

Figure 1: New hand grasping force sensing instrumented object

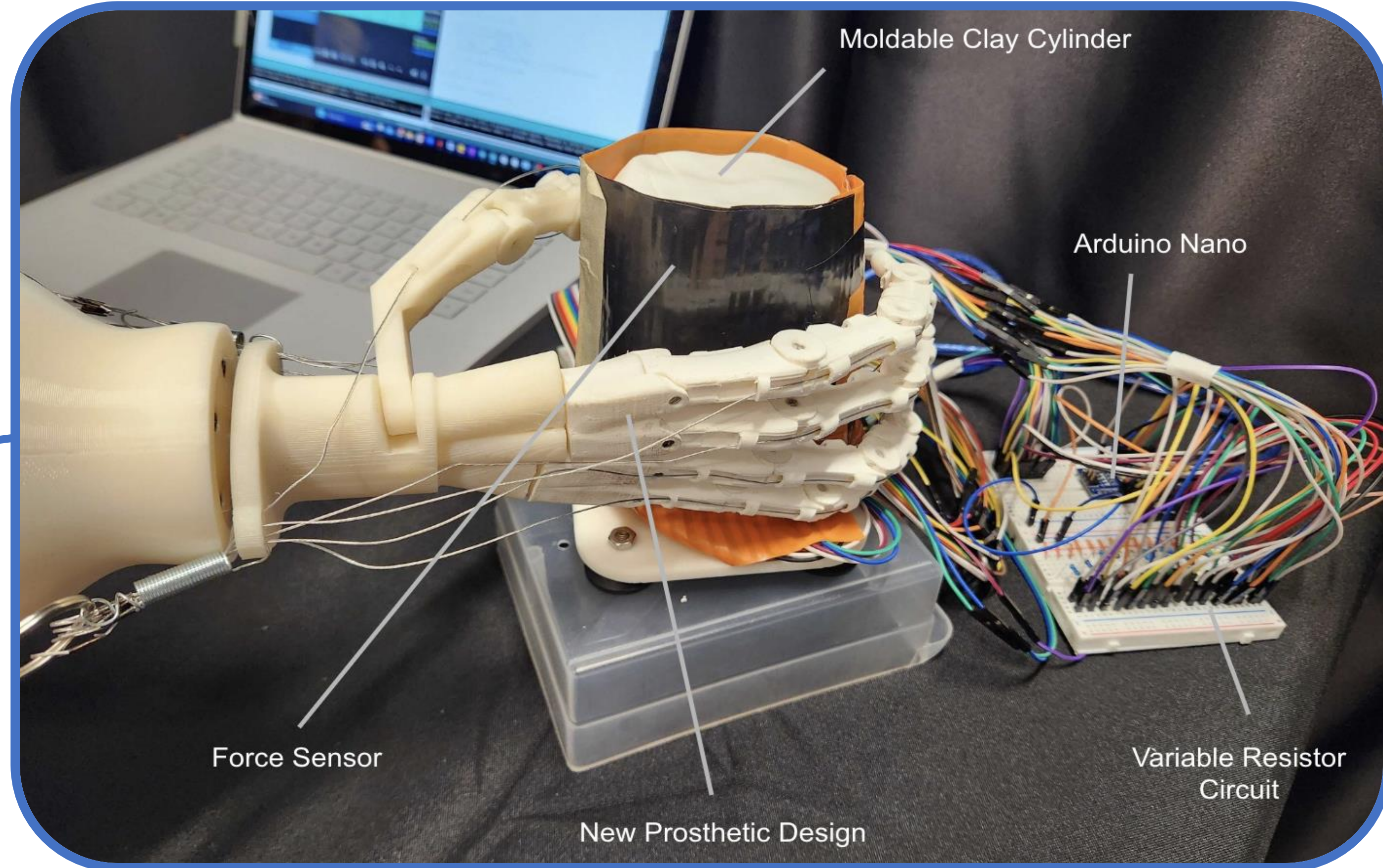
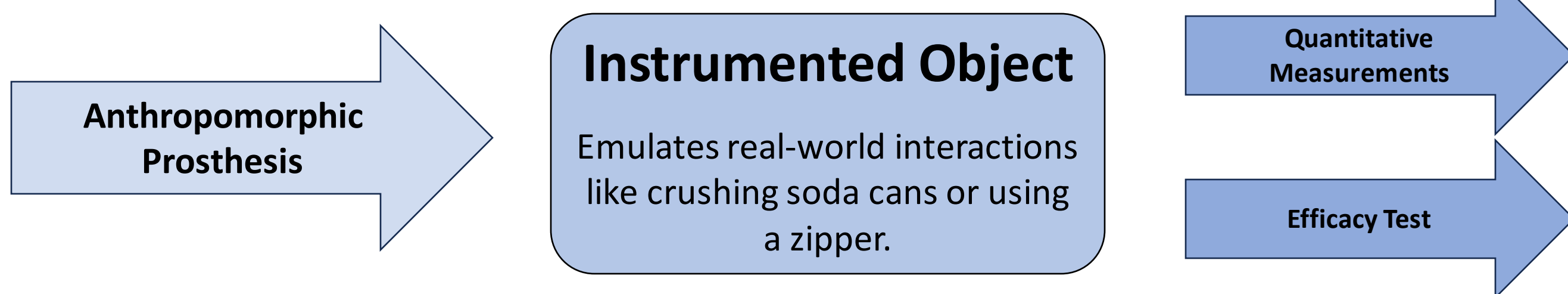


Figure 2: Experimental setup using new hand design, instrumented object, and force visualization program

Introduction

The Tendon-Driven Anthropomorphic Prosthesis (T-DAP) features tendon-based actuation to drive a human hand-inspired end effector.

The original T-DAP hand has limited mobility in the thumb, which affects the surface contact when grasping objects. This research aims to increase surface contact by improving the range of motion of the thumb and quantifying these improvements utilizing an instrumented object capable of sensing contact forces



Instrumented Object

Emulates real-world interactions like crushing soda cans or using a zipper.

New Thumb Design

The new hand's biomimetic design follows the path a natural thumb takes when grasping objects.

Increasing the thumb's range of motion increased surface contact.



Figure 3: Original hand design in extended and grasping positions

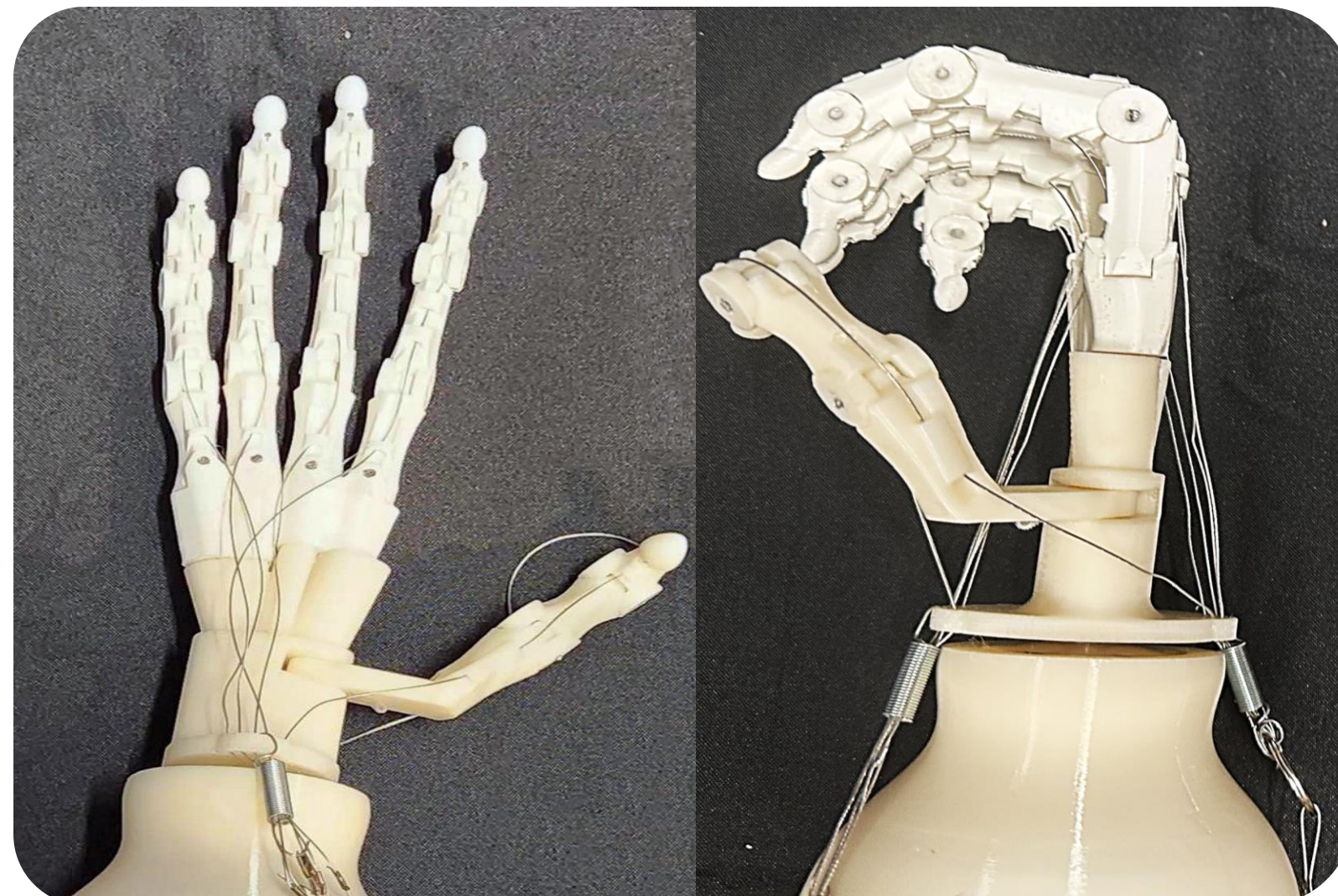
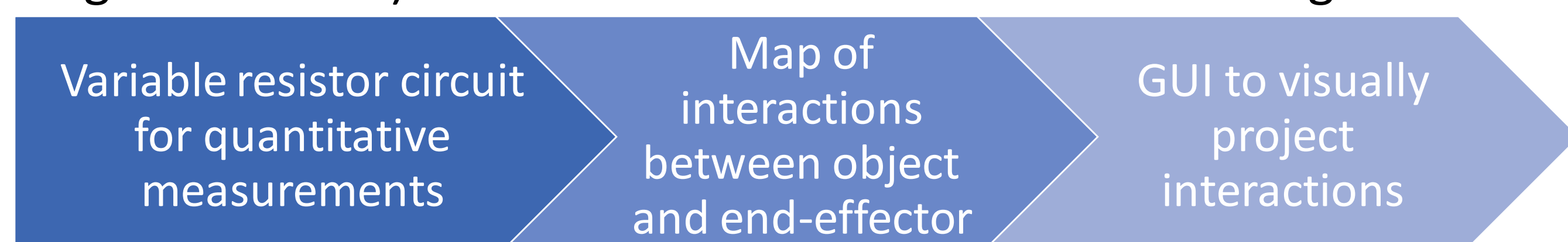


Figure 4: New hand design in extended and grasping positions

Issue with Original TDAP Hand Design	Solution on New Hand
Narrow Grasp	Increased projection of thumb
Low surface-level interactions with objects	Mimic natural hand movement
Poor mapping for haptic sensation	Use force sensors to directly map object interactions

Experimental Setup

To test the functionality of the new thumb design, an instrumented object with improved force sensing was created (see Figures 1 and 2). The force sensor includes the following:



Results

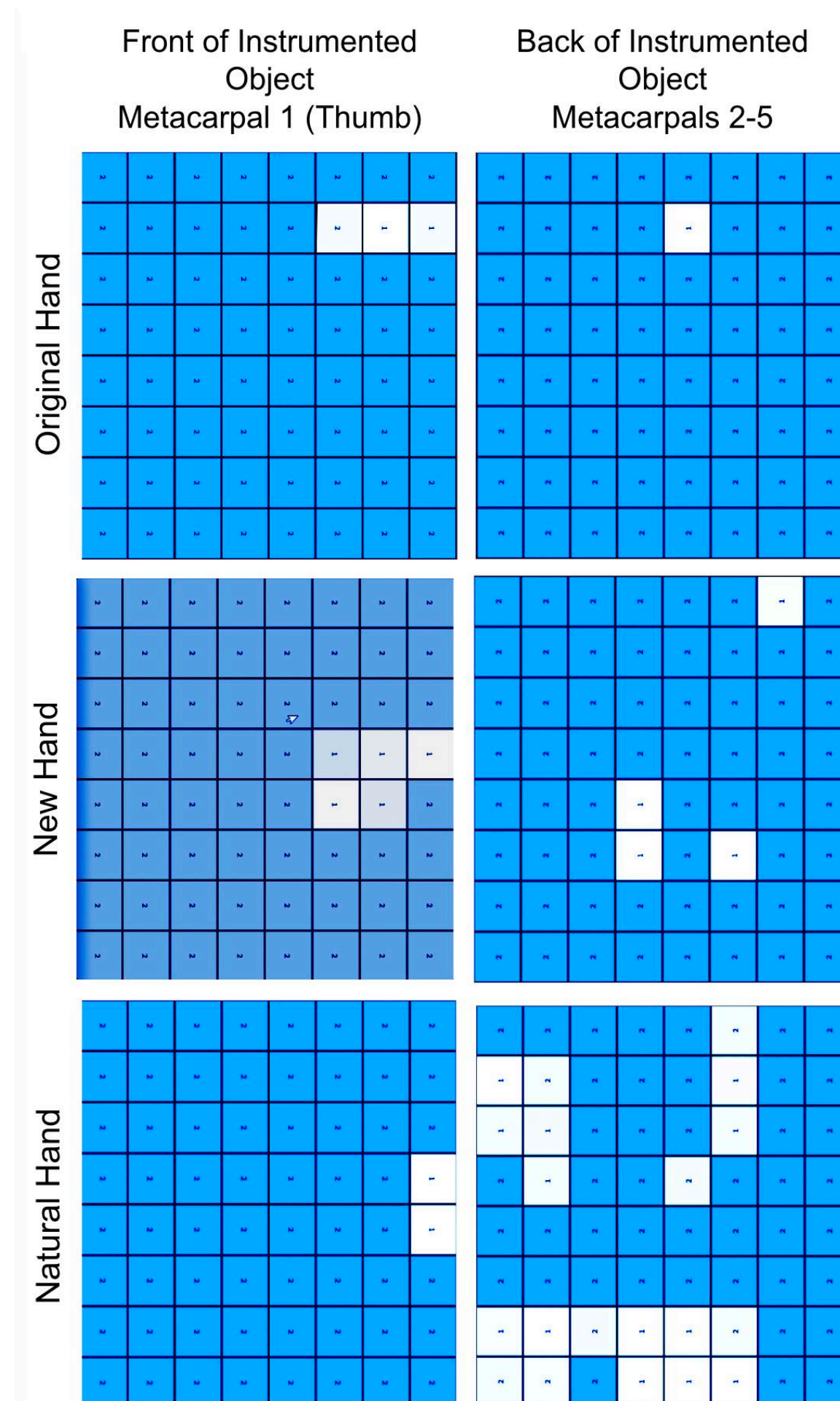


Figure 5: Visualization of force exerted by original, new, and natural hand on instrumented object

New hand increased surface contact with the object.

New hand relies on forces from thumb and metacarpals 2 and 5, natural hand relies on metacarpals 2-5.

Force exerted by the new hand was greater than original but less than natural hand.

Metacarpals 2 and 5 and the tip of the thumb have the highest surface interaction with the object.

Future Work

Continue hand redesign to better mimic natural hand:

- Change thumb actuation from outside to inside hand
- Reduce joint friction
- Include vertical thumb motion with horizontal rotation

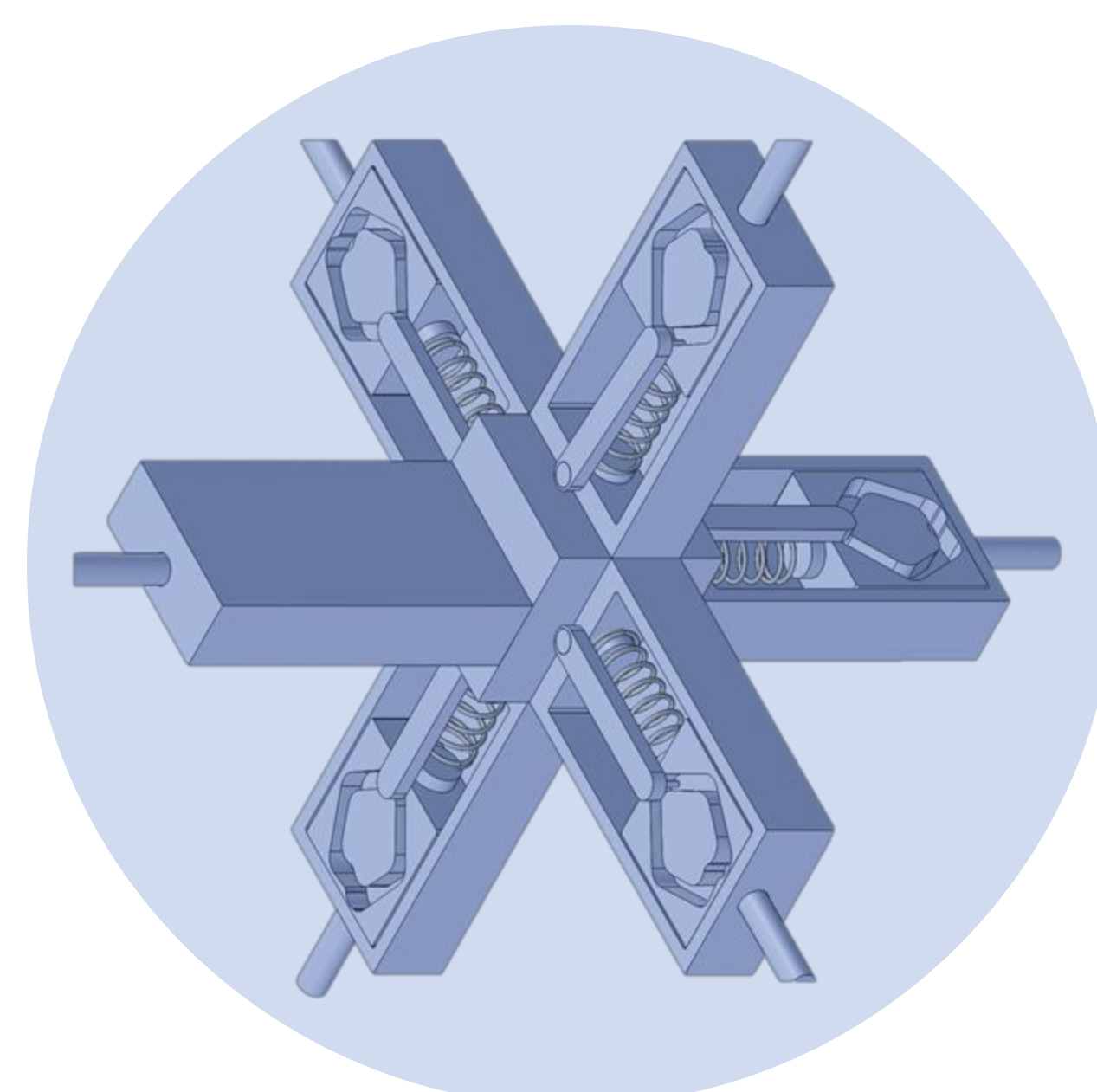


Figure 6: SolidWorks model of possible future instrumented object

Compare mechanical object to electrical solutions

Acknowledgments and References

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[1] E. Miller, A. Ihemriorochi, J. Brown, "A Wearable Anthropomorphically-Driven Prosthesis with a Built-In Haptic Feedback System," 125-131. 10.1109/ISMR48331.2020.9312933.