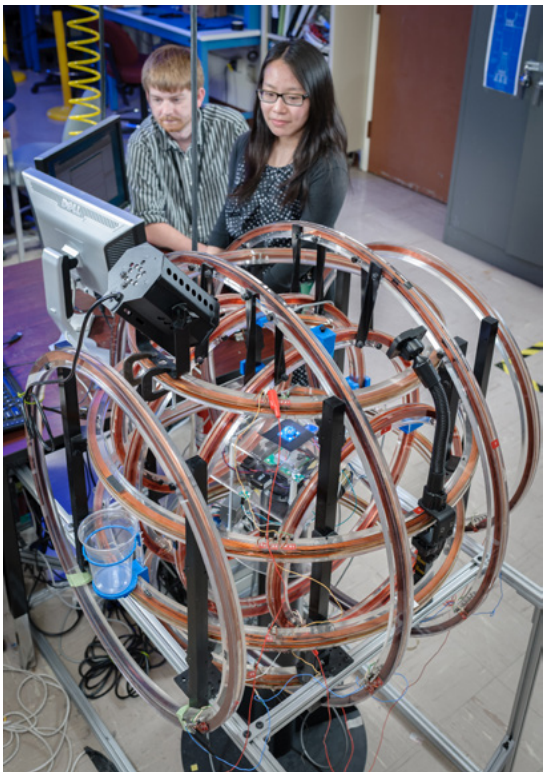
NASAfacts

Generalized Nanosatellite Avionics Testbed (G-NAT) Labs

Research facility that provides rapid testing capability for actively controlled small satellites

The Generalized Nanosatellite Avionics Testbed (G-NAT) lab at NASA Ames Research Center provides a flexible, easily accessible facility for developing hardware and software for advanced small spacecraft. A collaboration between the Mission Design Division and the Intelligent Systems Division, the objective of the lab is to provide testing data and general test protocols for advanced sensors, actuators, and processors for CubeSat-class spacecraft. By developing test schemes for advanced components outside of the standard mission lifecycle, the lab is able to help reduce the risk carried by advanced nanosatellite or CubeSat missions. Such missions are often allocated very little time for testing, and too often the test facilities must be custom-built for the needs of the mission at hand. The G-NAT lab helps to eliminate these problems by providing a testbed suite that combines easily accessible, commercial-off-the-shelf (COTS) processors with a collection of existing sensors and actuators.



The G-NAT lab is currently engaged in collaborations with a number of universities, and supports numerous intern programs

Lab facilities include:

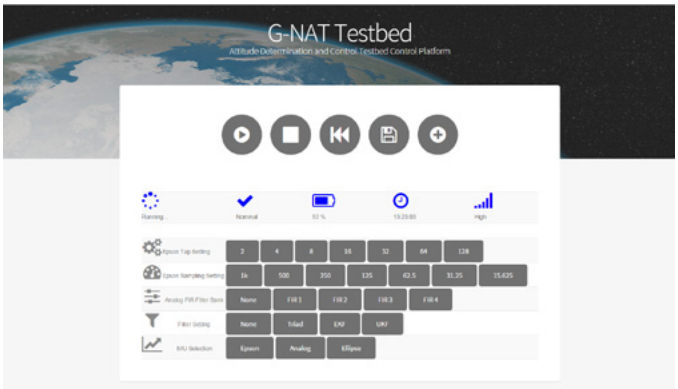
- An air bearing that provides three degrees of freedom (3-DOF) rotational motion
- A Helmholtz cage that generates a magnetic field equivalent to that encountered in space
- A sun emulator bulb that produces a sun vector with a known orientation
- An “attitude truth” system based on the open-source AprilTags software
- Command and control access to the testbed via a web-based graphic user interface (GUI)

Typical use cases:

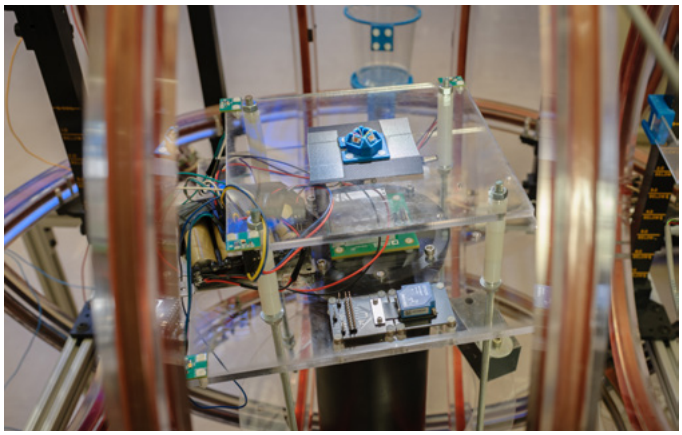
- Attitude determination studies using state information collected from the sun vector, magnetic field vector, and angular velocity information
- Attitude control studies using CubeSat-class actuators, such as reaction wheels or torque rods
- Flight software validation or scenario testing

Any test apparatus placed on the air bearing can rotate a full 360° about the vertical axis, and up to 45° about either horizontal axis. This range of motion is sufficient to allow researchers to study three-axis reorientation maneuvers using a wide variety of control actuators. Using the web-based GUI, remote collaborators can configure a variety of parameters on the testbed, and run experiments tailored to their research. Testbed state information is returned to the remote user in real-time, and data can be downloaded after test completion.

A typical use case for the lab is illustrated by the BioSentinel mission, a 6U CubeSat that will be launched on the first flight of the Space Launch System. This spacecraft will be the first NASA Ames-built CubeSat to operate in deep space, and for the spacecraft Safe Mode it is critical to have a high-quality inertial measurement unit (IMU). As part of the early design process for this mission, the G-NAT lab has been investigating the performance of a number of different candidate IMUs that conform to the power and volume constraints of the spacecraft. Tests being performed in the lab include bias stability, single- and multi-axis rotation accuracy, and sensor response to a vibrational environment. This test data is being shared with the BioSentinel spacecraft team, and additional tests can be quickly implemented based on the needs of the mission.



The web-based user interface for the G-NAT lab, available to remote collaborators.



An example testbed, with a sensor suite capable of determining the 3-axis attitude of a representative small spacecraft.

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