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IN-ORBIT ATTITUDE DETERMINATION AND SYSTEM MODELING OF SKOLTECH B1 AND B2 CUBESATS

Abstract

Attitude Determination of any satellite is necessary to understand its rotation and then pointing it in the desired direction, to serve its purpose. Many studies have used both attitude estimation and determination techniques, such as TRIAD, QUEST, and Kalman Filters, to design the attitude determination systems of satellites during the developmental stages of satellite systems. In this study, we present the attitude determination system (ADS) for the in-orbit Skoltech satellites B1 and B2. In August 2022, Skoltech launched two satellites with the purpose of testing inter-satellite communication and collecting data on gamma-ray flashes. The attitude information of these satellites is unknown, except for the time when the telemetric data is received by the ground station. However, the data received from the satellites indicates un-calibrated sensor measurements. As the sensors lack calibration, so the information about the satellite is to be recovered by observations made in orbit. The quality of ADS depends on the accuracy and reliability of the sensor measurements, therefore, processing the sensor data, calibrating it, and retrieving useful information is required prior to the ADS development. So, our goal is to use this limited ground calibration and in-space data to retrieve attitude information about the two identical satellites.

This study aims to calibrate satellite sensors and model the in-orbit attitude determination system for B1 and B2 based on the telemetric data being received from the satellites. As a first step in the development of ADS, we compare the sensor data with the reference models and derive offsets and scaling factors for the calibration. The sensors to be calibrated include gyroscopes, and magnetometers. At the next step, we perform attitude determination based on Kalman Filter assimilating measurements from gyroscopes and magnetometers. Additionally, we model sun sensors for precise attitude determination. Apart from these sensors, we use two-line elements (TLE) data to determine the absolute satellite position. We also use the GPS data of the B1 and B2 satellites to correct the results from the TLEs and improve their accuracy. We develop the ADS first with the artificial data obtained from the modelled sensors and finally implement it with the calibrated B1 and B2 sensor measurements. The final system developed is able to read the satellite telemetry data, calibrate it if required and use the measurements to estimate the satellite attitude, while they are in orbit.