Mini-MoB: A Micro-Friction Test Platform

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I. Abstract

The growing accumulation of so-called 'space junk' (post-operational spacecraft) in Earth orbit is of increasing concern to NASA due to the threat space debris poses to spacecraft operating in those regions. To mitigate this threat, NASA seeks to attach solar sails to non-functional satellites, inducing enough drag to initiate de-orbit. This maneuver, which requires grappling passive targets, is uniquely problematic in the frictionless environment of space.

We have developed a multi-agent test-bed to demonstrate robotic rendezvous, capture, and manipulation in a micro-friction environment using the Flight Robotics Laboratory (FRL) flat-floor. The three air-bearing platforms developed, designated Mini-Mobility Bases (Mini-MoB), are significantly smaller than the FRL's current micro-friction platforms. The increased maneuverability of the smaller bases expands the FRL's capability to accurately simulate interactions between smaller spacecraft.

II. System Architecture

FRL Flat-Floor:

- 46' x 88' epoxy floor varying no more than a milli-inch in height
- Air-bearing vehicles moving over the flat-floor have near-frictionless motion

Target Bases (2):

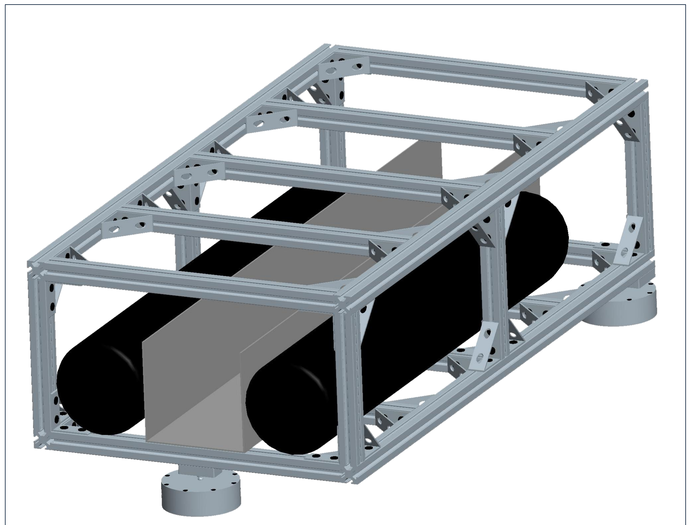
- Two target air-bearing vehicles which simply float on the flat-floor
- Designed to support a mock-up of FASTSAT (launched in 2010) as a target for rendezvous

Active Base (1):

- Air-bearing vehicle with thruster control
- Supports a robotic arm designed by Schafer to demonstrate grappling capability

III. Design

A. Self-contained: To simulate the frictionless environment of space as accurately as possible, the three Mini-MoBs were designed to be tetherless:



- Each base runs on two air tanks pressurized at 2200 psi
- Two 28V batteries supply power to the active base

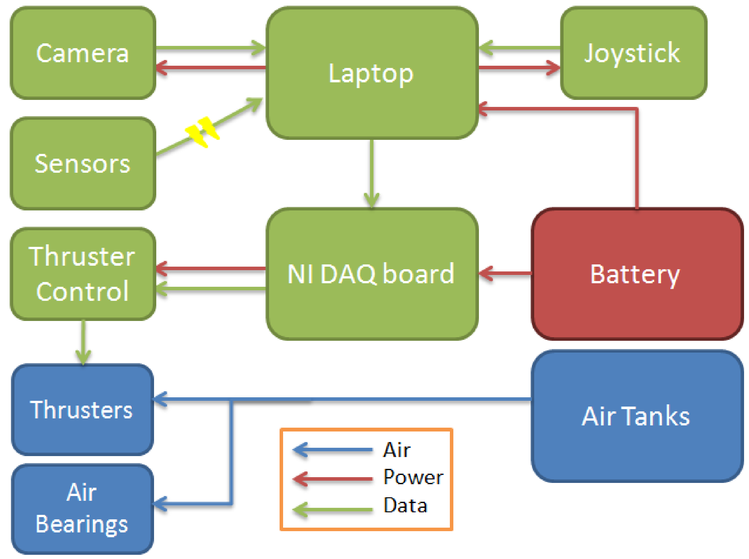
B. Increased maneuverability: compare to the Small Mobility Base, the smallest self-contained air-bearing vehicle previously in the FRL:

	Mini-MoB	SMB
Weight	300 lbs	3000 lbs
Area	10.7 ft^2	28.1 ft^2

C. Rendezvous and docking simulation:

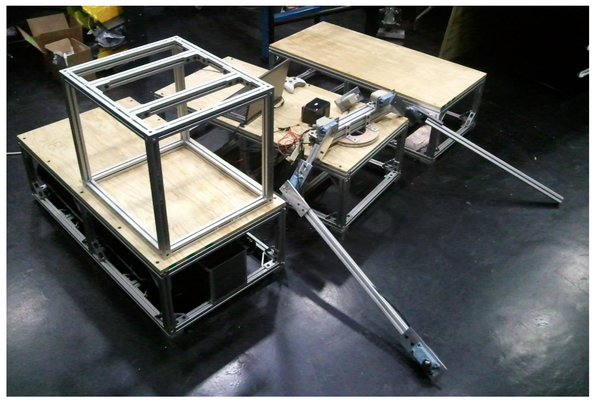
- Target practice: mock-up's similar size and reflective properties of original FASTSAT mimic FASTSAT as a target for grappling.
- Robotic arm mount: Schafer's robotic arm attaches to a second satellite mock-up for more accurate simulation of docking dynamics.

IV. System Diagram



V. Future Work

- Incorporate gyroscopes and accelerometers for precision position knowledge
- Add target tracking, path planning, and autonomous navigation capability
- Integrate robotic manipulator control and test



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