Galileo Hand: Mechanical Design of an Open-Source, Low Cost, under-actuated, Bionic Prosthetic Hand

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Introduction

This was originated to create the design of an open-source prosthesis, made with inexpensive materials and personal 3D printers. This project seeks to be distributed over the Internet as a "Do it Yourself" kit for anyone who has suffered amputation of the upper limbs. The prosthesis is designed to be easy to assemble and easy to repair.

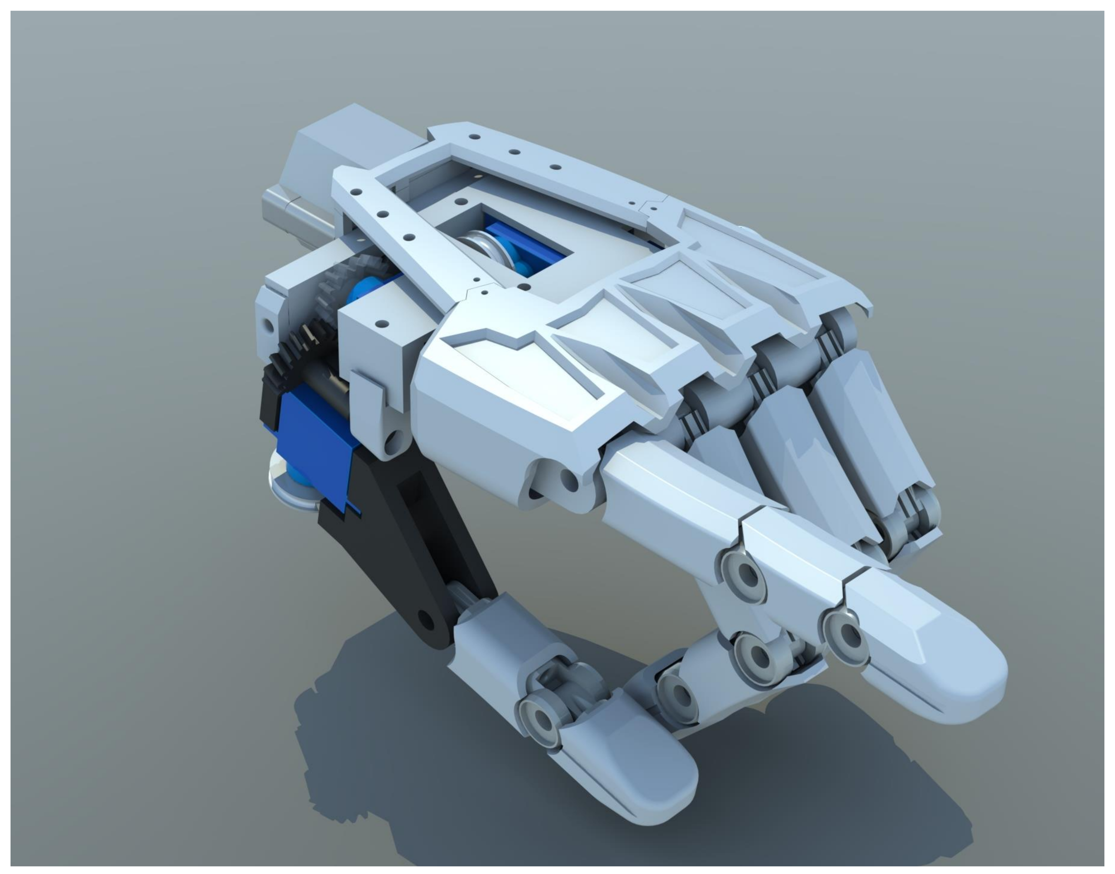

***Figure 1**. Isometric view of Galileo Hand.*

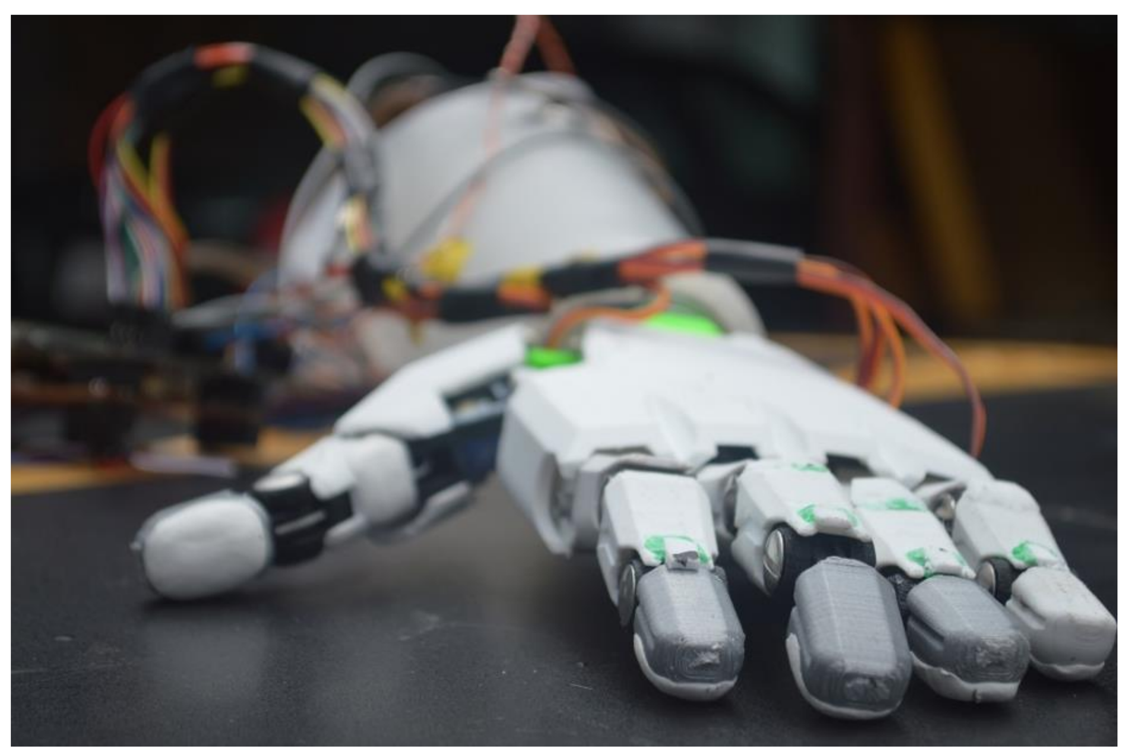

***Figure 2**. Galileo Hand project. 15 DOF hand prosthetic.*

Methods

I. Design of the Palm. The principal requirement was to be able to fit all the needed actuators inside de palm of prosthesis . We use miniature RC servomotors as actuators for their popularity.

1. Index finger.
2. Thumb rotation.
3. Middle finger.
4. Ring and pinky finger.
5. Thumb finger.

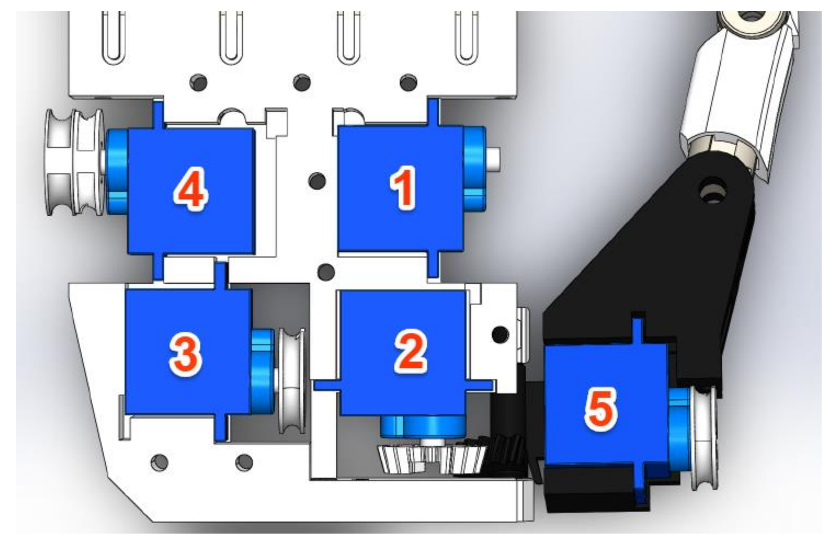

***Figure 3.** Top view of the palm without shells, enumerating each servomotor.*

II. Thumb rotation. Towards to mimic the human hand in shape and motion, the prosthesis has a rotating thumb. The mechanism is formed with a helical gear and a bevel spur gear. The thumb axis is rotated 15˚ to increase the grasping area, to grab cylindrical objects with a diameter up to 49.15mm.

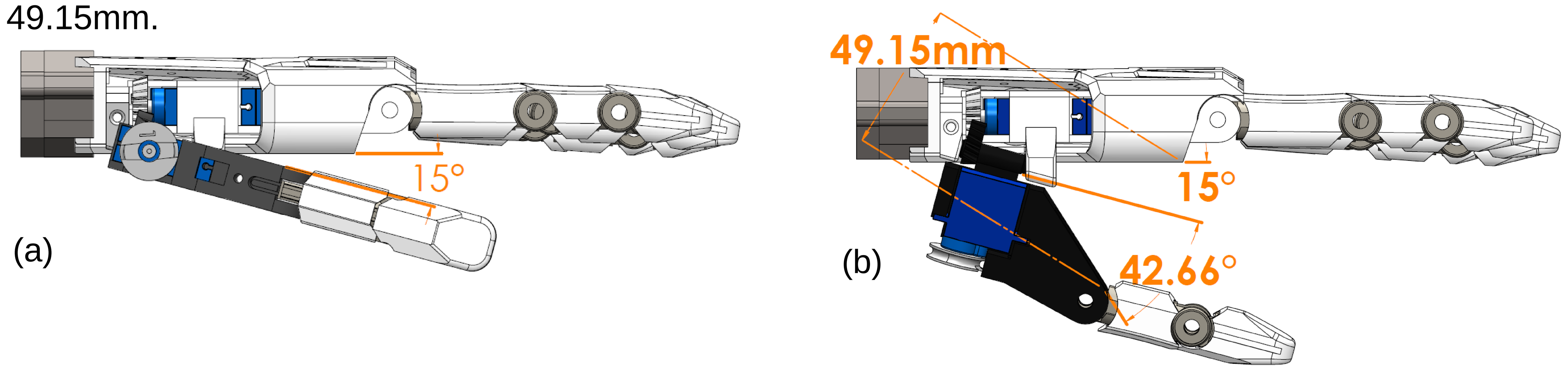

***Figure 4**. (a) Projected angle from de palm to the thumb finger, when the thumb is in open hand position.*
(b) Projected angle from palm to the thumb joint and the maximum opening, when the thumb is rotated 95˚.

III. Fingers design. The prosthesis has fingers with 3 phalanges each as a human hand but is driven by only one actuator (is under-actuated) nevertheless we can achieve an adaptive grasp [1],[2] and this characteristic reduces costs.

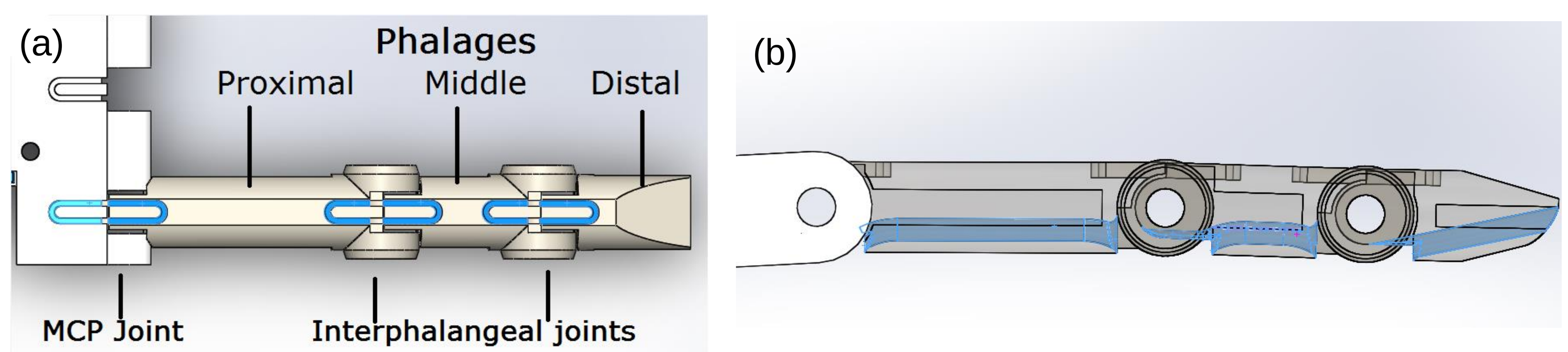

***Figure 5**. (a) Top view of index finger, supports for the rubber band highlighted in blue. (b) Lateral view of index finger, ducts for the tension cord highlighted in blue.*

Results

Grasps	Functions
Lateral grasp	Allows the patient to hold almost any kind of flat objects such as: sheets of paper, newspapers, cards, etc.
Hook	Enables the patient to be able to carry objects such as bags, toolboxes, lunchboxes and cylindrical objects.
Pinch	Enables fine grasping, used to grasp small objects..
Tripod grasp	Enables to grab small objects, such as pencils, markers, hand tools, and spherical objects.

Conclusion

The mechanisms described before were successfully incorporated. The prosthesis has a similar behavior to more expensive modern bionic prosthesis as described in [3] . In futures works we pretend to change the servomotors for DC motors with gearboxes and decoders in favor to have more control over the design, also provide greater torque to the phalanxes of the prosthesis and achieve more secure and more firmly grasp for heavy objects.

References

[1] W. Zhang, Q. Chen, Z. Sun and D. Zhao, "Passive adaptive grasp multi-fingered humanoid robot hand with high under-actuated function", IEEE Conference on Robotics & Automation, 2004
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[3] P. Slade, A. Akhtar, M. Nguyen, and T. Bretl. Tact: Design and performance of an open-source, affordable, myoelectric prosthetic hand. In Robotics and Automation (ICRA), 2015 IEEE International Conference on, pages 6451–6456. IEEE, 2015