Assistive Free-Flyers with Gecko-Inspired Adhesive Appendages for Automated Logistics in Space

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- Collaborator: Aaron Parness, JPL

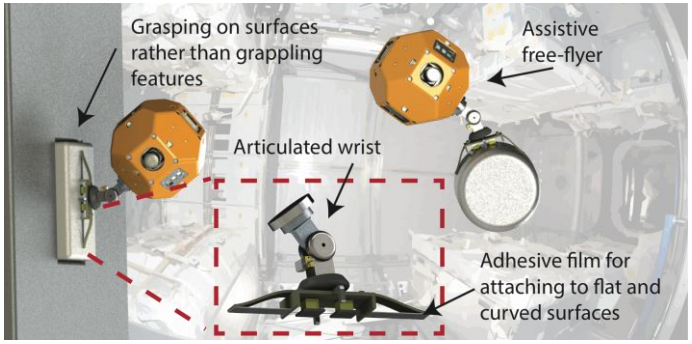
Team strength: team of experts in dexterous manipulation, grasping devices, motion planning and control, astronautics, and human spaceflight from Stanford, MIT, and JPL.

Research Objectives

Integrate adhesion-based grasping with control and planning to enable assistive free-flyers (AFF) to manipulate payloads inside and outside spacecraft.

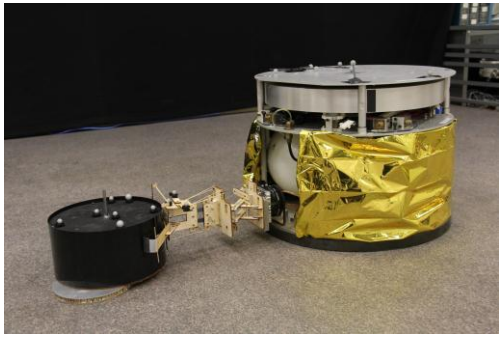
Technical objectives:

1. Design, analyze, and test mechanisms to grasp and manipulate payloads and tools using controllable adhesives.
2. Devise algorithms for safe navigation and reliable grasping/manipulation with adhesive appendages.
3. Validate technology in representative scenarios on test beds emulating zero-gravity conditions.



(a) Assistive free-flyers with gecko-inspired adhesive appendages

(b) Manipulating a water bag with adhesives



(c) Prototype of gecko-inspired adhesive flier on zero-g facility at Stanford

Technical approach:

- Leverage controllable gecko-inspired adhesives with gripper and wrist, to attach to objects and surfaces.
- Model dynamics of attachment to inform flier's planning
- Tailor and extend sampling-based kinodynamic planning algorithms for navigation and model predictive control algorithms for precise docking
- Validate on zero-gravity test beds.

Potential Impact

- Greatly reduce human time spent unpacking supplies, fetching tools, positioning and reading sensors.
- Pave the way for controllable adhesion in future extravehicular maintenance/exploration tasks.

Comparison with SOA: AFF with gecko-inspired adhesives attach to objects by lightly touching any moderately smooth flat or curved surface – without the need to encircle objects, thus easing requirements for perception and control.