Magnetorquer

Description

Magnetorquers are used in attitude determination control through the use of an external magnetic field. In the realm of electricity and magnetism a magnetic dipole moment vector is used to quantify the "power" of these magnetorquers. A magnetic dipole moment in the presence of an external magnetic field will experience a torque in the direction determined by the cross product of the magnetic dipole moment and the external magnetic field (magnetic dipole moments want to "align" with the external magnetic field"). The magnetic dipole moment is created through the use of current loop's enclosing a 2 dimensional area (AKA solenoids).

Big Picture

The magnetorquer demo serves as a gateway to the construction, development, and control of future magnetorquer's which will ultimately be implemented in the CubeSat design. Creating this demo creates familiarity with language common in the ADCS field while also learning the fundamental parameters involved in designing a magnetorquer. In addition it brings familiarity with common hardware allowing for a more accurate cost estimate. In general satellites or specifically CubeSats have a minimum of 3 magnetorques with magnetic dipole moment vectors along three orthogonal directions. Allowing torques to be applied in a certain direction so that the CubeSat can be oriented in any direction possible.

Design Constraints & Considerations

Create a table top demonstration of common sized magnetorquers and visibly show the resultant torques when current is provided.

- Requires and external power supply
- Requires external magnetic field (Thank you Earth)
- Heat generation created from higher current
- Power duration
- Spacial Dimensions
- Creation of a winding device to assemble magnetorquer/solenoids

Solenoid Calculations

Constants:

- Earth's magnetic field (B): 53.53 *10^-6 T
- Mu_0 = 4pi * 10^-7 Tm/A
- Mu = 0.006283185307
- X_v (Magnetic Volume Susceptibility)= 200,000 (Iron)
- 30 gauge magnet wire is used to construct the coils

Torque = $N * I * A * (1 + X_v * Mu_0 * B)$

- N = Number of terms in the solenoid
- I = Current
- A = Area enclosed by one loop

Using the following chosen values a torque of 2.0095 * 10^-6 is achieved.

- N = 764
- I = 0.5 A
- A = 7.85398 * 10^-5 m^2 (a diameter of 1 cm is used)

With this torque a rotational acceleration of 1.15 degrees per second^2 is achieved.

Current Progress

- Machined parts: 100%
- CAD model: 100%
- System model: 100%
- Control System: 35%

Demonstration

Timeline

Our goal for this project is to have a completed demonstrator for Imagine RIT.

- Complete CAD Package 4/1/16
- 3D print components/winding 4/10/2016
- Order required components 4/1/2016
- Assemble all components 4/21/2016

Future Goals

- Implement magnetic field sensors
- Implement torque sensors
- Determine system power requirements
- Improve overall functionallity

Points of Contact

Eli Laramie

Justin Kon

Pj Zaccagnino

Eric Gerstner