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OPTIMAL TUNING OF THE NANOSATELLITE ATTITUDE CONTROLLER USING TRIAD-AIDED KALMAN FILTER AND PARTICLE SWARM OPTIMIZATION

Abstract

Attitude determination and control (ADC) is getting more important while complex missions become more common even for nanosatellites. Although, the desired success in ADC depends on the mission requirements. There are different factors that affect the accuracy to be achieved. Preferred ADC methods and noise of the sensors are the most common factors of success. Also, there are different filtering methods, like Kalman Filter (KF), to reduce noise of sensors and its negative effects. However, tuning of the gains are highly affected from this noisy environment and it is getting harder to obtain desired attitude control accuracy. As a prevalent approach, trial-error method for tune of gains is not so suitable in this environment.

In this paper, an evolutionary algorithm, particle swarm optimization (PSO), is used to tune the gains of PD and LQR controllers to achieve Nadir pointing with a 3U CubeSat model. Noisy attitude sensors are solved by basic TRIAD algorithm to obtain attitude determination. Additionally, KF used to reduce bad effects of noisy sensor readings. PSO lets to search in a wide solution space to find global minimum or the best gains to control the satellite in a noisy environment. The main problem is changes of the solution space for each simulation due to random noises. This is main reason of fail in trial-error tuning. To overcome the problem, PSO is run multiple times in a row and as a main cost, average of all these costs are minimized. This basic change increased the processing time, but also increased the accuracy of obtained attitude control from optimized gains. So, this paper presents a gain optimization method to obtain a controller with high tolerance to different noise levels and providing desired control accuracy, while using the most fundamental control and determination methods.