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DESIGN AND DEVELOPMENT OF AN ONBOARD IN LOOP SIMULATION SYSTEM FOR IN ORBIT TESTING AND VALIDATION OF ACTIVE MAGNETIC CONTROL SYSTEM OF A NANO-SATELLITE

Abstract

The magnetically controlled nano-satellites can be categorized with the design of control system derived to meet the desired mission requirements. Passive magnetic control is equivalent to open loop control system; wherein the satellite aligns itself to the Earth's Magnetic field. Active magnetic control is closed loop control system; wherein satellites possess sensing unit (tri axial magnetometer) and an actuating unit (Magnetic Torquer Rods (MTR)) with a designed control law. Nowadays, the use of former control system in nano-satellite missions are exceptionally increasing. The major challenge in such missions is to test and validate the control system design for in orbit conditions. Designers follow software testing procedures to ensure the onboard software design is meeting the requirements. Once satellite is in space these missions have very less flexibility to modify the onboard software. Hence it is recommended to perform Hardware In Loop Simulations (HILS) and Onboard In Loop Simulations (OILS) to avoid any design or coding imperfections in the Attitude Determination and Control System (ADCS) algorithm design and implementation. Verification of ADCS software using HILS provides the profound results and confidence on the design but development of the same is more costlier and time consuming. The small satellite missions with the constraint on development time, cost and facility can always check the correctness of the ADCS software using OILS. This paper presents the design and development of OILS used for testing PISAT a three axis stabilized satellite with active magnetic control system. PISAT is configured with three MTRs about all the three axes and Inertial Measurement Unit (IMU) ADIS16405 of Analog Devices Inc. with a tri axial magnetometer, gyroscope and accelerometer with Serial Peripheral Interface (SPI). The OILS simulates IMU data and updates the senor output based on simulated nonlinear satellite rigid body dynamics. The Onboard Computer (OBC) provides the actuation signals in terms of duty cycle with polarity. The detected polarity multiplied with maximum magnetic moment interacts with the current magnetic field to generate the realized torque onto the satellite. Thus, the realized torque in combination of various modeled disturbance torques updates the angular rate and the attitude of the satellite. The estimated attitude about all three axes simulates the magnetic field data in sensor frame. The input to the OBC is the combined magnetometer and gyroscope data as IMU input updated every 128msec through SPI Interface.