Ground-Based Preparatory Activities (11)
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# DESIGN AND MANUFACTURING OF HARDWARE IN LOOP SIMULATION TESTBED EQUIPPED WITH VARIABLE SPEED CONTROL MOMENT GYROSCOPES

**Abstract**

Preflight verification of attitude control algorithm on ground is most critical instead essential step in entire life cycle of space mission. Complexity associated with realization of spacecraft attitude motion in microgravity environment requires intricate mechanisms such as spherical air bearing assembly requires is expensive and necessitates extra equipment such as air compressor for maintaining negligible friction joint. Three axis gimbal-based systems add mechanical complexity and inertia of the setup needs to be considered while performing the tests. This research discusses an affordable and reconfigurable testbed for attitude control system. The testbed consists of platform balancing on pinpoint with its center of mass kept below but close to point of contact and development of miniature standalone Single Gimbal Control Moment Gyroscope which can be used as Reaction Wheel (RW), Control Moment Gyroscope (CMG) or Variable Speed Control Moment Gyroscope (VSCMG). Proposed method does not require external equipment to maintain free attitude motion. A command-and-control software developed for real time telemetry manual open loop or complete close loop control. The platform consists of a Wi-Fi enabled MCU equipped with three axis gyroscope and magnetometer for body orientation and angular velocity. Standalone SGCMG unit is assembly of reaction wheel motor and gimbal motor with dedicated Wi-Fi enabled MCU to have close loop control of reaction wheel angular velocity, gimbal angle and gimbal angular velocity. Interactive Graphical User Interface (GUI) allows 3D visualization of platform and SGCMG states in real-time. High bandwidth communication between customized developed command-and-control software and test bed on-board computers allows just in time updates of controller parameters switching between various control algorithms. Proposed testbed is affordable, maintenance free, easy to reconfigure and reproduce due standalone nature of SGCMG unit and is an intuitive tool for control systems engineers intended for preflight testing of new algorithms on ground.