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IMPLEMENTATION AND VALIDATION OF MURRELL'S VERSION KALMAN FILTER FOR ATTITUDE ESTIMATION

Abstract

Obtaining accurate and repeatable attitude information is crucial for the functioning of a satellite, and is an essential input during any pointing mode. The hardware of the Attitude Determination System (ADS) usually comprises sensors such as the IMU, magnetometer, and sun sensors. In addition to this, onboard computation is required to calculate the complementary reference vectors and to run the determination and estimation algorithms. Team Anant is a group of undergraduate students working to build a 3U Cubesat with a hyperspectral camera as its primary payload. This paper discusses the implementation and validation of Murrell's Version Kalman Filter, along with fine sun sensor selection, as performed by the members of the team. The paper begins with the comparison of various Extended Kalman Filter algorithms and the motivation to choose Murrell's version Kalman Filter. The algorithm was implemented in MATLAB, and realistic sensor models were utilized for the sun sensor, magnetometer, and gyroscope. Using these models, the Filter was verified against a dynamic model of the satellite under the influence of a realistic space environment. This was made possible due to the orbit propagator developed indigenously by the team. The Murrell's version Kalman Filter was successfully integrated with the orbit propagator, and the error between actual and estimated quaternion was obtained. The performance of the Filter was validated by performing Monte Carlo Analysis by varying the initial conditions. This paper also discusses the effect of the initial value of the error covariance matrix on the performance of the Filter and its tuning to obtain optimum results. The Cramer Rao Bound has been used to establish a lower bound on the error covariance matrix. The accuracy, stability, and convergence time of Filter were also statistically computed. Moreover, a detailed analysis of selecting a fine sensor for the satellite was also performed after validating estimation algorithms.