Università di Genova

A Helping Hand: Exoskeleton Gloves for Rehabilitation and Paralysis Recovery

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Co-supervisor : **Danilo Canepa**

The need of Exoskeletons

Psychological Impact

Financial Problems

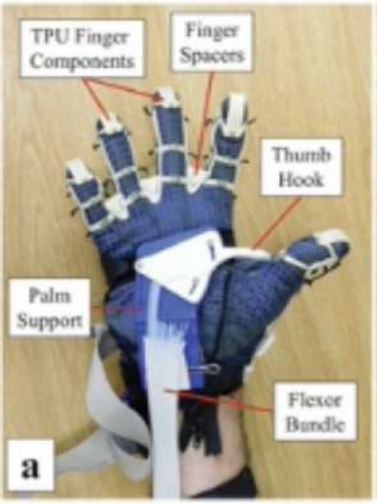
Loss of Independence

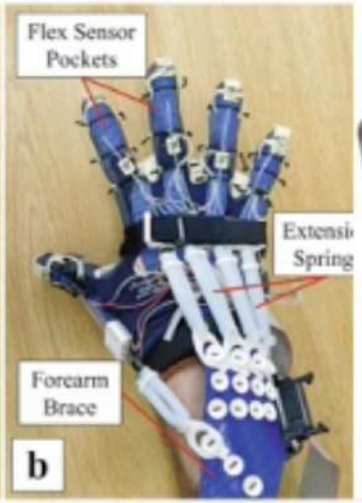
Limited access to public spaces

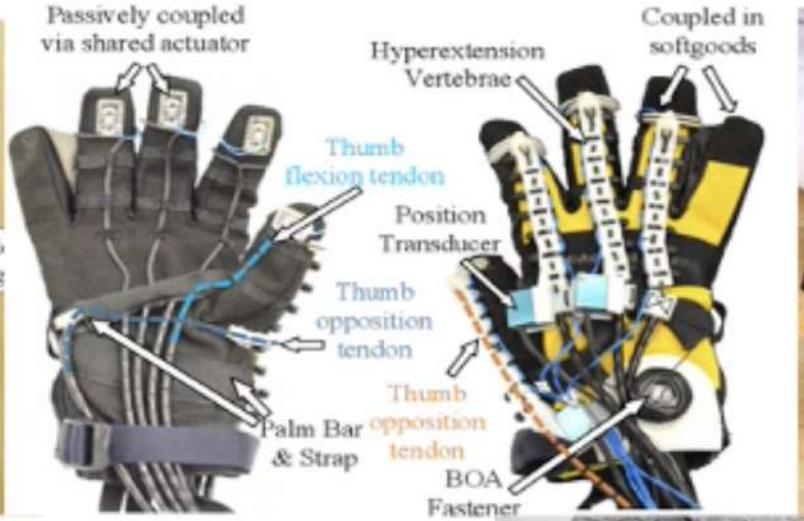
Disuse Osteoporosis

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

existing exoskeletion-gloves







What Makes Our Glove Different

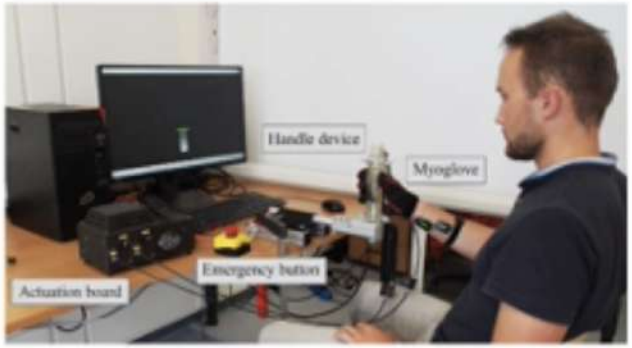
- Low cost
- Portability
- Customizable for Patient Needs
- No external control
- low maintenance
- Solid grip
- Waterproof and Washable
- AI – Control
- 2 in 1 Design
- Suitable for both Paralyzed and Rehabilitation Patients

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)

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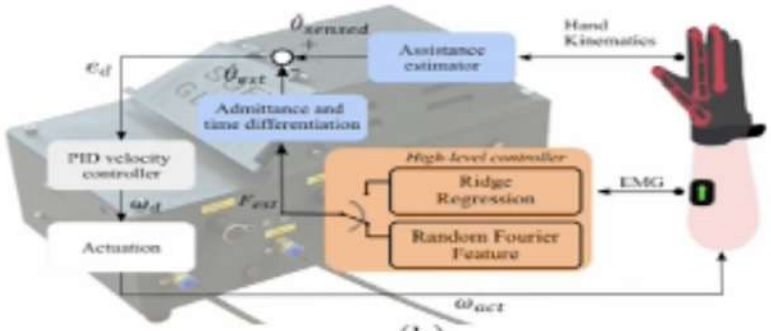


(b)

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

Working Principle

Start

↓

Send Motor Command (Velocity Command → Close Fingers)

↓

Monitor Motor Power Consumption

— No Change → Continue → Send Motor Command Again

— Change Detected (Resistance Found)

↓

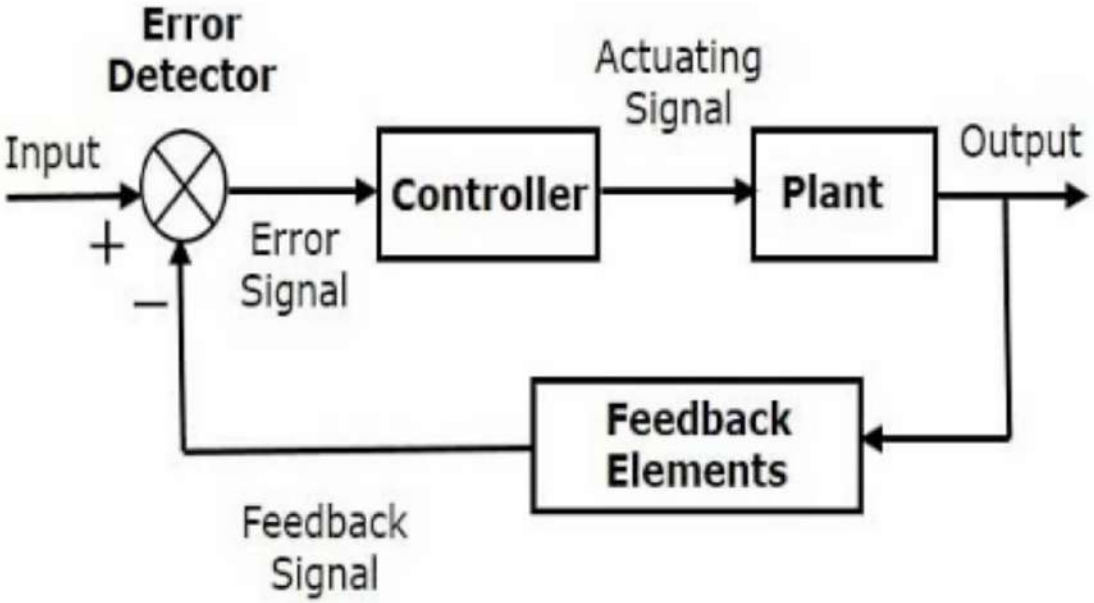
Check Force Level

— Low Force → Continue → Send Motor Command

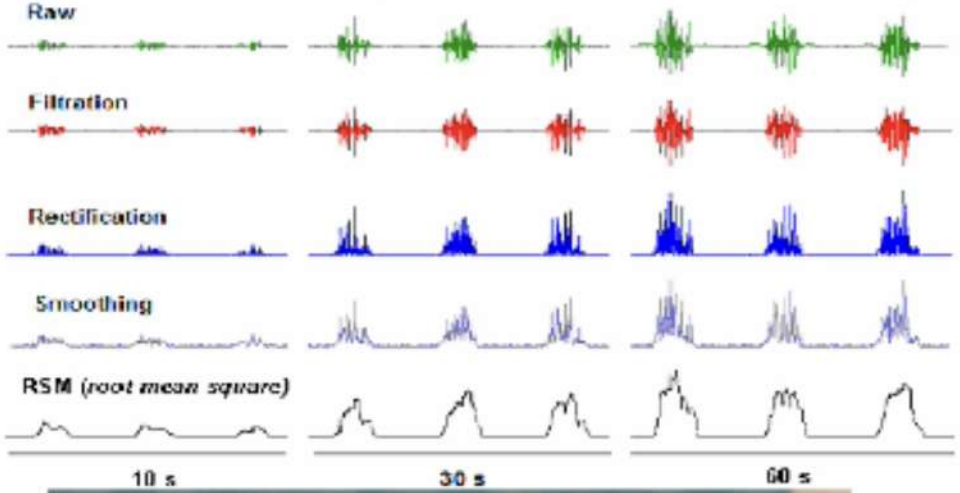
— High Force → Match Encoder Value

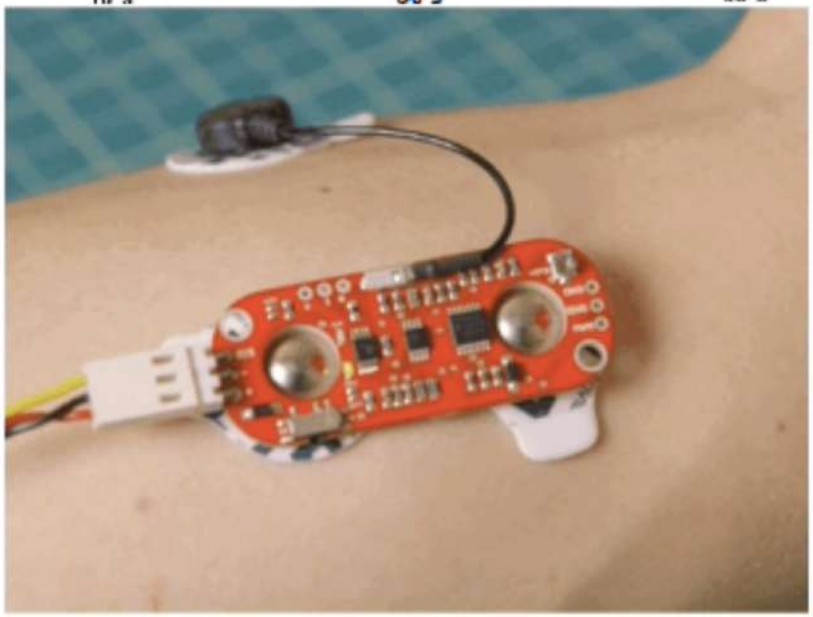
— Yes → Stop Motor → Engage Brake → End

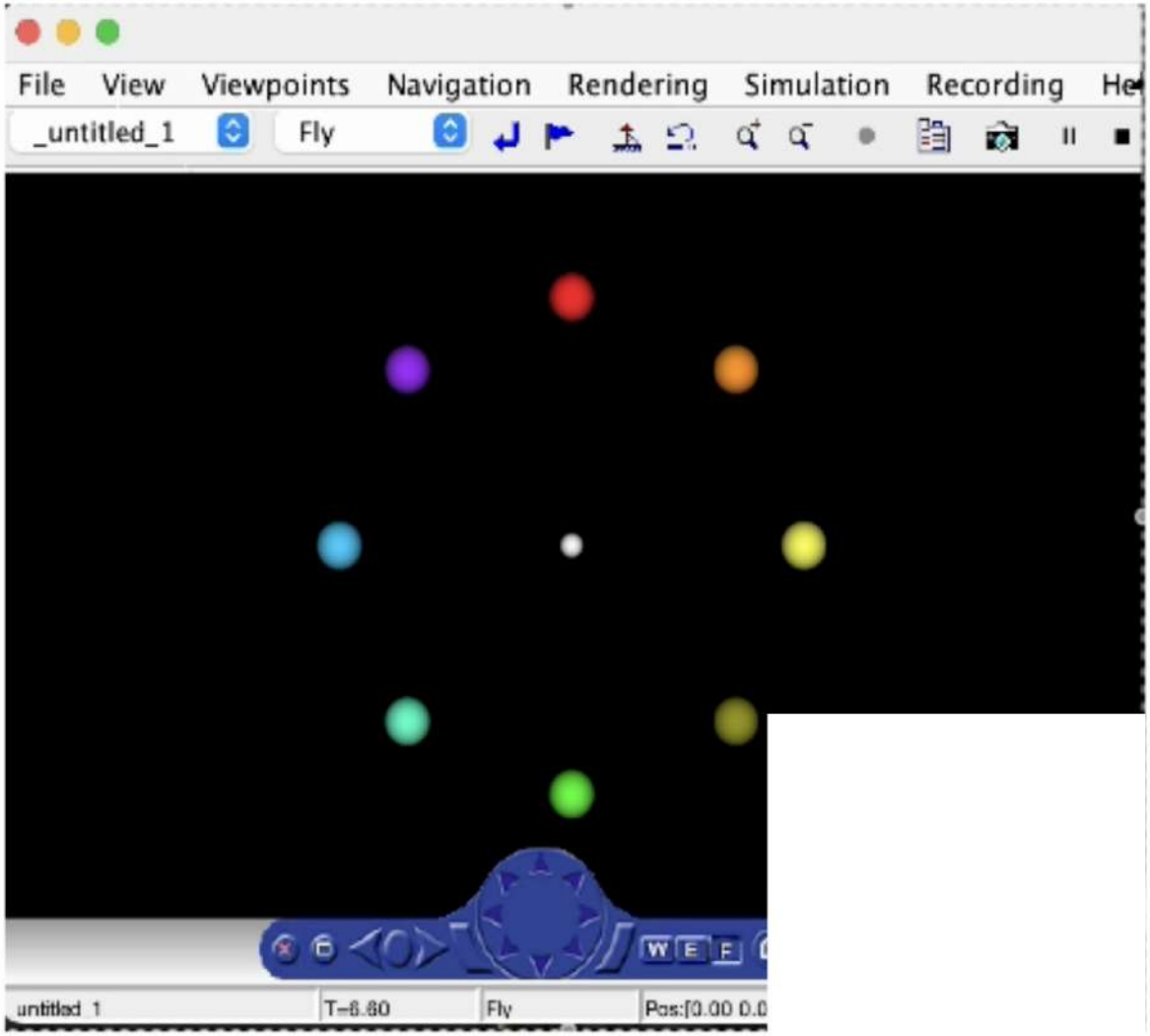
— No → Adjust → Monitor Again



How to activate & deactivate the actuator ?

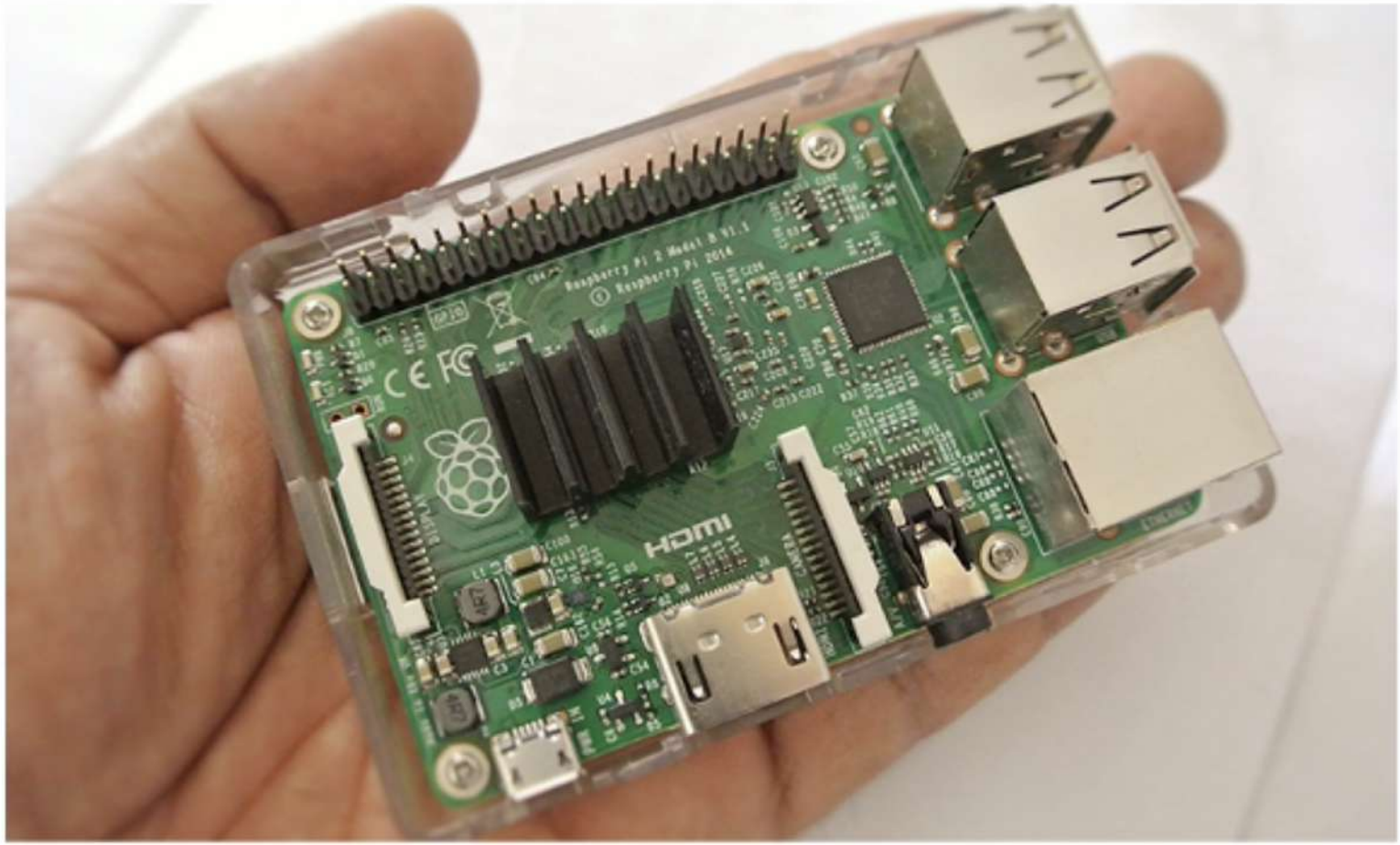






Review of electromyography onset detection methods for real-time control of robotic exoskeletons. *Journal of NeuroEngineering and Rehabilitation*, *20*(1), 141

Machine Learning on Raspberry Pi is really Possible ?



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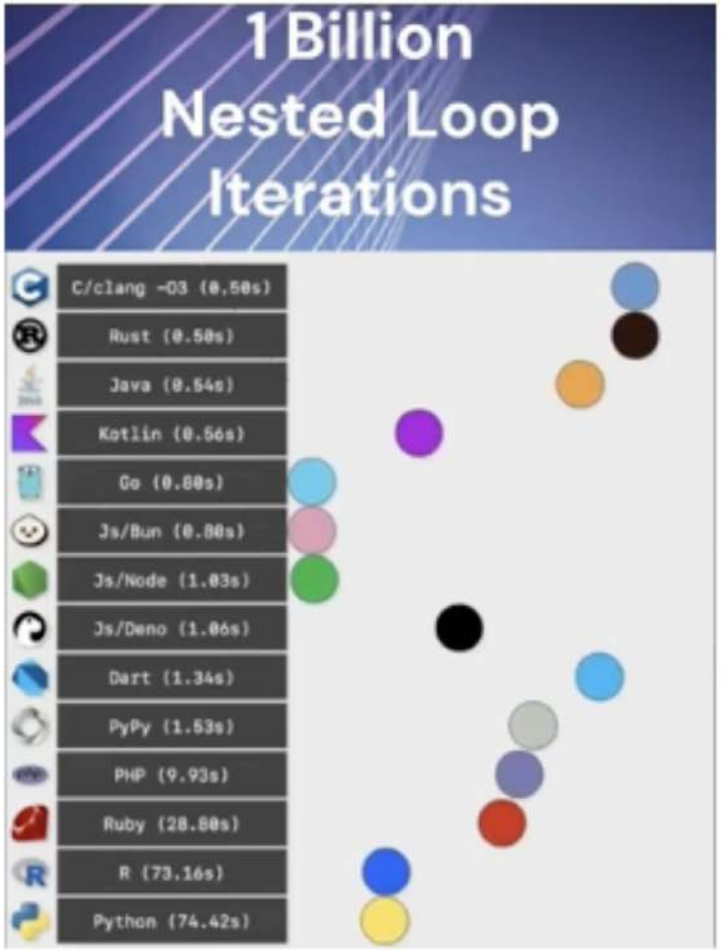


Python:

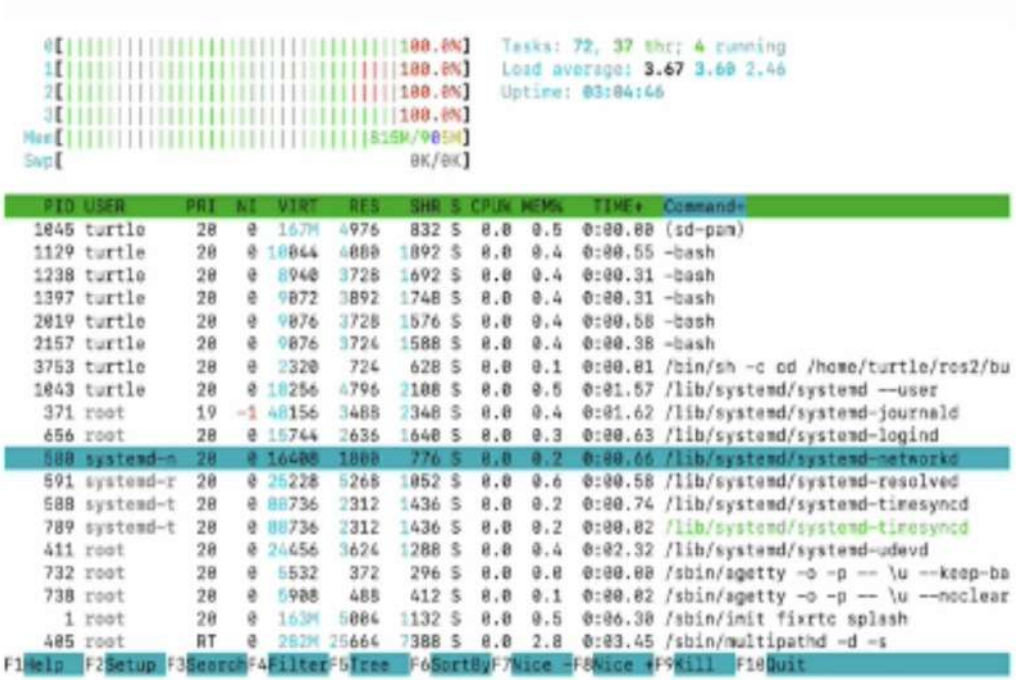
* Interpreted Language
* require more computational power

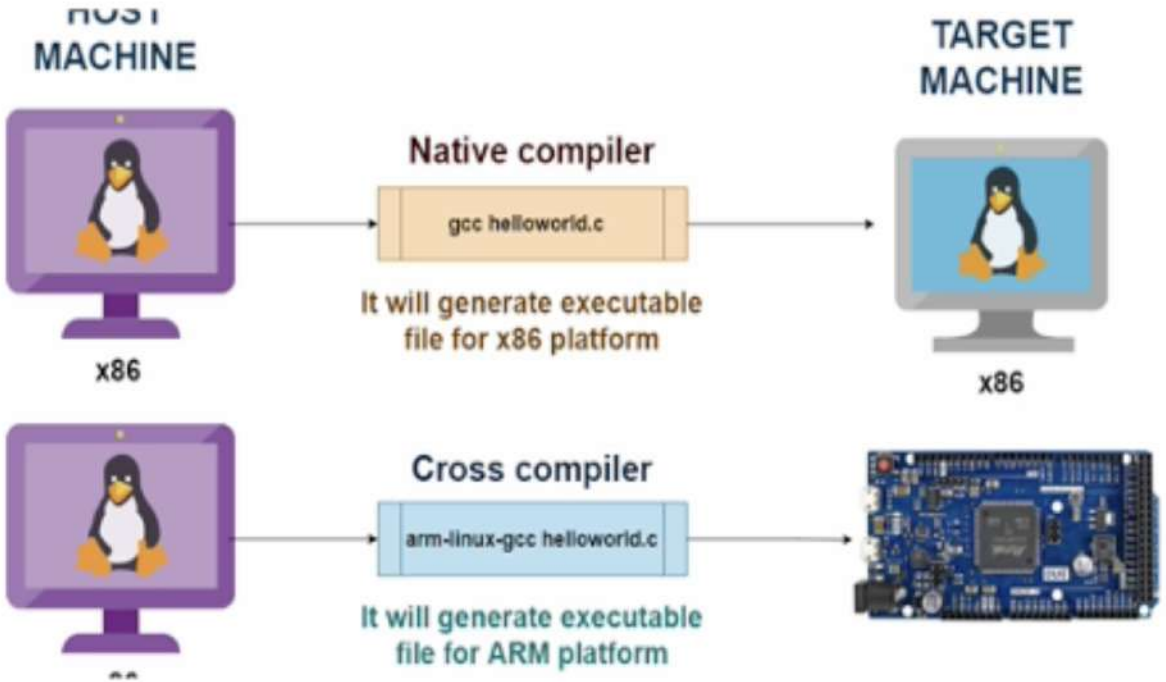
C++

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

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

Cross Compiling or Customizing OS Image Using Packer





https://www.packer.io

https://earthly.dev/blog/cross-compiling-raspberry-pi/?utm

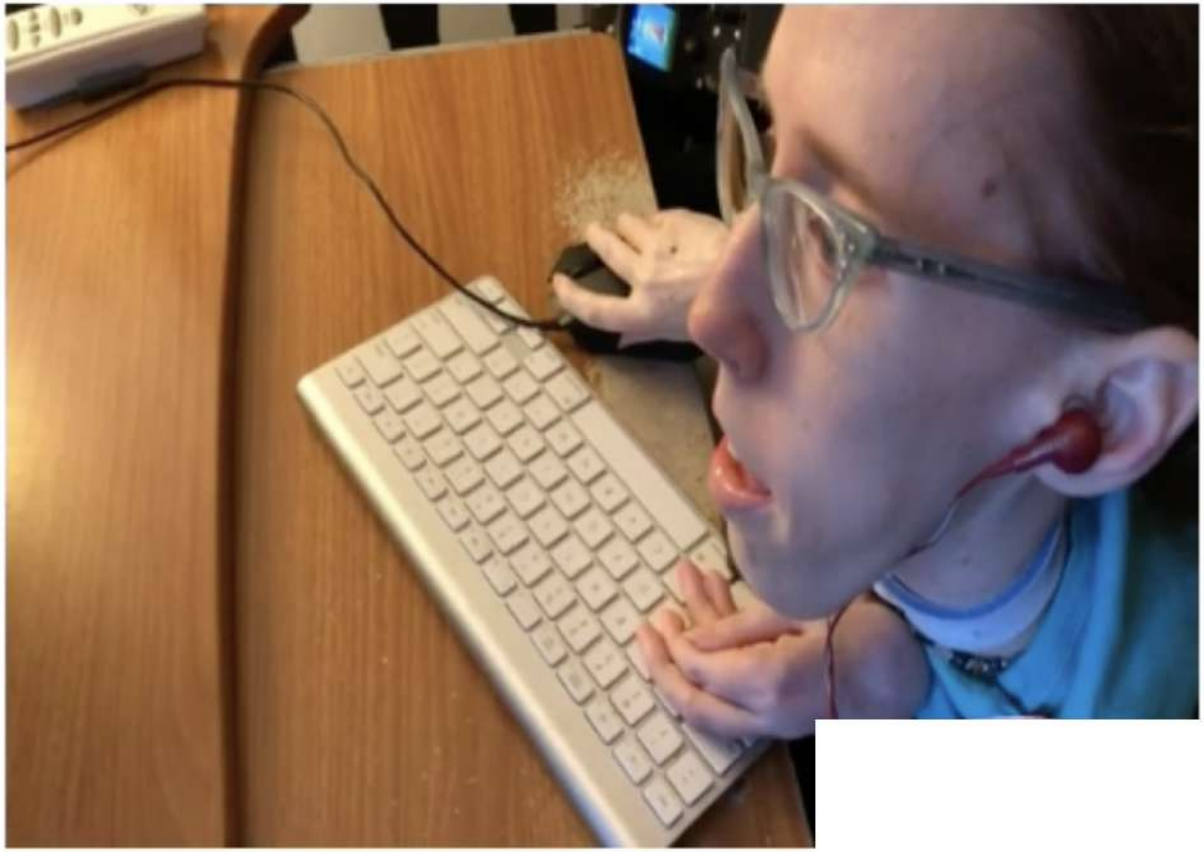
Hand Exercises also Possible

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

https://www.youtube.com/shorts/Zw6Qyr9lxl0

Gaming Control with the Glove

- Improves Engagement
- Improves Strength and Flexibility



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

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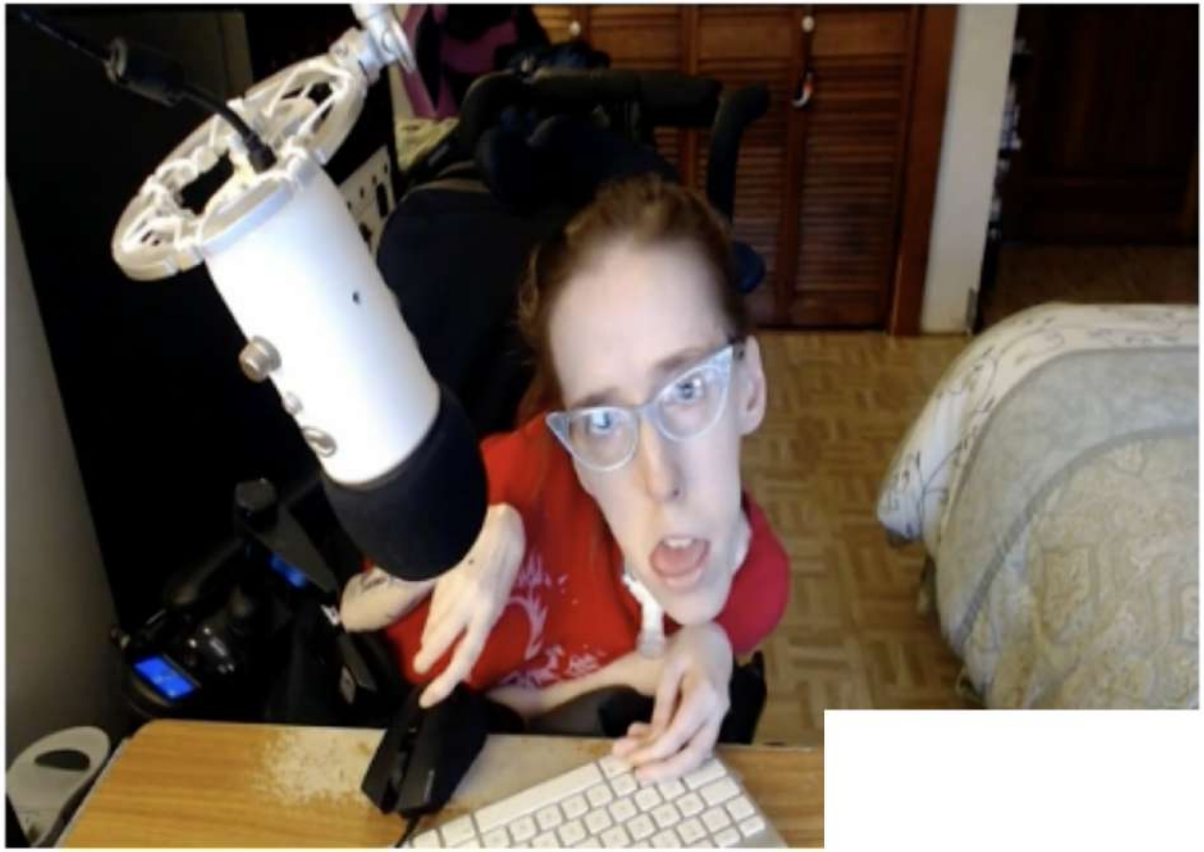

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Pros & Cons of the exo-skeletion gloves

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.

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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**

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