

# Design and prototyping of a 5-DoF robotic extra-finger for human hand augmentation

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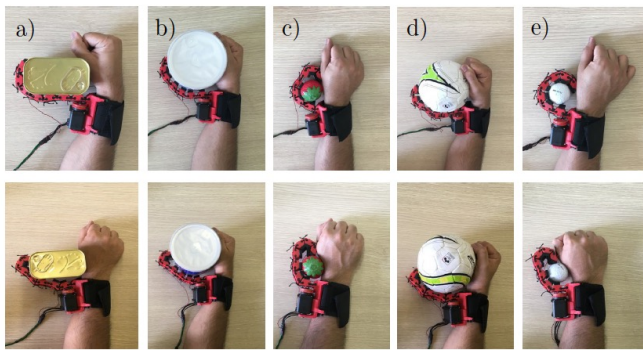
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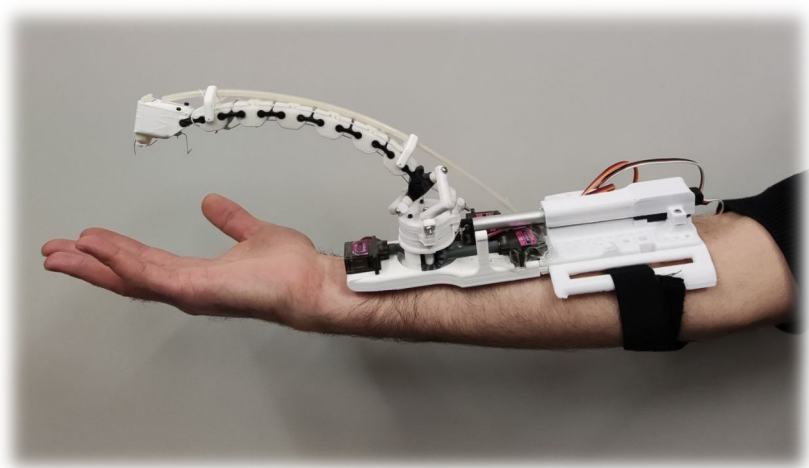
## Introduction

- Human hand augmentation by means of supernumerary robotic limbs (SRLs) represents a recent and active research topic.<sup>1</sup>
- Our research group has particularly involved in the development of supernumerary extra-fingers. Adding a single or double extra robotic finger can improve the grasping capabilities of the human hand and its dexterity even in complex actions.



- The robotic extra finger has a modular structure, each module is composed of a rigid part and a flexible joint.
- The device is tendon-driven and it is actuated by a single motor, providing the flexion movement.

**Main idea:** In this work we present an improved extra finger with three additional DoF at the base and one at the fingertip to: *i)* improve extra-finger capabilities in terms of dexterity and *ii)* exploit supernumerary extra fingers in assistive, rehabilitation and haptics applications.



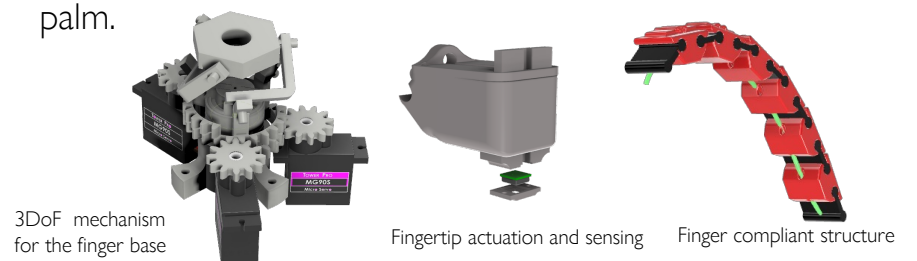
## Ongoing activities:

- Device mechanical optimization.
- Device control.
- Interaction with the human hand in grasping and manipulation tasks.

<sup>1</sup>Prattichizzo, D., Pozzi, M., Baldi, T. L., Malvezzi, M., Hussain, I., Rossi, S., & Salvietti, G. (2021). Human augmentation by wearable supernumerary robotic limbs: review and perspectives. *Progress in Biomedical Engineering*, 3(4), 042005.

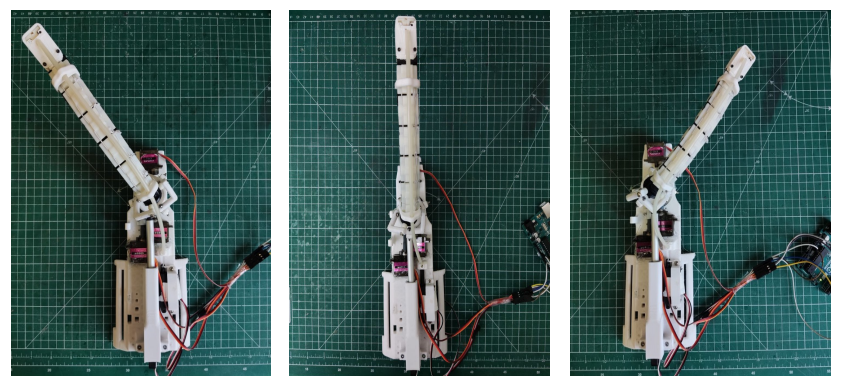
## Development:

- To exploit the extra finger in haptic applications, we increased its workspace by providing it with the adduction/abduction motion, by connecting the proximal module to a platform orientable by means of a gear system.
- A linear actuator is used to actuate the tendon.
- A micro-force sensor is installed in the distal module to control the interaction with the human hand and with grasped objects.
- The stiffness of the flexible elements connecting finger phalanges has been calculated so that when the actuator pulls the tendon, the extra-finger flexes by keeping the distal phalanx approximately perpendicular to the hand palm.



## First tests on the prototype

- Workspace**



- Force at the fingertip**

