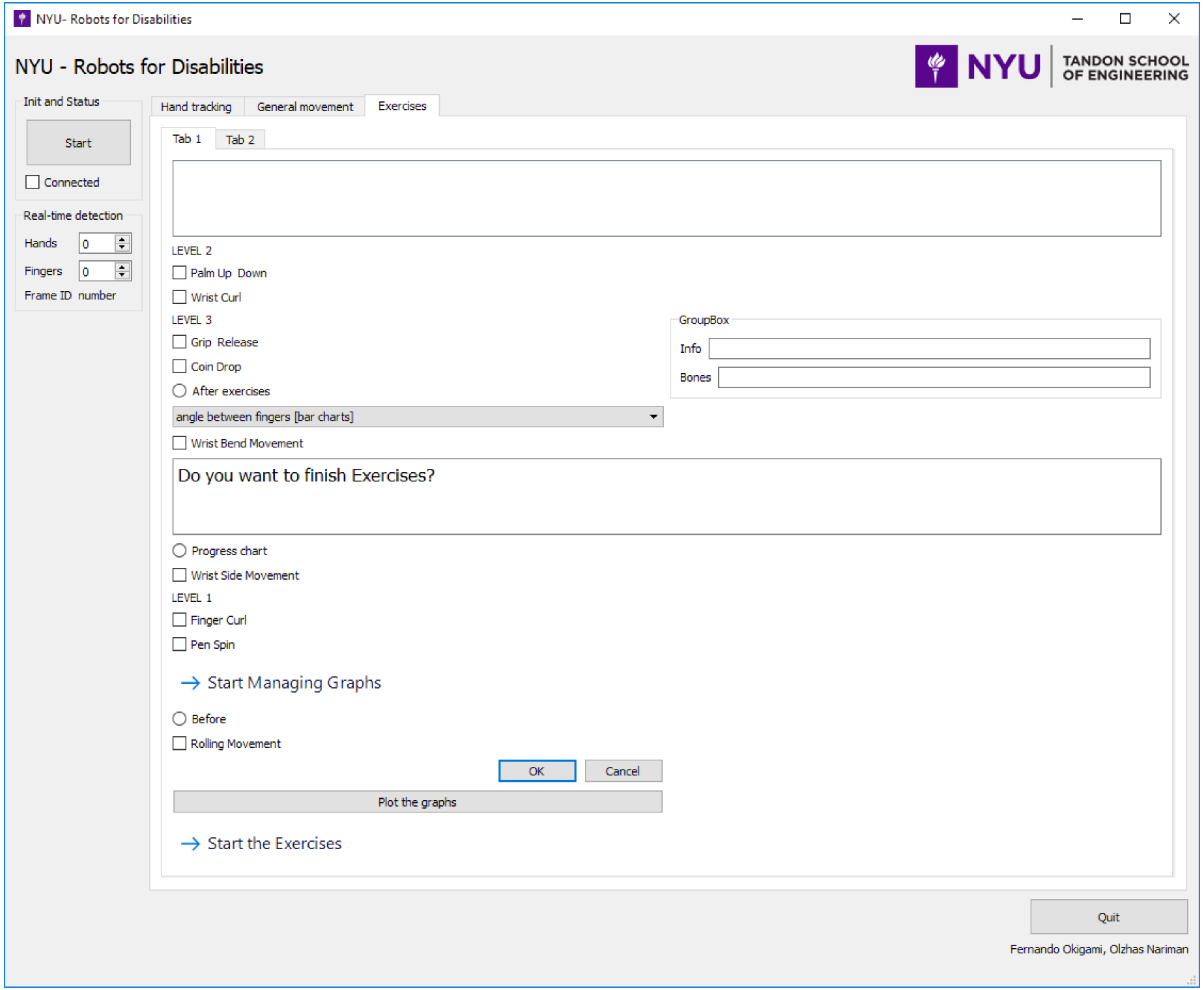
"you can't manage what you can't measure."
Peter Drucker

General movement tab





Specific exercises tab



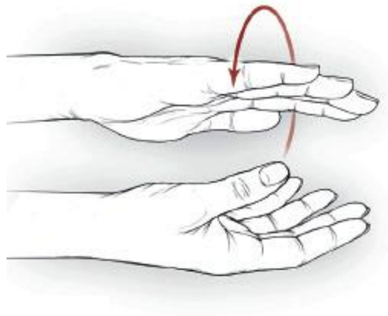
There’s room to do much more!

NYU

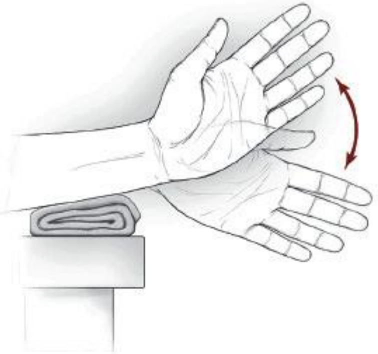
Proposed exercises to be done in the platform

1. Wrist extension and flexion
• Place your forearm on a table on a rolled-up towel for padding with your hand hanging off the edge of the table, palm down.
• Move the hand upward until you feel a gentle stretch.
• Return to the starting position.
• Repeat the same motions with the elbow bent at your side, palm facing up.

2. Wrist supination/pronation
• Stand or sit with your arm at your side with the elbow bent to 90 degrees, palm facing down.
• Rotate your forearm, so that your palm faces up and then down.



3. Wrist ulnar/radial deviation
• Support your forearm on a table on a rolled-up towel for padding or on your knee, thumb upward.
• Move the wrist up and down through its full range of motion.



https://www.health.harvard.edu/pain/5-exercises-to-improve-hand-mobility-and-reduce-pain

LIVE DEMO