

National Aeronautics and
Space Administration



TECHNOLOGY SOLUTION

Robotics, Automation and Control

Gimbal for Steering Propelled CubeSats

Compact, Mount-ready Package to Facilitate Attitude Control

NASA is preparing for the next generation of CubeSats that are propelled and will make directional maneuvers. The new gimbal mount provides a seat for the motor and controls the position of the thrusters that propel the CubeSat as it moves about and/or changes orbits. This small-footprint device controls the rotation (360 degrees) and tilt (+/- 12 degrees) of a directional system to a very high accuracy (0.02 degrees). It alleviates the need for more traditional directional control hardware, including magnetorquers and magnetometers. The gimbal controls larger masses for its size than other positioning systems. It has a low parts count (six) and can support up to 0.5 kg mass. NASA built a prototype and conducted several tests to prove its control and precision capabilities, and its ability to withstand vibration testing. Now NASA seeks companies to commercialize the gimbal.

BENEFITS

- Low parts count: the gimbal alone comprises six parts; with motors and frangibolts, the parts count is nine
- High precision: controls position to 0.02°
- Reduced mass, volume, and power requirements compared to magnetorquers and magnetometers

APPLICATIONS

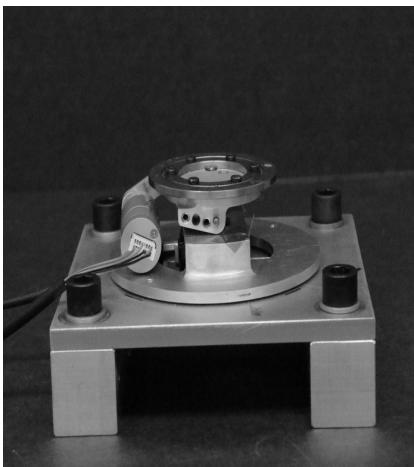
The technology has several potential applications:

- Aerospace: attitude control of electric propulsion thrusters for spacecraft, including CubeSats
- Optics: precise imager/camera positioning
- Manufacturing: laser control

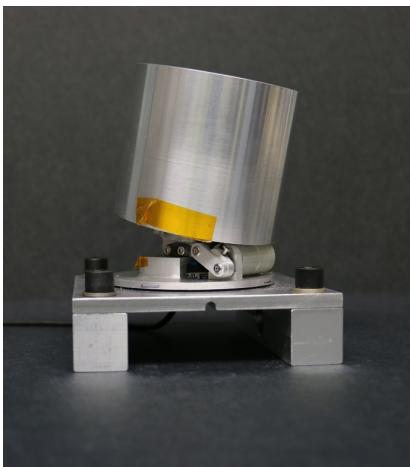


THE TECHNOLOGY

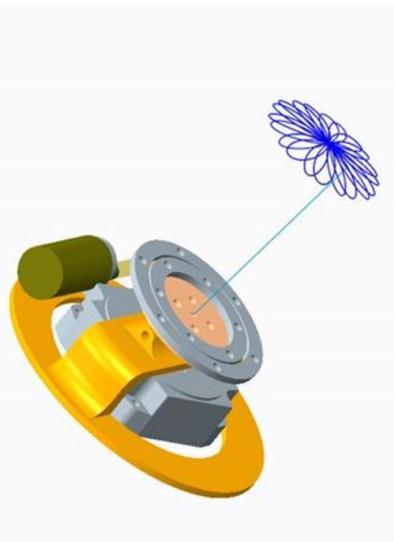
The small thruster mount, roughly the size of a doughnut, controls the rotation and tilt of a directional system to a high degree of accuracy (0.02 degrees). NASA developed the rotary tilting gimbal (RTG) for thruster directional control of CubeSats. This RTG is designed to provide precision control in both the tilting and rotary degree of freedom by using accurate positioning, encoded piezoelectric motors, and a close tolerance machined structure. The RTG functions via rotary motion of the integrated assembly by a grounded piezoelectric support motor, and tilts via a rotary motor that rides on the primary structure. This alleviates the need for more traditional, directional control hardware, including magnetorquers and magnetometers. The subject technology has a resulting rotational degree of freedom of 360 degrees and a tilting degree of freedom of +/- 12 degrees. The rotary motor is connected to the tilt plate by a two-piece crank assembly. The gimbal weight, including the motors, is about 420 grams; without motors, it is about 100 grams. The operating temperature range is 0-50C. Sinusoidal testing was performed before and after the random vibration tests to determine if any structural changes occurred as a result of the tests. The gimbal met the qualification requirements and did not present any significant structural changes from flight-level testing.



The gimbal mount



The gimbal mount test setup with a mass that simulates the mass of a thruster



This image shows the trace pattern from the gimbal with the laser mount for testing/calibration.

PUBLICATIONS

Patent No: 10,351,265