Integrated Spacecraft Autonomous Attitude Control (ISAAC) Testbed

Kyle Fox, Danny Juctman, Zachary Nadeau, Joseph McNaughton, Michael Tomaso, Adam Duke, Catherine Yopp

Faculty: Sergey Drakunov & Dr. Patrick Currier | **NASA Mentor:** Michael DuPuis

Abstract

- The purpose is to give undergraduate students an opportunity to design, manufacture, and maintain a mock spacecraft, to be used as a testbed for autonomous control systems.
- The spacecraft is based on two previous models the JX-01, an undergraduate built testbed, and the Asteroid Free Flyer, led by NASA engineer and ERAU doctoral student Michael Dupuis.
- Final goal is to perform experiments to test multiple methods to mitigate effects of internal and external forces such as fuel sloshing, solar radiation, debris collision, and CG change.

Background

- Previous research on was conducted in the form of the JX-01 and Asteroid Free Flyer projects.
- The Asteroid Free Flyer project, led by NASA engineer and ERAU doctoral student Michael Dupuis, created a prototype spacecraft for the purposes of flying in and around asteroids in microgravity.
- The ISAAC Testbed will broaden their scope and gives undergraduates the opportunity to design spacecraft components and control algorithms,and test their effects on actual hardware.

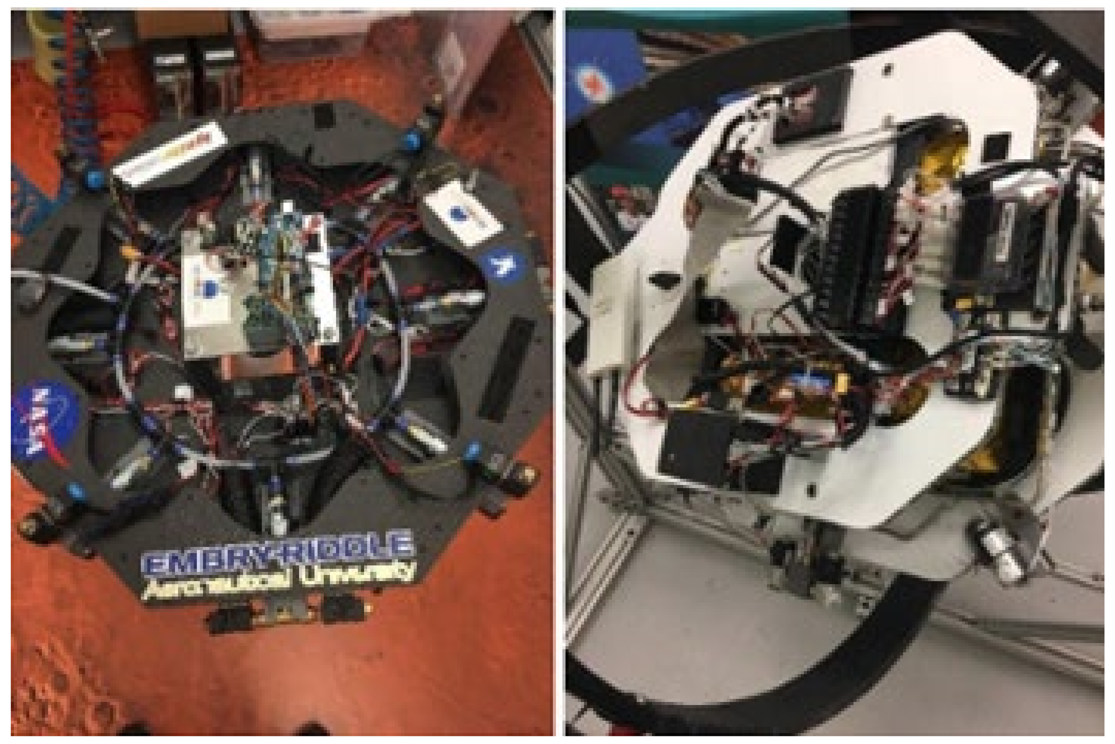


Figure 1. *Left:* current JX-01 prototype
Right: NASA Asteroid Free Flyer prototype

Methodology

- Design scheme involves a larger chassis, enabling the hosting of fuel tanks; removes need for a tether based external fuel line.
- Increased size requires removal from existing air bearing mount in order to be suspended from test chamber; suspension will increase range of motion to test sensors and control subsystems for stabilization.
- Inclusion of 16 attitude controlling solenoids that run at 200psi; tanks to be pressurized at 2500-5000psi for testing when not tethered.
- The sensor suite and electrical subsystem to include multi-sensor feedback and cable management improvements; IMUs, LIDAR, DAS, and external object-based state estimation to be integrate. Automated Health Monitoring System (HMS) will also be incorporated to estimate the mean time between component failures and improve the turnaround time for repair
- Fully internal pneumatic system capable of operating under its own stored pressure; two main tanks will be carbon fiber tanks each pressurized to 3500 psi (max. 5500 psi)
- Rudimentary static landing gear included to allow convenient accessibility while spacecraft is under maintenance

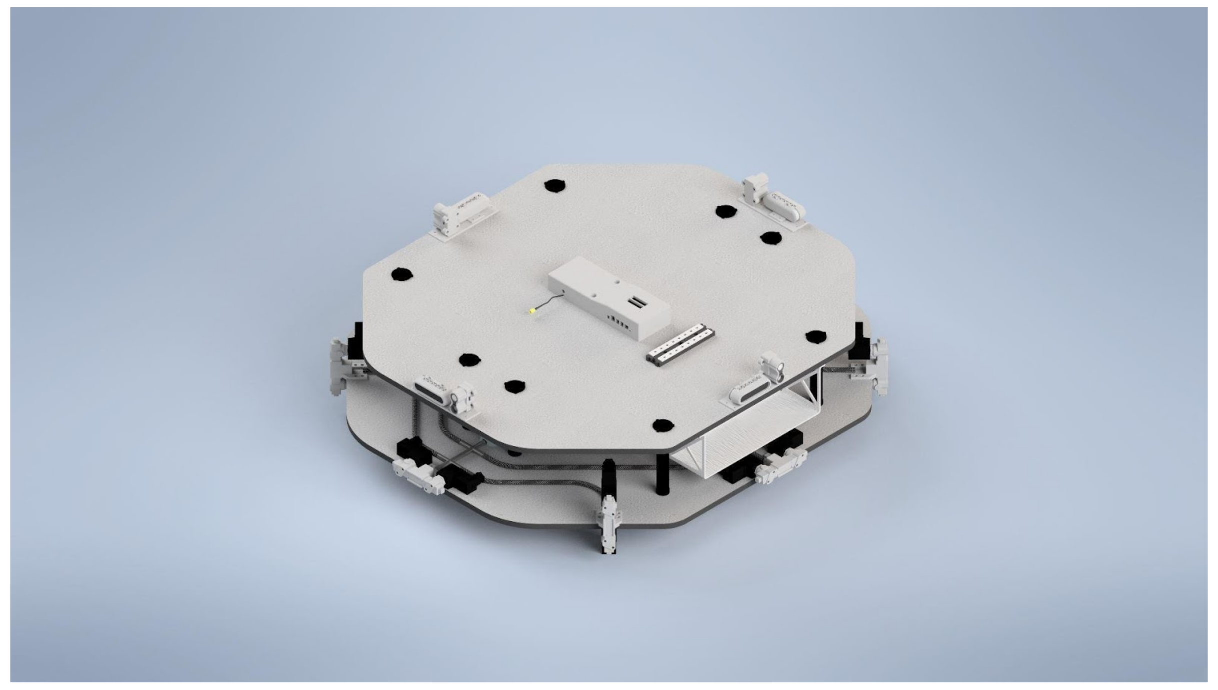


Figure 2. A rendering of the ISAAC Prototype

Discussion

- The spacecraft will help decrease the cost to space by providing a base structure that can then be outfitted in any way to suit the desired mission requirements
- Missions will include orbital, lunar, Martian, and asteroid; can be customized to include scientific equipment, solar panels, additional computer systems, or other propulsion systems

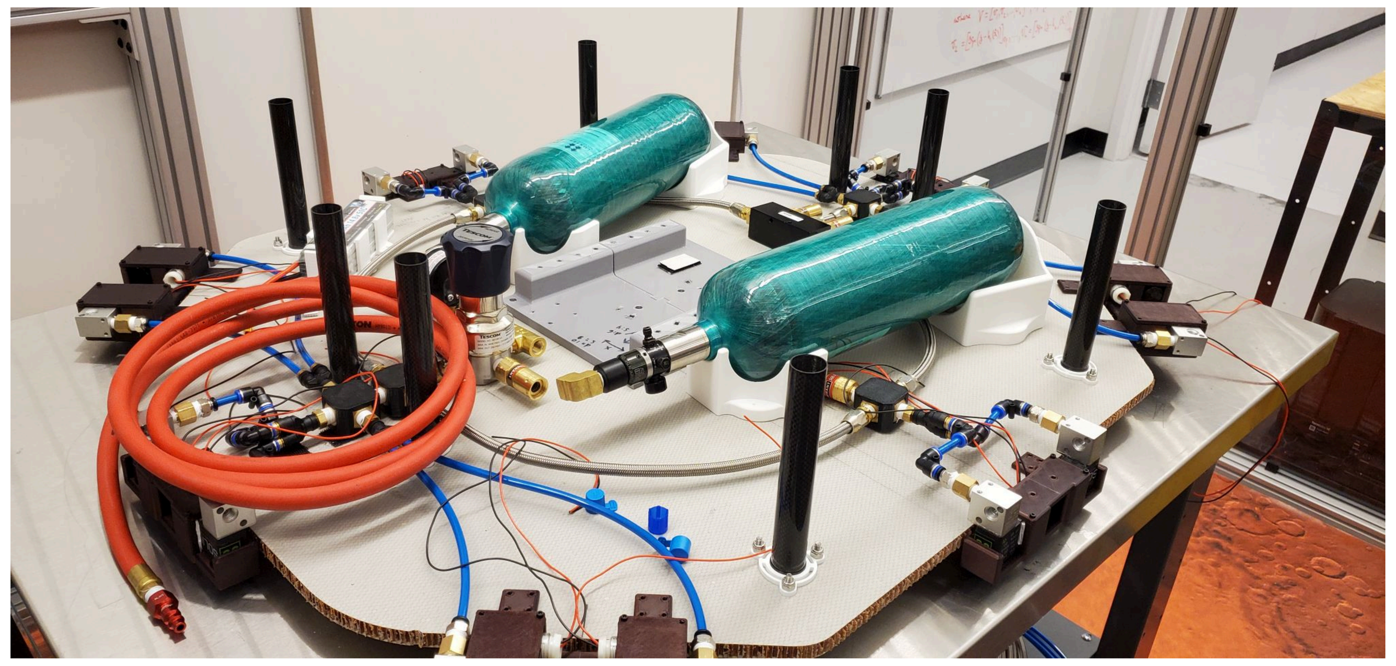
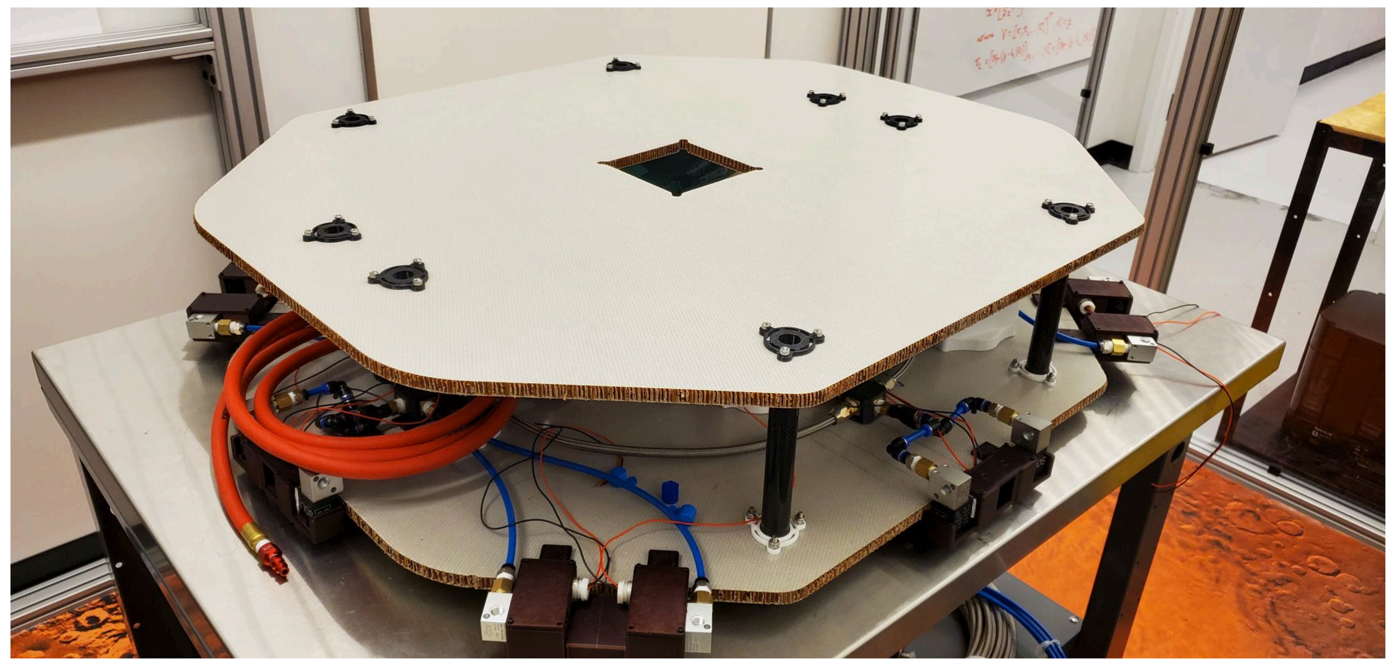


Figure 3. The current build status of the ISAAC Testbed



Results

- At the current state of the research, the spacecraft controller is complete, and we are in final stage of building with testing being done in the last week of march for data collection.

OFFICE OF UNDERGRADUATE RESEARCH at EMBRY-RIDDLE | MATLAB & SIMULINK | ANSYS | AUTODESK INVENTOR | CATIA | NASA | Ki | EPPL