



Università  
di Genova

# A Helping Hand: Exoskeleton Gloves for Rehabilitation and Paralysis Recovery

## Students:

Alvin Isac - s7789223

Mohsen Kashefi - s5964796

Seyed Alireza Mortazavi - s6136275

Mohammad Ali Pouryaghoub - s6063201

Professor : **Maura Casadio**

Co-supervisor : **Danilo Canepa**

# The need of Exoskeletons

Psychological Impact

Financial Problems

Loss of Independence

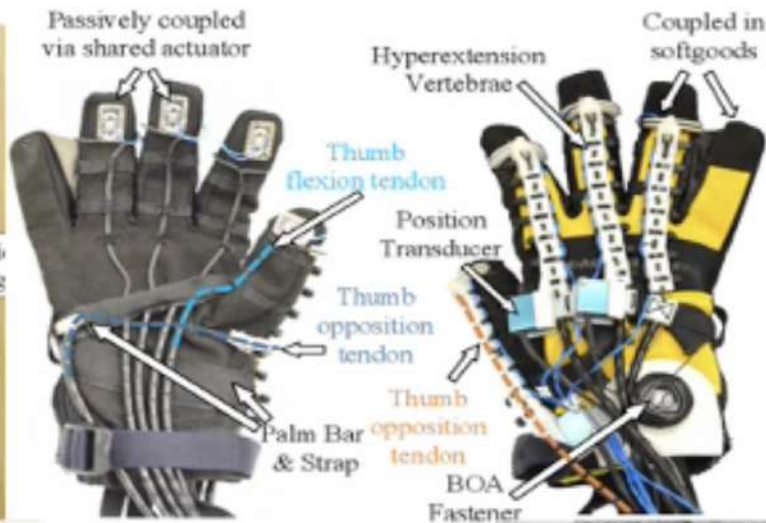
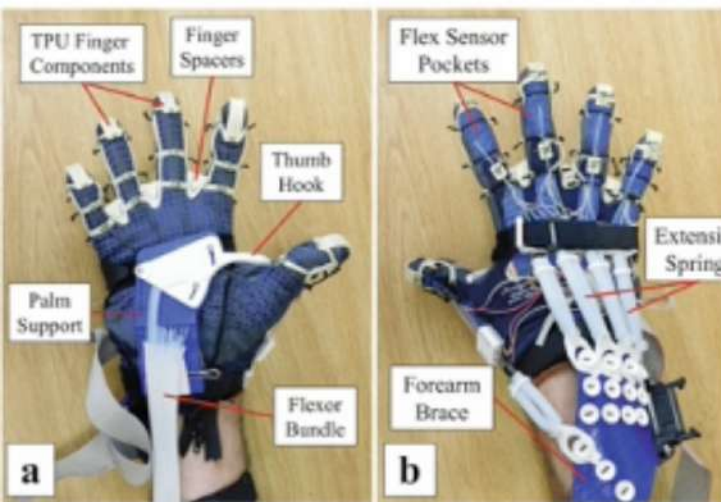
Limited access to public spaces

Disuse Osteoporosis



G. Donald Whedon, Physiological Aspects of Disuse Osteoporosis, *Calcified Tissue International*, 1984

# existing exoskeleton-gloves





# What Makes Our Glove Different

- Low cost
- Portability
- Customizable for Patient Needs
- No external control
- low maintenance
- Solid grip
- Waterproof and Washable
- AI – Control
- 2 in 1 Design
- Suitable for both Paralyzed and Rehabilitation Patients



Exo-Glove Poly II: A polymer-based soft wearable robot for the hand with a tendon-driven actuation system," *Soft Robotics*, vol. 3, no. 2, pp. 59–68, 2016, doi: 10.1089/soro.2016.0011.

## Key Components of Our Design

- KE-1300T Silicone
- Raspberry Pi
- Lithium Battery
- Motors
- Encoders
- power consumption sensor
- Emg Sensor



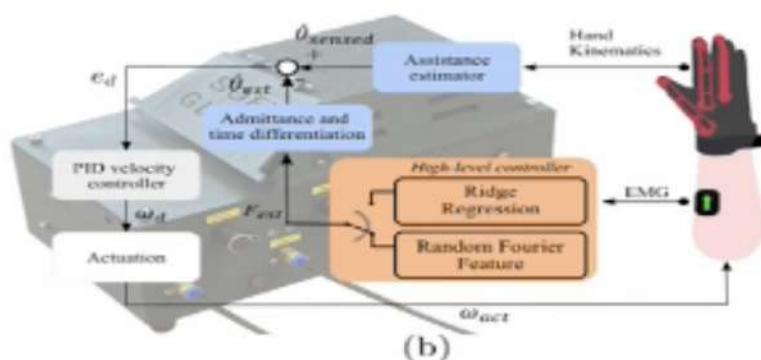
# Existing ML Project:



(a)

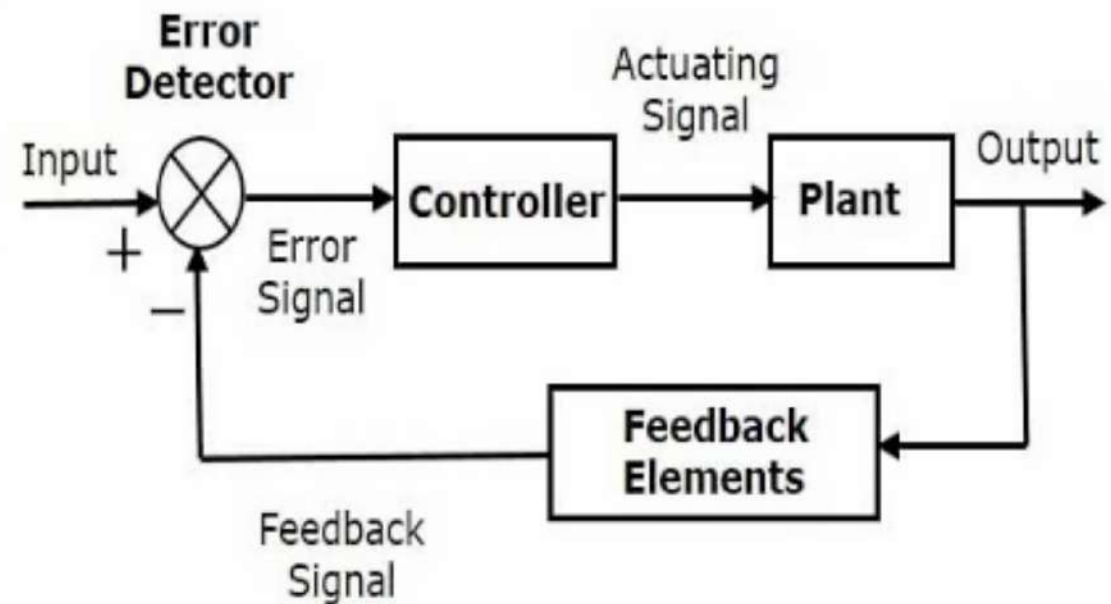
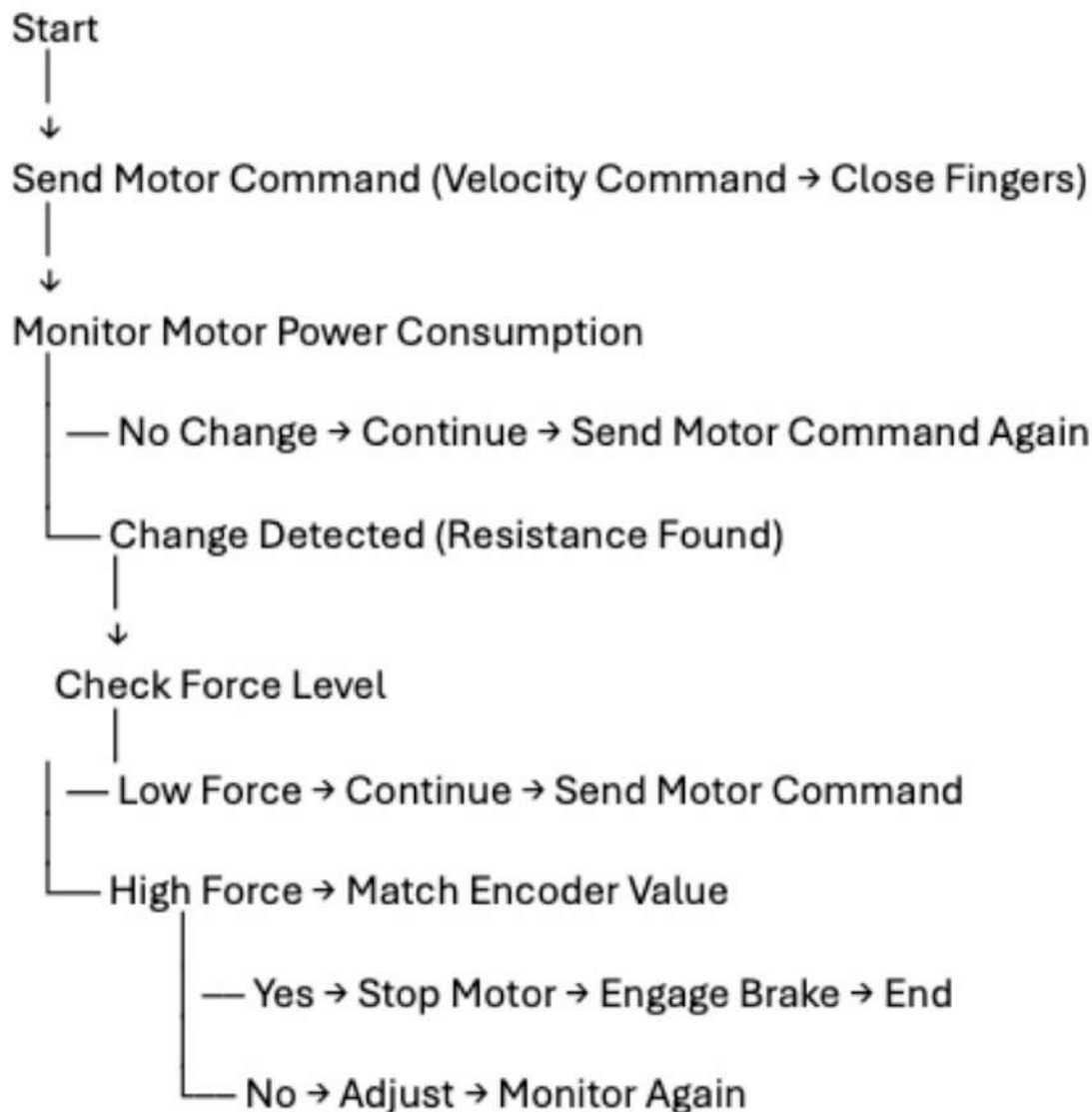


(a)

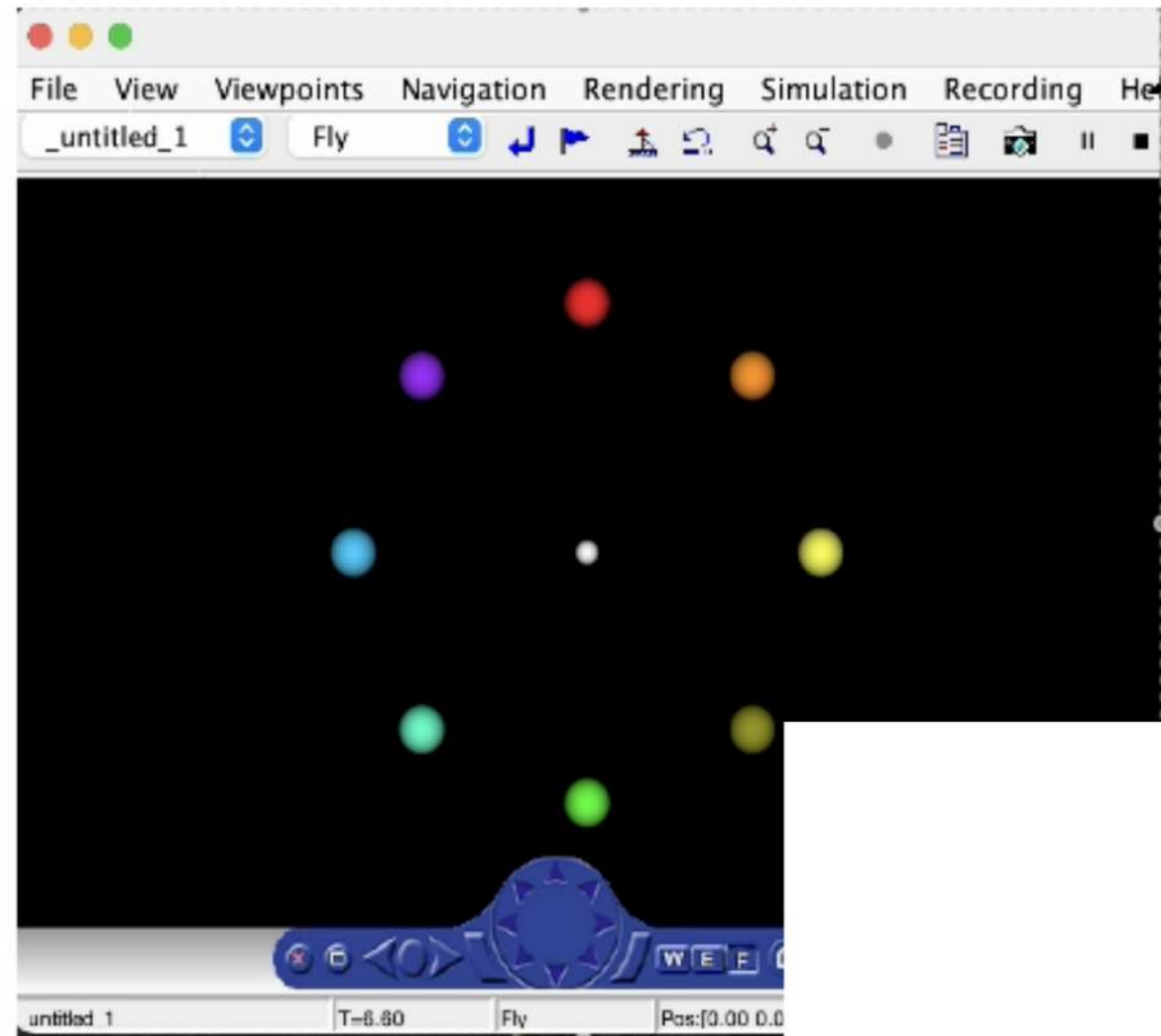
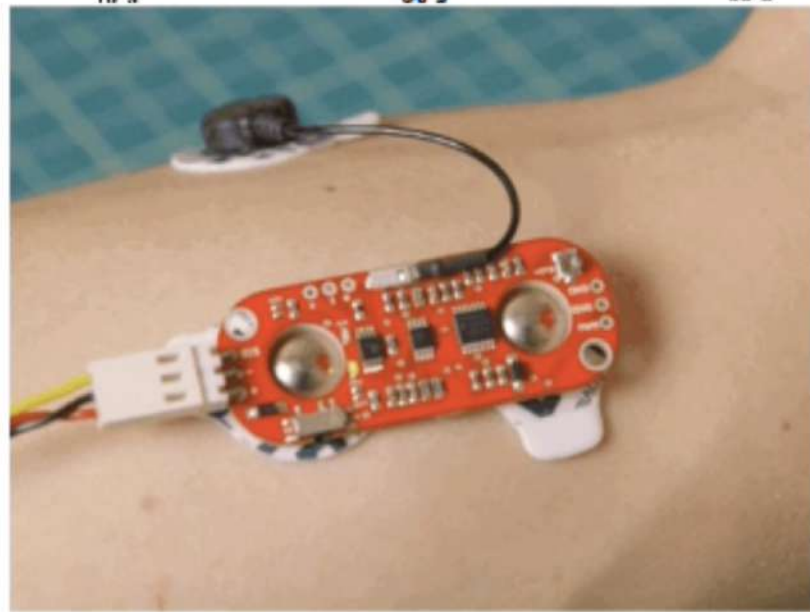
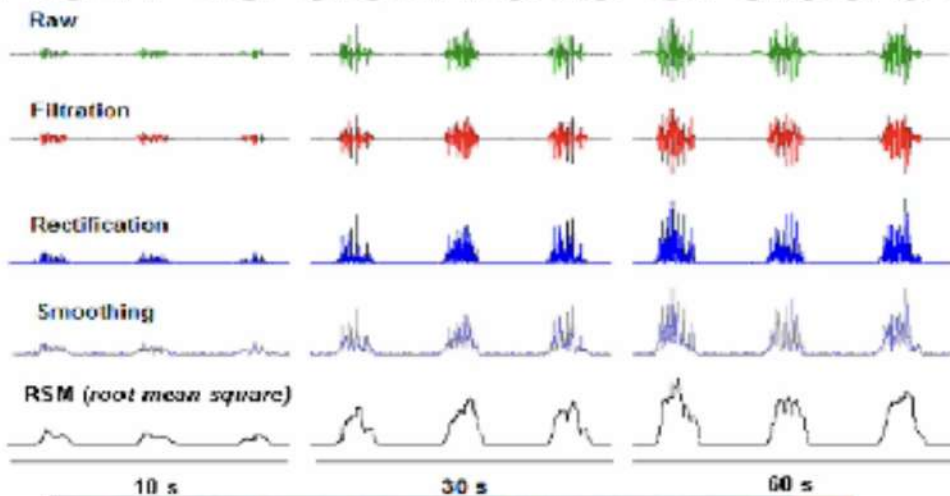


(b)

# Working Principle



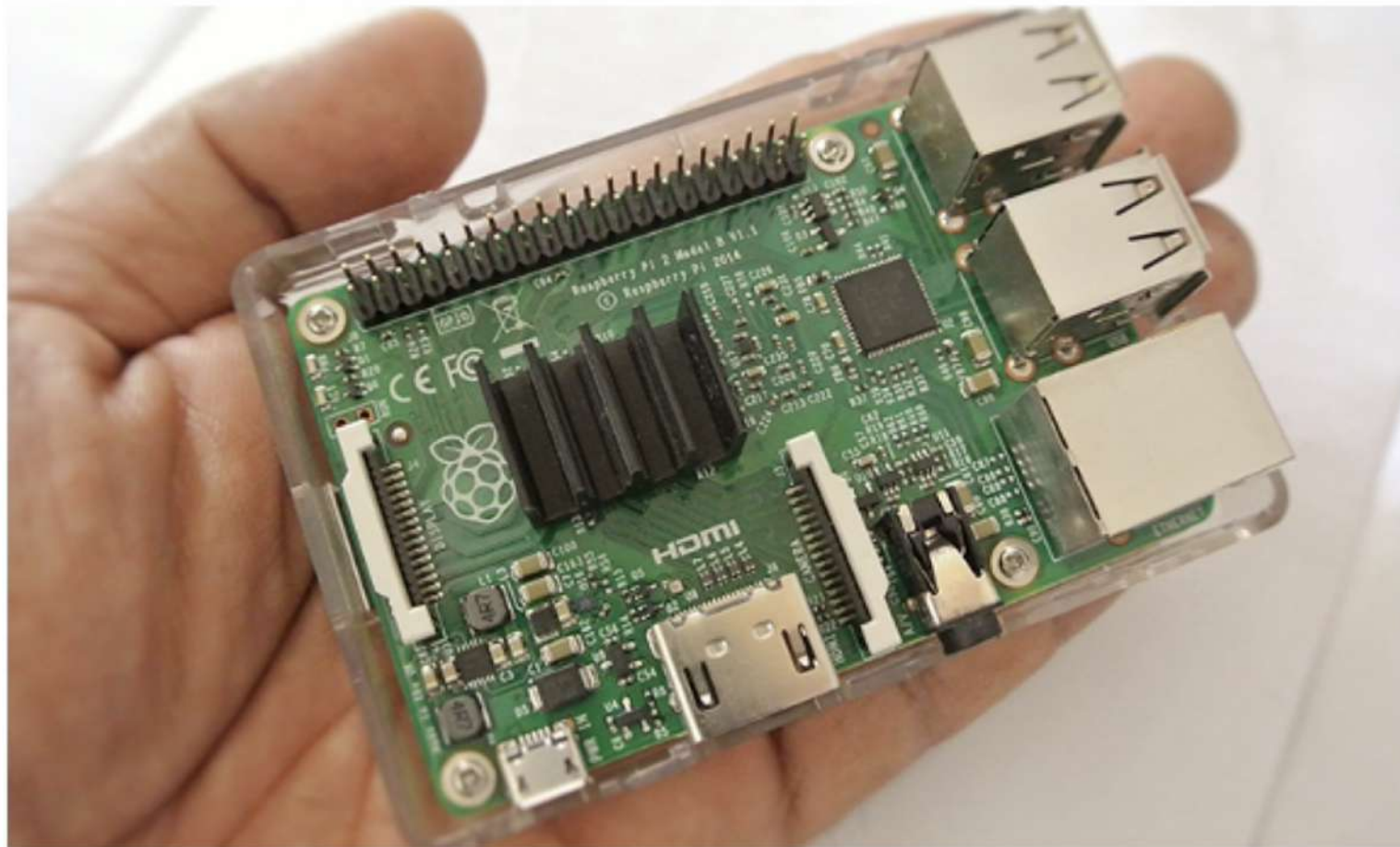
# How to activate & deactivate the actuator ?



Review of electromyography onset detection methods for real-time control of robotic exoskeletons. *Journal of NeuroEngineering and Rehabilitation*. 20(1), 141



# Machine Learning on Raspberry Pi is really Possible ?



# Machine Learning on Raspberry Pi is really Possible ?



## Python:

- \* Interpreted Language
- \* require more computational power

## C++

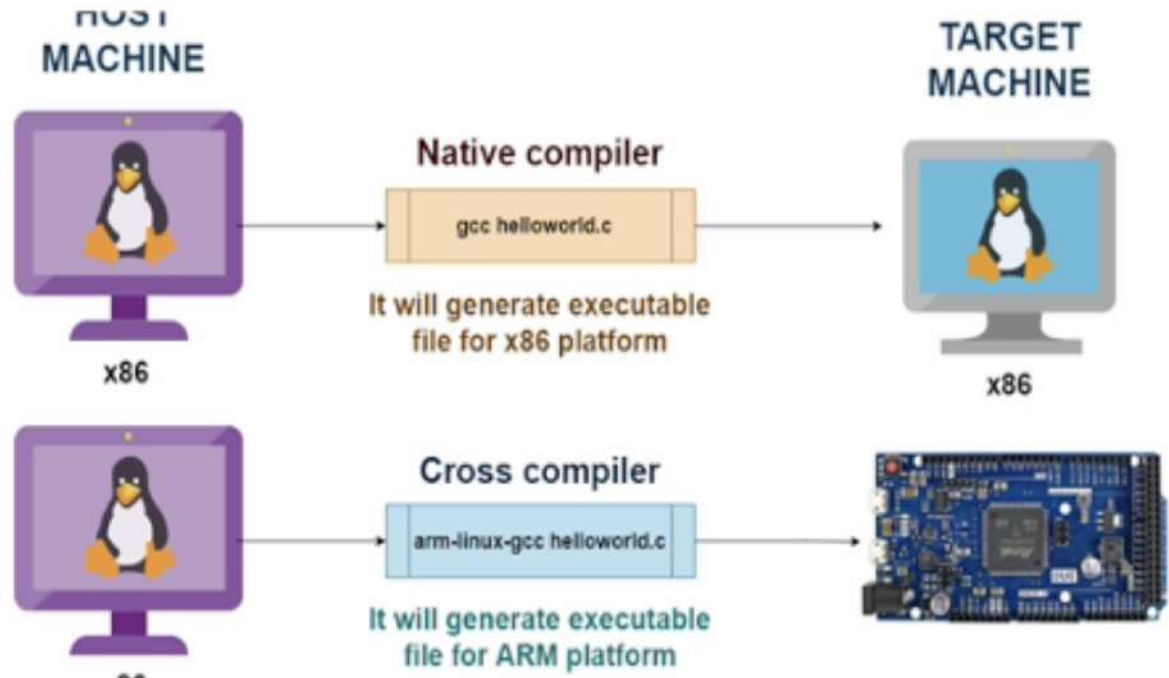
- \* compiled into the machine language
- \* requires less memory and cpu can run directly

# Cross Compiling or Customizing OS Image Using Packer

```
0[|||||100.0%] Tasks: 72, 37 thr: 4 running
1[|||||100.0%] Load average: 3.67 3.68 2.46
2[|||||100.0%] Uptime: 03:04:46
3[|||||100.0%]
Mem[|||||515M/965M]
Swap[|||||0K/0K]
```

PID	USER	PRI	NI	VIRT	RES	SHR	S	CPU%	MEM%	TIME+	Command
1045	turtle	20	0	167M	4976	832	S	0.0	0.5	0:00.00	(sd-pam)
1129	turtle	20	0	10044	4000	1092	S	0.0	0.4	0:00.55	-bash
1238	turtle	20	0	8940	3728	1692	S	0.0	0.4	0:00.31	-bash
1397	turtle	20	0	9872	3892	1748	S	0.0	0.4	0:00.31	-bash
2019	turtle	20	0	9876	3728	1576	S	0.0	0.4	0:00.58	-bash
2157	turtle	20	0	9876	3724	1588	S	0.0	0.4	0:00.38	-bash
3753	turtle	20	0	2320	724	628	S	0.0	0.1	0:00.01	/bin/sh -c cd /home/turtle/ros2/bu
1043	turtle	20	0	10256	4796	2108	S	0.0	0.5	0:01.57	/lib/systemd/systemd --user
371	root	19	-1	40156	3488	2348	S	0.0	0.4	0:01.62	/lib/systemd/systemd-journald
656	root	20	0	15744	2636	1640	S	0.0	0.3	0:00.63	/lib/systemd/systemd-logind
588	systemd-n	20	0	16408	1808	776	S	0.0	0.2	0:00.66	/lib/systemd/systemd-networkd
591	systemd-r	20	0	25228	5268	1052	S	0.0	0.6	0:00.58	/lib/systemd/systemd-resolved
588	systemd-t	20	0	80736	2312	1436	S	0.0	0.2	0:00.74	/lib/systemd/systemd-timesyncd
789	systemd-t	20	0	80736	2312	1436	S	0.0	0.2	0:00.02	/lib/systemd/systemd-timesyncd
411	root	20	0	24456	3624	1288	S	0.0	0.4	0:02.32	/lib/systemd/systemd-udevd
732	root	20	0	5532	372	296	S	0.0	0.0	0:00.00	/sbin/agetty -o -p -- \u --keep-ba
738	root	20	0	5908	488	412	S	0.0	0.1	0:00.02	/sbin/agetty -o -p -- \u --noclear
1	root	20	0	163M	5004	1132	S	0.0	0.5	0:06.30	/sbin/limit fixrtc splash
485	root	RT	0	282M	25664	7388	S	0.0	2.8	0:03.45	/sbin/multipathd -d -s

F1 Help F2 Setup F3 Search F4 Filter F5 Free F6 Sort By F7 Nice F8 Nice F9 Kill F10 Quit





# Hand Exercises also Possible

- Improves Strength and Flexibility
- Enhances Circulation
- Reduces Pain and Stiffness
- Builds Confidence
- Promotes Neuroplasticity

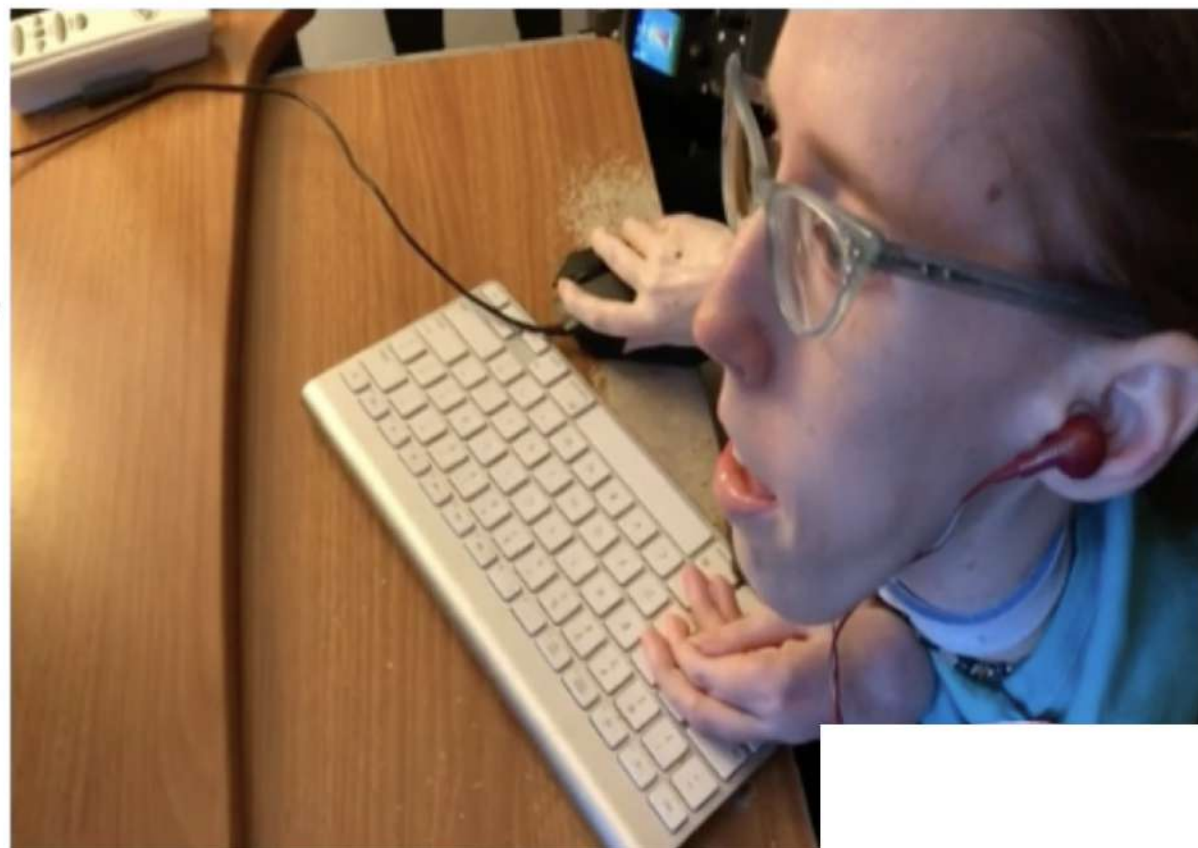
<https://www.youtube.com/shorts/Zw6Qyr9lx10>





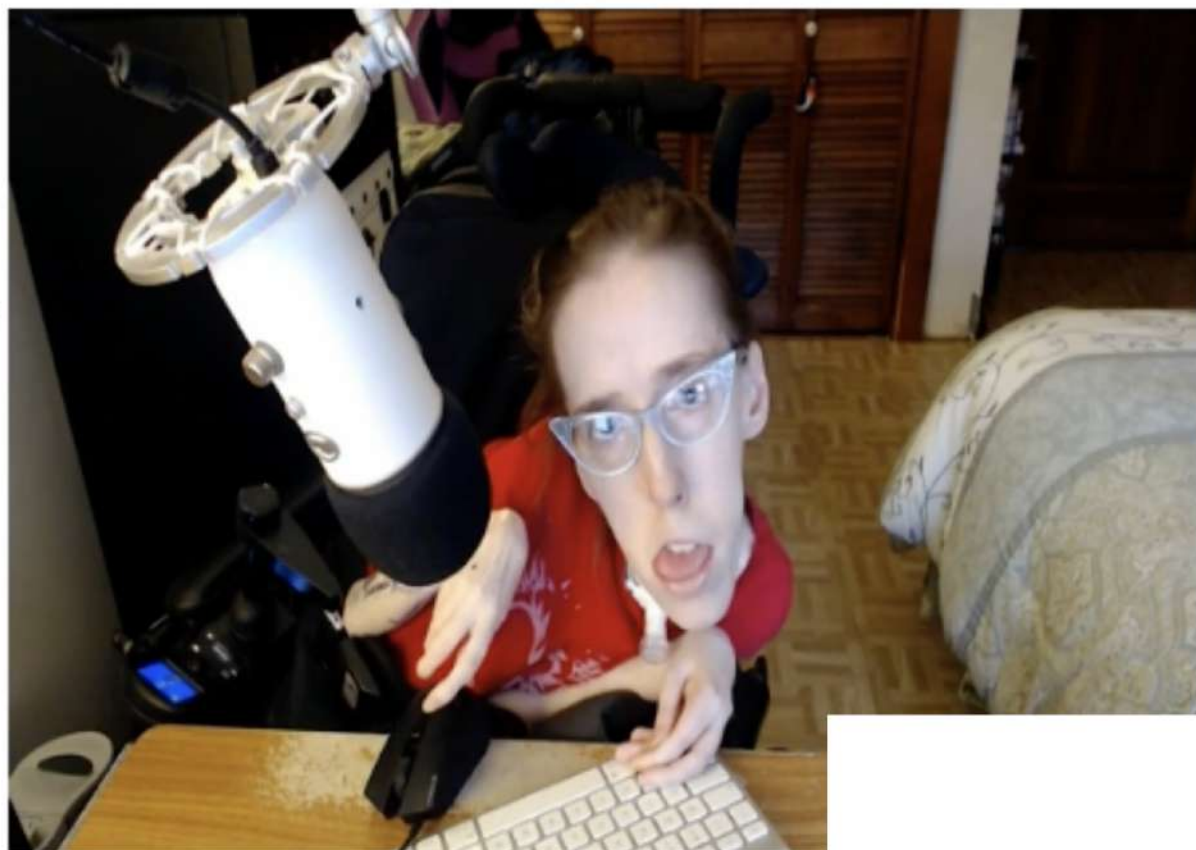
# Gaming Control with the Glove

- Improves Engagement
- Improves Strength and Flexibility



# Gaming Control with the Glove

- Improves Engagement
- Improves Strength and Flexibility



<https://www.youtube.com/watch?v=OzpmMo02JR4>

# Pros & Cons of the exo-skeleton gloves

## Pros

- Can provide a good grip
- Low cost
- Waterproof
- Customize based on patient needs – battery, motor
- Portable
- No problem of wearing long time

## Cons

- Sometimes can provide additional force on unknown object
- Every time need to change the algorithm for new objects and extract to c++
- Less training data

# Reference

Exo-Glove Poly II: A polymer-based soft wearable robot for the hand with a tendon-driven actuation system," *Soft Robotics*, vol. 3, no. 2, pp. 59–68, 2016, doi: 10.1089/soro.2016.0011.

Review of electromyography onset detection methods for real-time control of robotic exoskeletons. *Journal of NeuroEngineering and Rehabilitation*, 20(1), 141

EMG-Driven Machine Learning Control of a Soft Glove for Grasping Assistance and Rehabilitation. *IEEE Robotics and Automation Letters*, 7(2), 1566–1573.

Sotiropoulos, G., & Al-Zawawi, S. (2023). Performance of Parallelism in Python and C++. *International Journal of Computer Science*, 50(2), 310-320. <https://www.iaeng.org>

Soft hand exoskeletons for rehabilitation: Approaches to design, manufacturing methods, and future prospects," *Robotics*, vol. 13, no. 3, p. 50, 2024. DOI: 10.3390/robotics13030050.




# Thank you!!

Special thanks to professor **Maura Casadio** & Co-supervisor : **Danilo Canepa**

## Team Members


**Mohammad Ali Pouryaghoub**

 s6063201@studenti.unige.it


 M.Sc Robotic Engineering – University of Genova


**Mohsen Kashefi**

 s5964796@studenti.unige.it

 M.Sc Robotic Engineering – University of Genova

**Seyed Alireza Mortazavi**

 s6136275@studenti.unige.it

 M.Sc Robotic Engineering – University of Genova

**Alvin Isac**

 Alvin-Isac.Prem-Sunder@eleves.ec-nantes.fr

 M.Sc Robotic Engineering – University of Genova & Ecole Centrale de Nantes