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IMPROVING THE ATTITUDE DETERMINATION SENSORS AND ALGORITHMS FOR A CUBESAT - ESTCUBE-2 EXAMPLE

Abstract

In order for CubeSats to act as a platform for scientific and commercial missions it is necessary to provide accurate and reliable attitude control. In order to achieve this, the first step is acquiring a very accurate knowledge of the attitude. This is often limited on CubeSats due to the cost and volume limitations set by the satellite. In addition, various disturbances, especially magnetic influences, can be much larger on a CubeSat platform. There are two different design drivers for the ADCS of the ESTCube-2 nanosatellite. First, the electric solar wind sail tether deployment, which requires high spin rate control while simultaneously pointing the spin axis relative to the Earth's polar axis with less than 3 degrees error. The tether deployment requires spin rates of over 1 revolution per second. To achieve these spin rates the ADCS software loop has to reach control frequencies of 10hz, while providing accurate information regarding the spin rate and attitude of the satellite. The second challenge for the system is pointing a telescopic Earth Observation Instrument. As the goal is to provide both Nadir tracking and tracking a specific landmark here we aim to maximize the accuracy of the attitude determination. These challenges are addressed by the various sensors used on board, including a custom designed star tracker, fine Sun sensors, gyroscopes and magnetometers. These sensors are then fed to the sensor fusion system that is able to combine information from those sensors while also taking into account various sensor biases, temperature dependencies and any time delay between sensors from data acquisition or processing while also automatically estimating the sensor noise of the sensors used. This paper will focus on presenting a custom robust sensor fusion approach that is based on the Unscented Kalman Filter and the design of the various sensors used on-board the ESTCube-2 satellite.