

Ground-Based Preparatory Activities (13)
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COMPREHENSIVE DEVELOPMENT OF SPACECRAFT ATTITUDE DETERMINATION AND
CONTROL SIMULATOR TESTBED LEVERAGING 3-AXIS REACTION WHEELS IN A
CONTROLLED SPACE-LIKE ENVIRONMENT

Abstract

Attitude Determination and Control Systems (ADCS) are paramount for the success of space missions, enabling precise pointing of antennas and payloads for data collection and communication. To ensure reliability and optimal performance, rigorous ground-based testing is essential. The Space Dynamics and Flight Control Laboratory at IIT Kanpur has developed a comprehensive Ground-Based Satellite Simulator Testbed to replicate space conditions and validate ADCS performance. The testbed incorporates a diverse array of sensors, including Sun Sensors, Gyroscopes, Accelerometers, and Magnetometers, to accurately determine the satellite's orientation. An Extended Kalman Filter (EKF) is employed to mitigate sensor noise and improve estimation accuracy. For attitude control, the testbed utilizes Three-axis Reaction Wheels as the primary actuators and Magnetorquers as secondary actuators. To simulate the Earth's magnetic field, an in-house developed Helmholtz Cage is employed to generate magnetic field environments. Additionally, a halogen light source is used to mimic solar radiation, enabling the testing of Sun Sensors under realistic conditions. The on-board computations are executed using STM 32 microcontroller family which efficiently processes sensor data, implements control algorithms, and communicates with other system components. A Raspberry Pi serves as the computational hub, performing complex calculations, running simulations, and interfacing with external systems. By conducting extensive testing and analysis on the Ground-Based Satellite Simulator Testbed, valuable insights can be gained into the performance of ADCS systems. The research insight is critical for identifying potential issues, optimizing system parameters, and ultimately ensuring the success of future space missions