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LASER COMMUNICATION CROSSLINKS FOR SATELLITE AUTONOMOUS NAVIGATION

Abstract

Satellite autonomous navigation is of growing interest for use in future constellation missions in order to mitigate reliance on ground-based tracking, and thus reduce cost and complexity in ground operations. This paper aims to demonstrate a new method of autonomous navigation that leverages the distribution and potential connectivity of satellites in a constellation, and can be used in at any altitude, in Earth-orbit and beyond. An existing autonomous navigation method that uses intersatellite data (direct observations of the range and bearing from one satellite to another) is adapted to use laser communication (lasercom) crosslinks. Lasercom is being proposed for a large number of future satellite missions, as it offers enhanced data rates for lower size, weight, and power, more security, and less regulation compared to traditional radio-frequency (RF) systems. Lasercom additionally offers more precise ranging than traditional RF systems, and can be used to derive bearing measurements over longer separations than traditional visual sensors. A simulation approach is designed to analyze the navigation performance of the proposed method. The Cramer-Rao Lower Bound technique is used to demonstrate the impact of varying simulation parameters and inputs. The first set of simulations show that using lasercom crosslink measurements between two low-Earth orbit (LEO) satellites can potentially achieve absolute positioning errors on the order of meters, which is an order of magnitude improvement over traditional methods. Additional simulations are executed to demonstrate the outcome of varying the geometry and the quantity of satellites using the proposed method. These cases are run for different LEO-to-LEO configurations, a LEO-to-GEO scenario, and two LEO Walker Delta constellation patterns. The results show that greater geometric diversity and quantity of measurements help to reduce positioning errors, and further demonstrate the potential improvement using the proposed method.