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ATTITUDE MANOEUVRING UNDER DYNAMIC PATH AND TIME CONSTRAINTS FOR IMPROVED GPS COVERAGE OF FORMATION-FLYING NANOSATELLITES

Abstract

The ability to track changing attitude targets while under strict time and path constraints is a key factor in many possible future space missions. Large-angle attitude manoeuvres are subjected to path constraints such as maintaining ground-link communication, GPS lock, or sun avoidance, all while tracking dynamic primary targets in real time. Presented in this paper is an onboard and nearly real-time approach to maximizing secondary-target tracking or avoidance while tracking primary targets when time constraints and a lack of a priori knowledge of the targets restricts the use of the typical avoidance and random-search techniques. These common techniques can result in calculation and slew times that are unacceptable when unpredictable large-angle manoeuvres must be routinely performed within a tight time frame. It will be shown the proposed three-axis tracking controller can provide a robust solution that minimizes required calculation time and keeps slew manoeuvres near optimal while maximizing the secondary path requirements. This algorithm is being developed for the CanX-45 satellites currently being integrated at the University of Toronto's Space Flight Laboratory. CanX-45 are identical satellites that will be launched together to demonstrate autonomous formation flying with sub-metre control, based on differential GPS measurements. These satellites make use of a precision cold-gas propulsion system whose thrusters are positioned on one face of the satellite, requiring the attitude subsystem to slew the spacecraft to perform its station-keeping manoeuvres. These slews must be performed while keeping the GPS receiver (mounted 90 deg to the thrusters) pointing toward zenith to maximize GPS contact, but must also keep the GPS receiver's relative angular rate low, so as to keep a majority of the same GPS satellites locked between sequential GPS measurements. The presented control technique has been developed for satellite formation flying but is applicable to missions requiring continuous GPS lock while tracking any form of primary attitude targets and can be easily adapted to accommodate other path constraints.