# A Platform for Remotely Assisted Versatile Manipulation In Orbit


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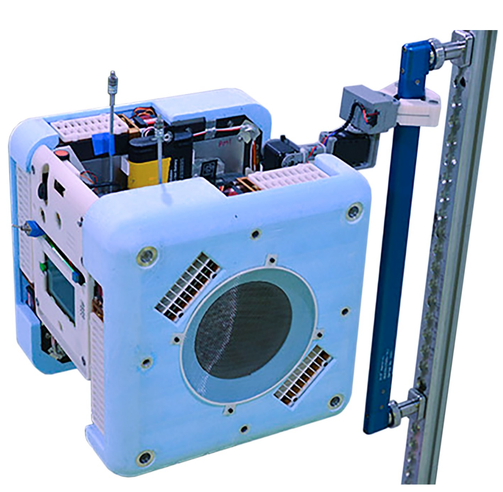
## Motivation and Overview



**NASA's Assistive Free-flying Robot - Astrobee**

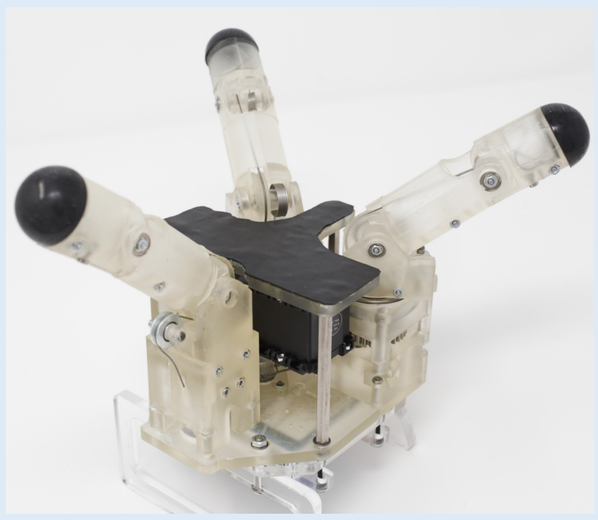
**Challenges in Enabling Versatile Manipulation:**

- Limited payload size and weight
- Surface-to-orbit communication is characterized by low bandwidth and high latency

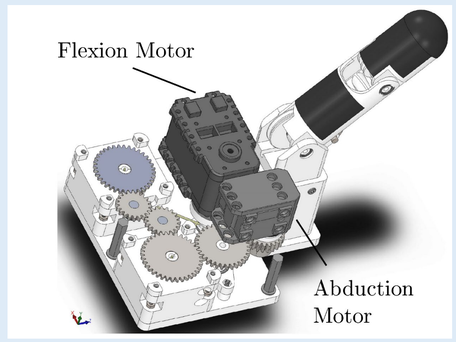
**Proposed Solutions:**

- Light-weight underactuated hand designs
- Control scheme based on supervised autonomy

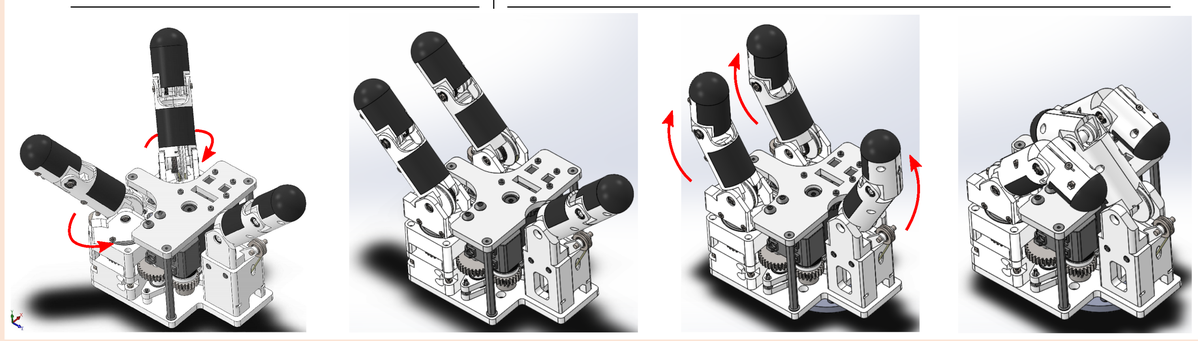
## Highly-underactuated Hand Design



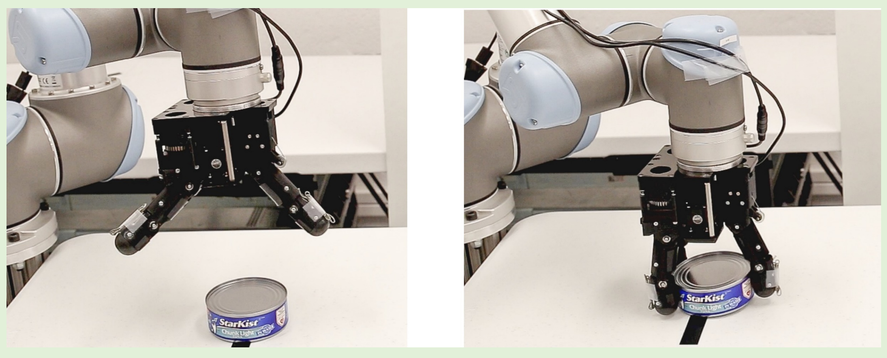
- Three fingers
- Eight DoFs
- Two actuators




**Actuator 1** (Abduction) | **Actuator 2** (Flexion)

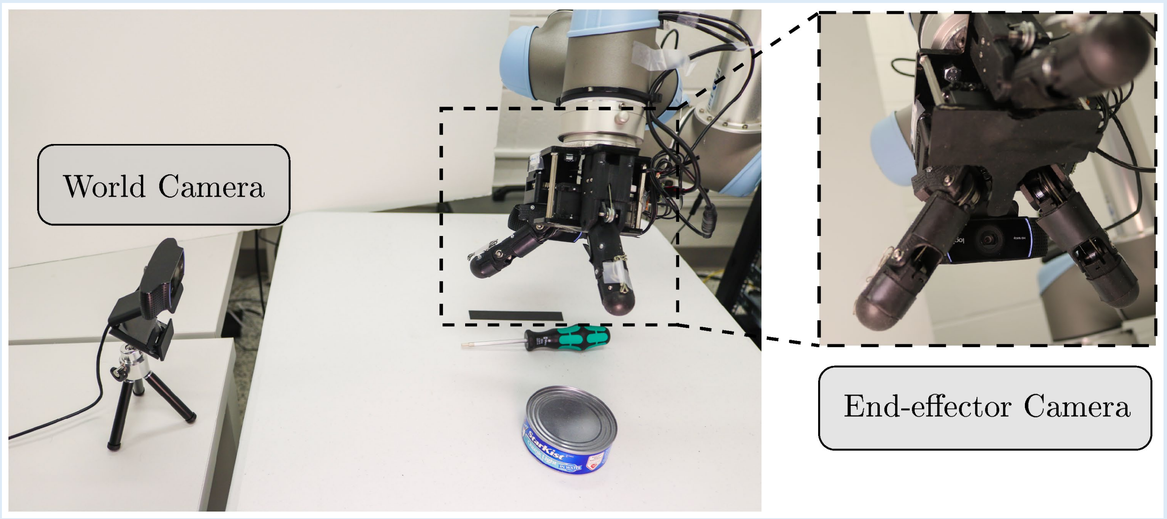


Hardware demonstrates grasping

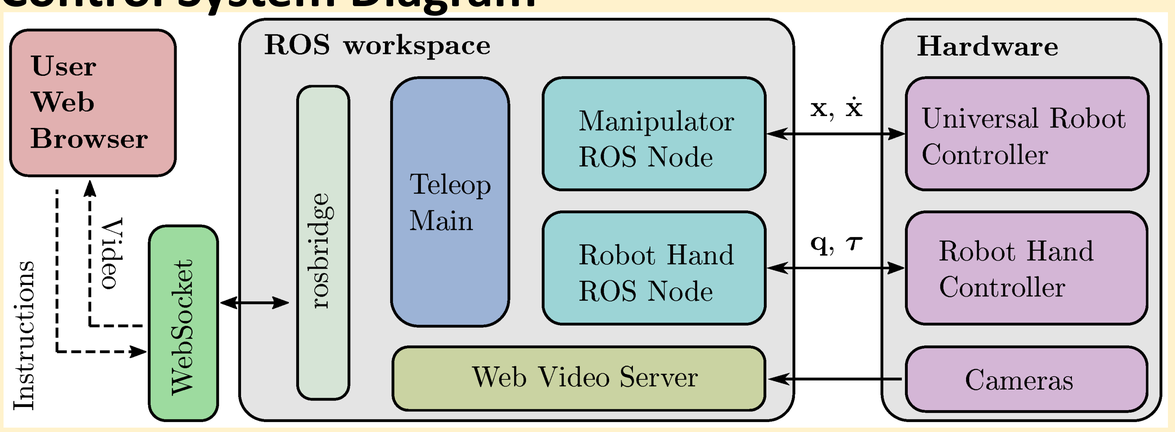


## Teleoperation Framework

### Experimental Setup

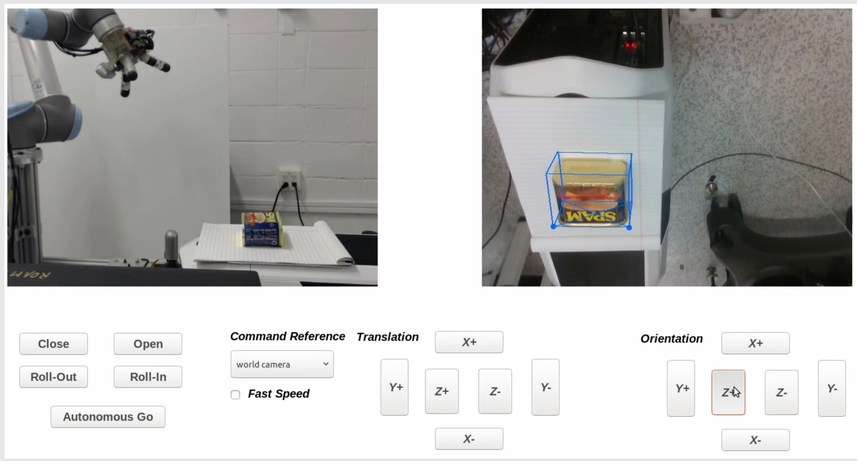



### Control System Diagram




### Teleoperation Interface

*Modes:*
*Direct control*
*Autonomous*




## Preliminary User Study


Objects in the test

- Direct control mode
- Five users participated
- Four objects pick-n-place

***Results***

Users finished 4 objects by average at **4 min 28 s**

*The results illustrated feasibility, but showed limitations that motivate autonomy*

## References


[1] Chen, Tianjian, Maximilian Haas-Heger, and Matei Ciocarlie. "Underactuated hand design using mechanically realizable manifolds." 2018 IEEE International Conference on Robotics and Automation (ICRA). IEEE, 2018.

[2] Ciocarlie, Matei, et al. "Mobile manipulation through an assistive home robot." 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems. IEEE, 2012.