Assistive Dorsal Grasper Modifications for In-Home Experiment

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Motivation and Introduction

- Spinal cord injury affects an estimated 40 million people worldwide every year [1]. Cervical-level spinal cord injury (SCI) results in tetraplegia, or paraplegia, and can dramatically reduce a person's ability to perform common activities of daily living (ADL), ultimately leading to loss of independence.
- People with SCI at the C6/C7 cervical levels generally lose voluntary flexion of the wrist and fingers, **however wrist extension typically remains.**
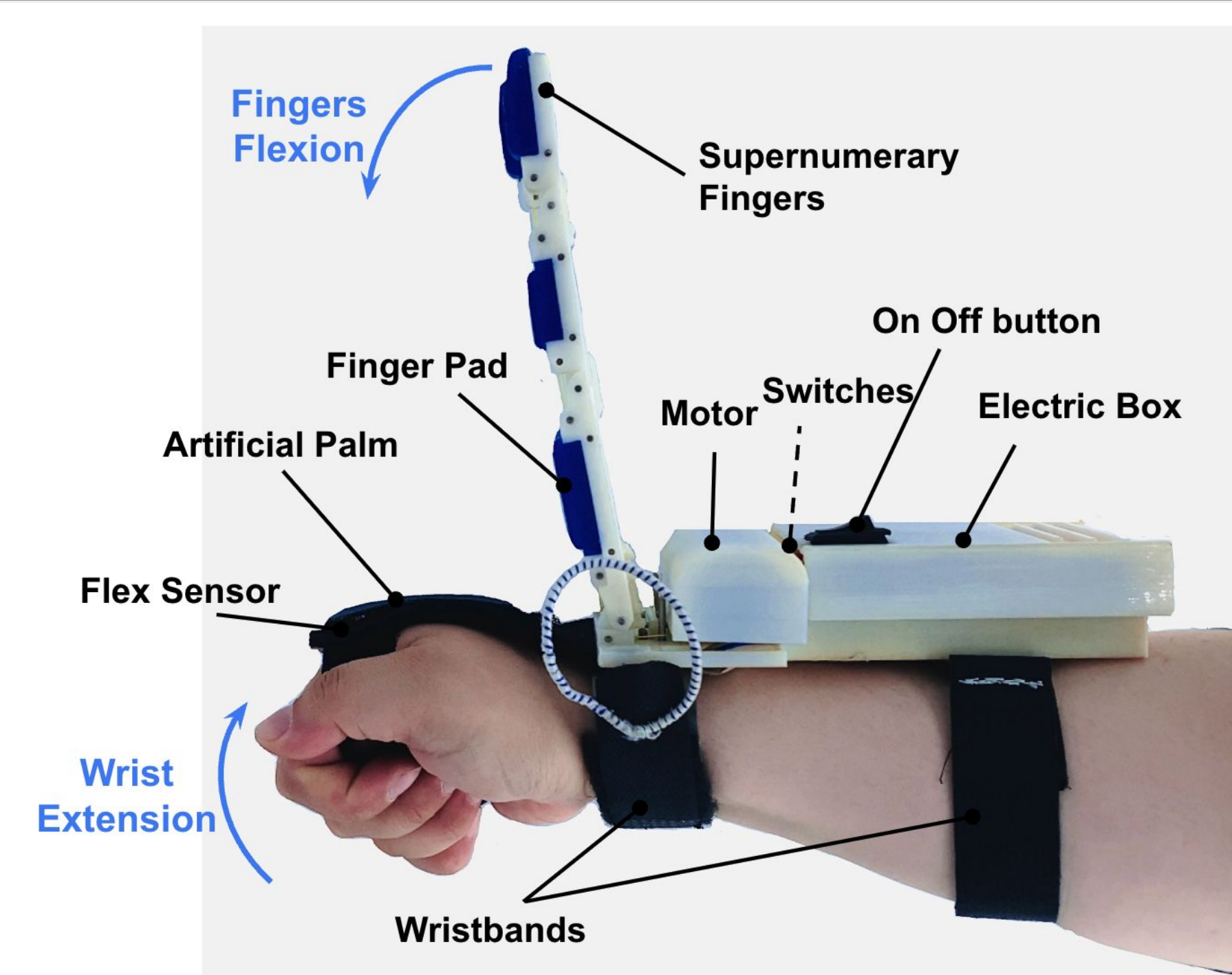

Wrist extended / Fingers closed [2]
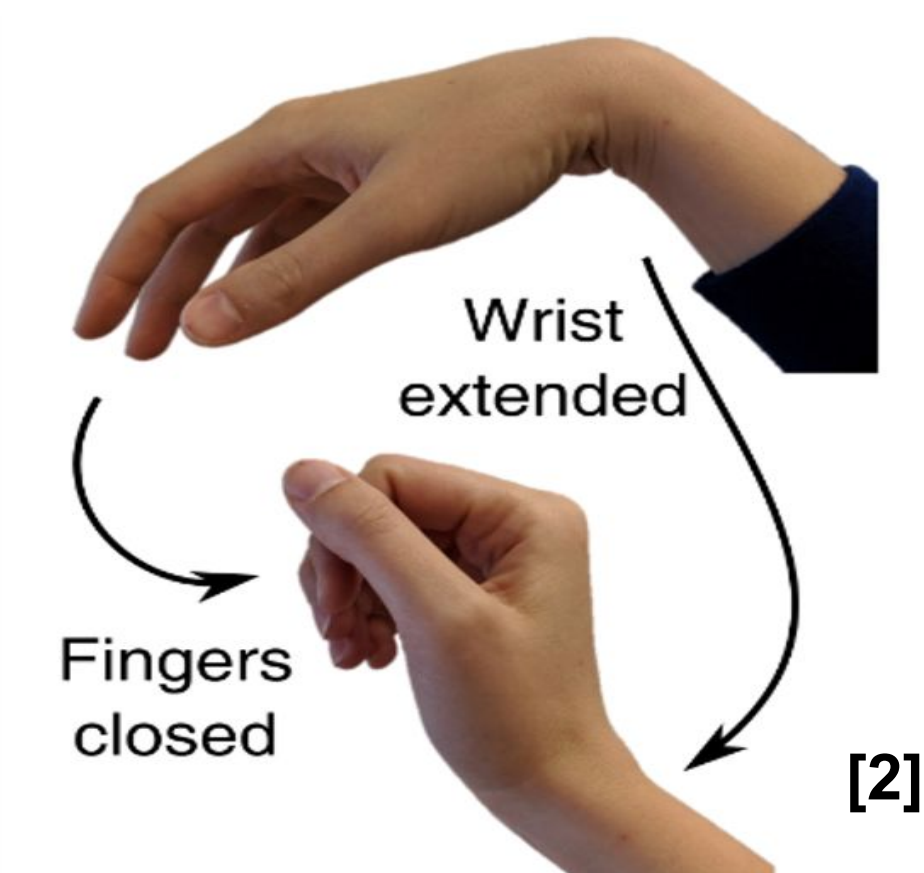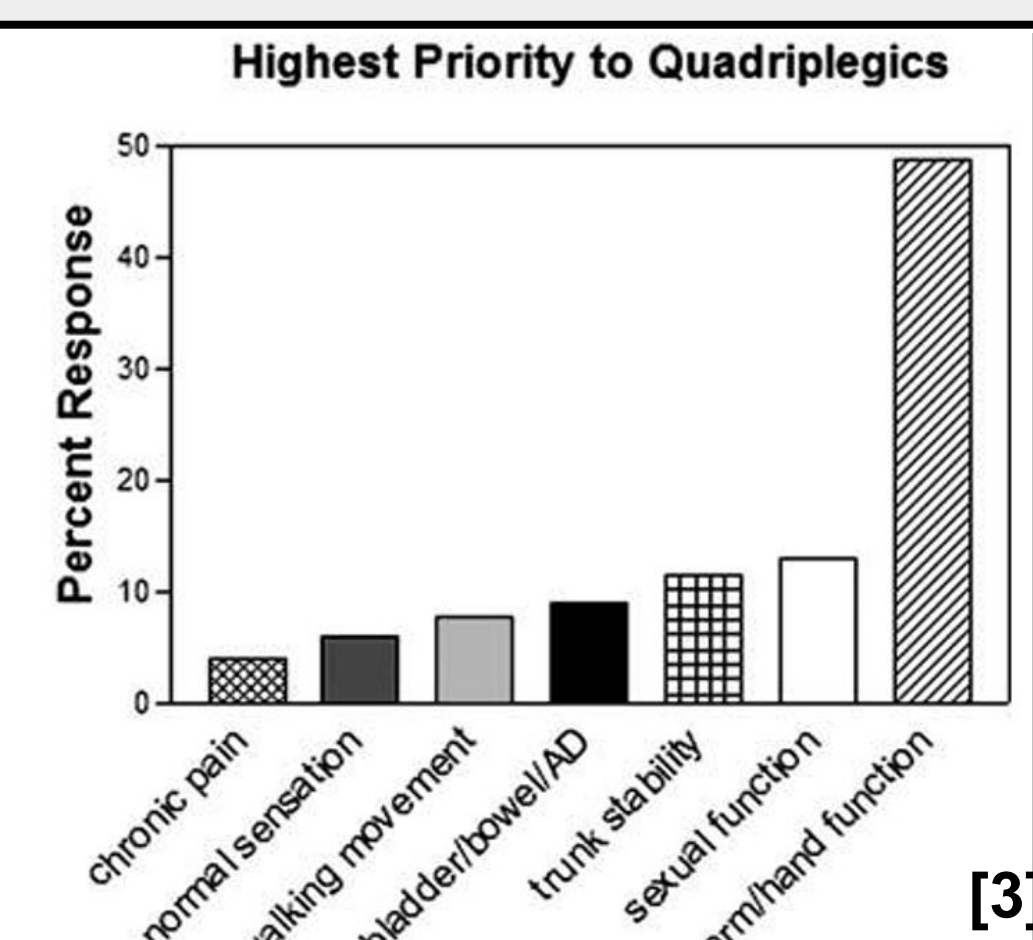
Highest Priority to Quadriplegics [3]

Dorsal Grasper 3.0

- The Dorsal Grasper, an assistive grasping device introduced in prior work, augments the user with supernumerary fingers and a palm to enable grasping with the back of the hand.
- We also program multiple user control methods to enable flexibility in unstructured tasks and to study what modes users prefer most.
- We introduce improved elements in a modified design to:
  - **Increase grasp force**
  - **Ease don and doff via new wristbands**
  - **Enable untethering with battery power**

Development Process

Hardware (Improved elements)

3D Design

Fingers, Sliding Cover, Sliding Battery Cover, Motor Cover, Base
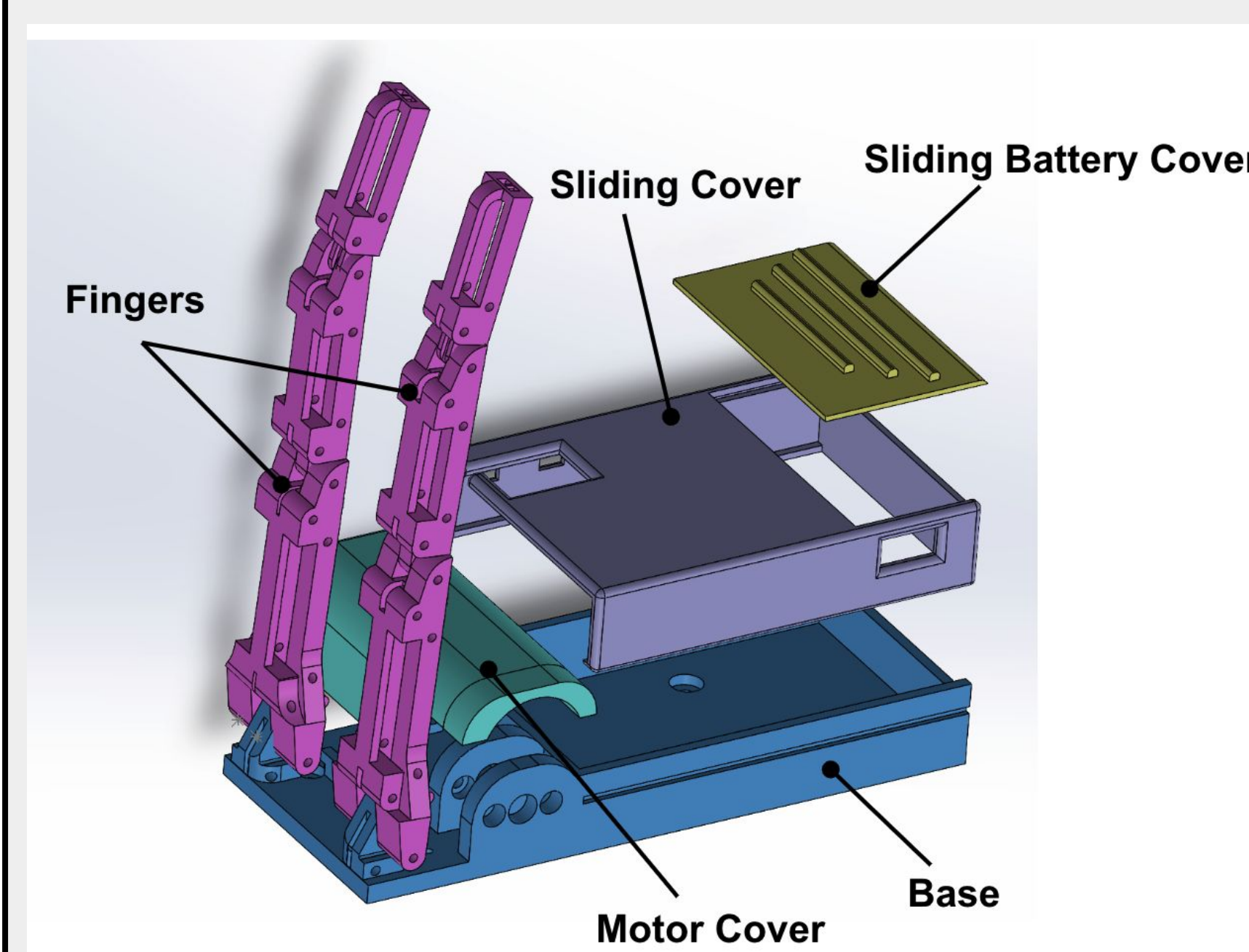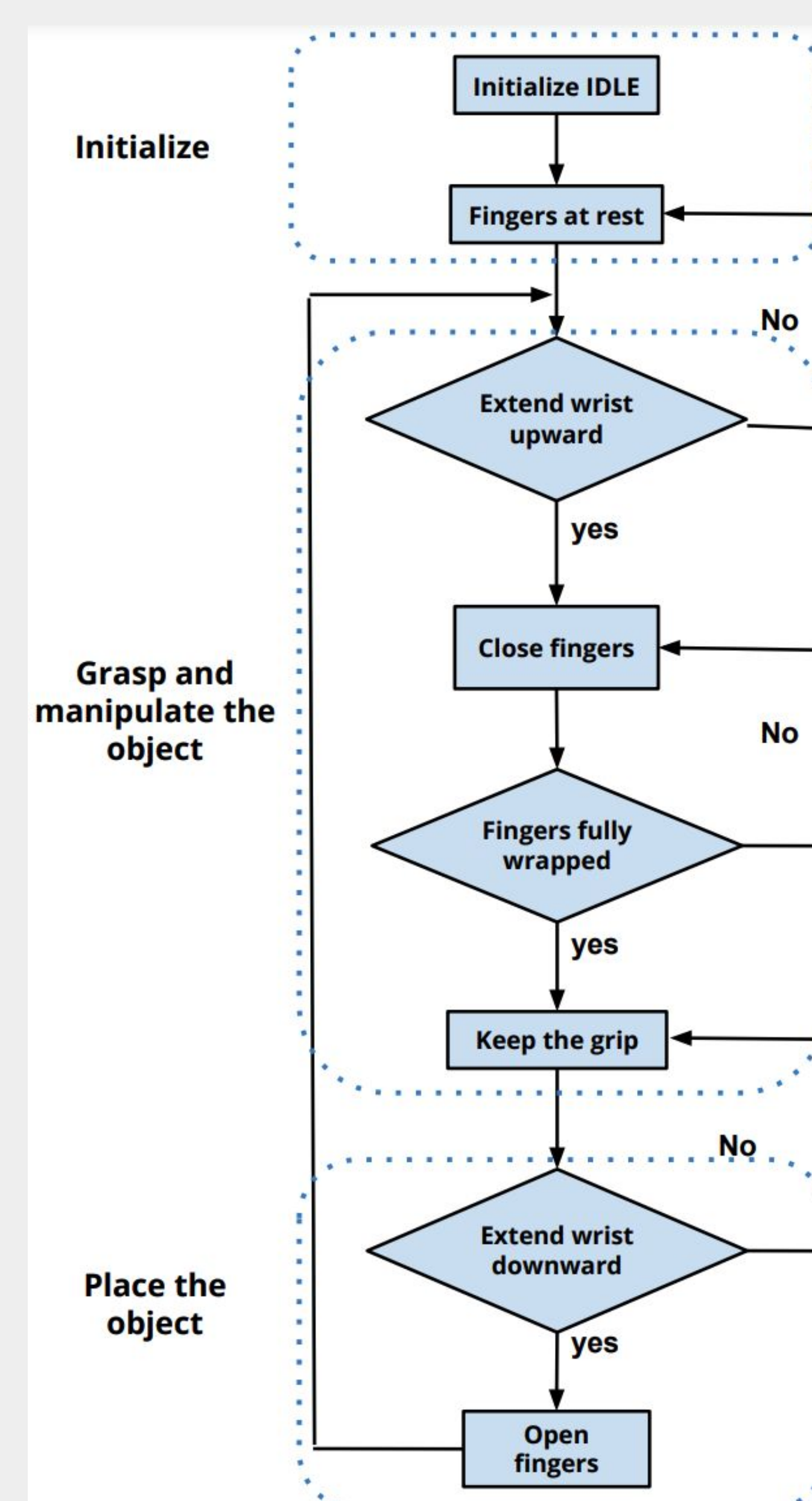
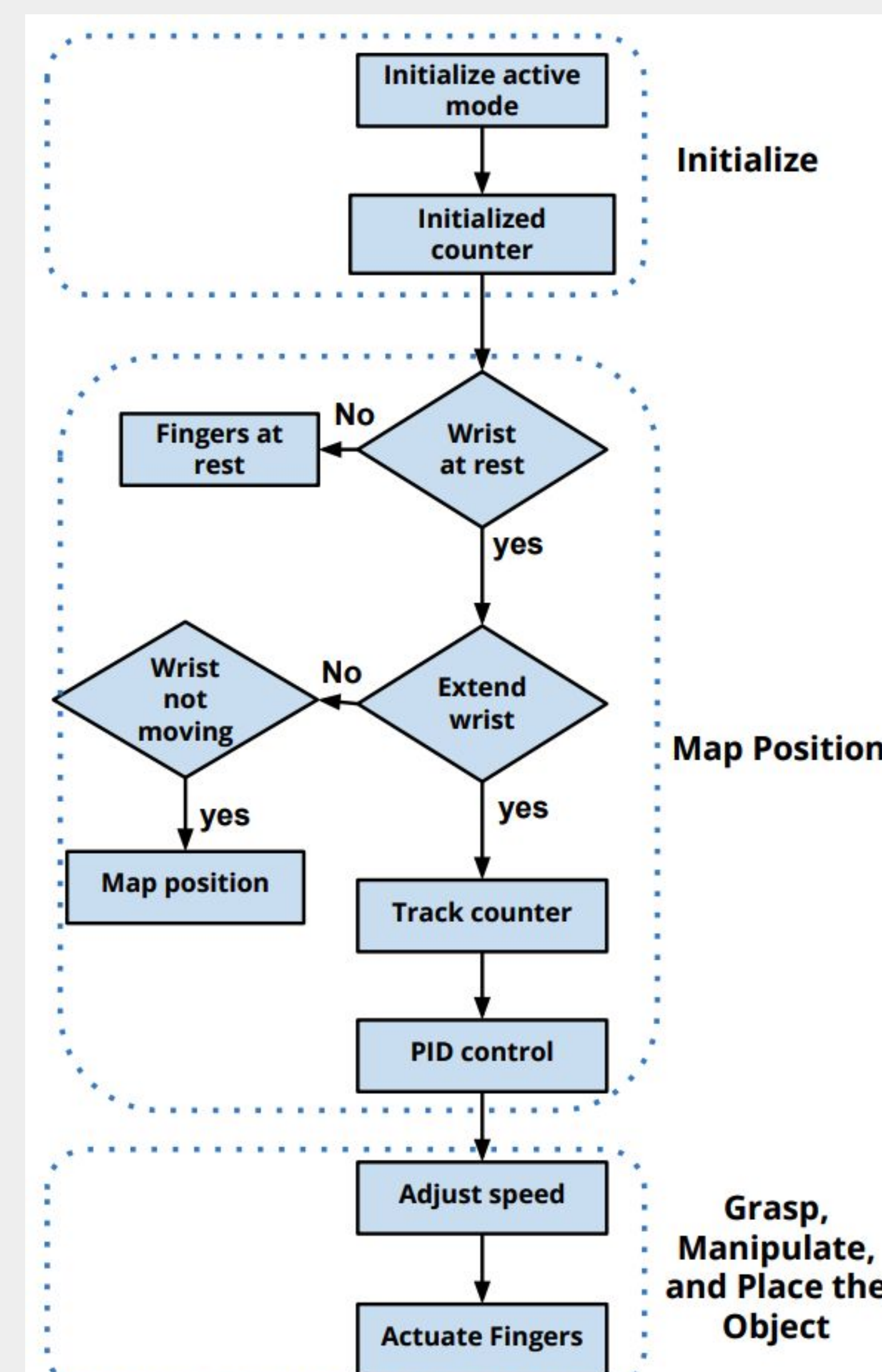#### Metal Wristbands

Software (User control modes)

Wrist Threshold Mode

Wrist Tracking Mode

In-Home Case Study

- An in-home case study of an author with C5-6, ASIA A, SCI was performed to evaluate the Dorsal grasper for readiness in home environment. For this study, 3 daily activities were performed using the device:
  - Picking and placing items from fridge
  - Making tea
  - Doing Laundry
- Results include improvement in user independency in controlling the device, grip force for several set of objects with various weights and surface types.

Conclusion and Future Work

- Results indicate that improvements to the design support user performance on a subset of objects that complement existing compensatory strategies.
- The user selected the wrist threshold mode to control the positioning of the fingers, preferring it to the tracking mode. However, future work should better personalize the threshold values, which affect user experience.
- The in-home case study indicated promising results on variety of objects and grasp force.

References

[1] . K. Yip and A. Malaspina, "Spinal cord trauma and the molecular point of no return." Molecular neurodegeneration, vol. 7, no. 1, p. 6,2012.
[2]. Dorsal Grasper 1.0, J. Lee, L. Yu, L. Derbier, and H. S. Stuart, "Assistive supernumerary grasping with the back of the hand," in 2021 IEEE International Conference on Robotics and Automation (ICRA). IEEE, 2021, pp. 6154-6160.
[3]. K. Anderson. J. Neurotra. 21, 1371-1383 (2004)

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