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STUDY ON THE OPTIMIZATION OF CUBESAT SWARM RENDEZVOUS TRAJECTORIES FOR ON-ORBIT INSPECTION IN GEO UNDER PERTURBATIONS USING EKF AND GENETIC ALGORITHMS

Abstract

Satellites operating in the Geostationary Orbit (GEO) are essentially used for supporting continuous communication and surveillance due to its fixed position relative to the Earth . Considering the importance, cost and the mission duration of these satellites, On-orbit inspection through Cubesat Swarms presents a promising and cost effective solution for in-depth health monitoring of such objects. However, rendezvous operations for CubeSat swarms targeting geostationary orbit (GSO) satellites present unique challenges due to the influence of gravity perturbations, J2 effects, solar radiation pressure (SRP) and Third-Body Perturbations . These factors impact trajectory stability and increase fuel consumption for station keeping and precision maneuvering while acquiring the target satellite. This review explores the current methodologies and advances in trajectory optimization techniques that leverage these perturbations to enhance fuel efficiency and trajectory stability of Swarms. A key focus is given to the integration of Extended Kalman Filters (EKF) and genetic algorithms to improve the accuracy and adaptability of cooperative navigation of Cubesats in perturbed environments. An extensive simulation study is shown in the latter part providing a roadmap for future research on fuel-efficient, perturbation-driven rendezvous solutions in high-altitude CubeSat missions.