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MAGNETOMETER ONLY ATTITUDE ESTIMATION FOR SPIN SATELLITES

Abstract

Attitude control by spin stabilization has a long history which goes back to the early days of space exploration. In this context early publications have extensive discussion on attitude estimation for spinning spacecrafts and specifically spin-axis estimation. Later on, in next few decades spin-stabilization lost its popularity and displaced by three axis control methods. Today, as the small satellite missions pervade, spin-stabilization offers a simple attitude control solution for specifically micro and nano satellites and has a large potential for implementation on numerous missions.

Recently there are some examples for spin-stabilized nanosatellite mission. The designers for the attitude determination and control subsystem use traditional filtering algorithms that we use for 3-axis stabilized satellites to estimate the attitude. Although this is true and the same algorithms are usable for the spin-stabilized satellites, there are simpler ways of solving the attitude for the spin satellites. By implanting these simpler attitude estimation algorithms we can reduce the complexity together with the computational load of the algorithm and increase the robustness.

In this paper, we propose an attitude estimation algorithm for spin satellites. The algorithm is loosely based on a filter proposed by Bar-Itzhack. Using a simple linear Kalman filter (KF) algorithm we estimate the spin axis and rate of the satellite. We assume that only the magnetometer measurements are available. In addition to the spin states, the filter estimates the magnetometer biases to improve the spin axis estimation accuracy. We show that using the centered magnetometer measurements the bias for the magnetometer onboard the spinning satellite can be also estimated with a linear KF, independently from the attitude. The algorithm is tested for a hypothetical nanosatellite via numerical simulations. The results are discussed in detail and suggestions for implementation of the algorithm are given.