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ADCS RATE CONTROLLER USING INTERMEDIATE AXIS THEOREM

Abstract

The Framsat-1 satellite from Orbit NTNU is a 1U cubesat. It uses a magnetorquer to actuate, and the OBC and ADCS share a board, which limits the ADCS when considering the processing power and storage capabilities of the unit. Furthermore, since the satellite is 1U, its set of sensors is limited to IMU, magnetometer in addition to one sun-sensor-payload. The lack of in particular multiple sun-sensors makes it difficult to accurately estimate certain states, like the satellite's orientation and the sun vector.

The mission objective for the ADCS is to optimize the solar distribution for the different sides of the satellite. The reason for this is to make charging using solar-panels more effective by avoiding overheating, and also to allow semi-periodic testing of a sun-sensor payload. Achieving this objective is somewhat challenging since we are limited regarding calculation power and which parameters we can easily and accurately access, which would be relevant to optimize this problem, as described above. This means that the controller will need to have a simple yet effective design to achieve the mission objective for the ADCS.

Our solution is to take advantage of the intermediate axis theorem, which is also known as the Tennis Racket Theorem or the Dzhanibekov effect. To do this, we design a rate controller that will attempt to actuate the majority of the spin along the intermediate axis of the satellite. According to the theorem, this should make it so that the body of the satellite will periodically flip back and forth along one of the other axes, which should provide a more sun-distributive rotation while we at the same time can keep the controller and the controller-reference simple by design.

In this paper, we will discuss how the intermediate axis theorem can be used in ADCS controller design to improve solar distribution for the satellite, while also reducing the need to manually actuate in order to achieve this.