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IN-FLIGHT ATTITUDE DETERMINATION AND CONTROL STRATEGY FOR EARTH OBSERVATION MISSIONS OF THE DIWATA-2 MICROSATELLITE

Abstract

This study presents the techniques implemented in Diwata-2's Attitude Determination and Control System (ADCS) for earth observation. It is to satisfy a 0.1 degree pointing accuracy requirement and shall be achieved through in-flight calibration of its attitude components using Lunar observation. The satellite is also desired to maximize its available ground observation surface area in a given mission pass. An attitude maneuver sequence design for extended target pointing is proposed and its flight control behavior shall be investigated. Flight limitations of the current ADCS shall also be described.

Diwata-2 is the Philippines' scientific earth observation satellite operating in a 600km altitude sun synchronous orbit. Its primary mission payloads include a 4.7m-resolution High Precision Telescope (HPT) with 2.3x3.1 km field of view and a Spaceborne Multispectral Imager with 62x83km FOV and 591 selective bands from 430-1020nm range. These payloads and the ADCS must function in coordination for a successful earth observation mission.

Accurate attitude estimation is essential for the target to be captured by the cameras particularly in the HPT's narrow field of view. For Diwata-2's attitude sensors, the Geomagnetic Aspect Sensors and Sun Aspect Sensors are generally reliable but may be insufficient where it was determined to only have a 1.9 degree accuracy. Star Trackers are more accurate with < 0.1 degree error but are more sensitive requiring a consistent clear view of the stars with minimal distortion. The Fiber Optic Gyroscope is used to detect the angular velocity of the satellite for control and also estimates the attitude if the sensors are not available. These components may contain bias errors and misalignment offsets which may only be apparent during flight operation. An experiment with a clear reference target, such as the Moon, is

suggested as a solution. Sequential scheduling of the use of its components are also planned to maximize their functional conditions.

For target pointing control, conventional pushbroom scanning is usually implemented but limits the scan direction parallel to the orbit trajectory. For targets that are located across the satellite swath, a moving ground target path is planned and its required satellite maneuvers are calculated. The study of this control procedure are carried out based on actual flight data using a ground Hardware-in-the-Loop simulation system.

The updated strategy shall finally be evaluated based on how the resulting earth observation images satisfy the mission requirements.