Imaging of Self Conjuncting Objects Ahead of the Time of Closest Approach with NEOSSat

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ABSTRACT

In this paper we seek to answer the question that if enough observations of a conjuncting object are taken ahead of the Time of Closest Approach (TCA), could a satellite autonomously estimate the risk of collision in order to independently decide if action needs to be taken.

The Near-Earth Object Surveillance Satellite (NEOSSat) is a space based optical sensor initially intended as a high Earth orbit space observation sensor, but has shown recent capabilities to track objects in the LEO environment. Launched in 2013 to a highly congested 785 km sun-synchronous orbit, NEOSSat undergoes numerous conjunctions with nearby space debris, typically with several conjunctions within 5 km daily. The microsatellite payload is a 15cm aperture Maksutov-Cassegrain optical telescope, which serves as a dual use scientific instrument and star tracker. With this sensor NEOSSat is able to image conjuncting objects in-situ, both as objects close in near the TCA, and if the geometry is favorable, over several orbits just ahead of the TCA. Close proximity of conjuncting debris allows for unique characterization of LEO debris not normally visible to optical sensors.

The opportunities for general LEO to LEO optical imaging are scarce due to the high relative angular rates of any two LEO objects. This is not case just ahead of a TCA, where an object is at constant bearing and decreasing range in the minutes before conjunction. Small observing windows of low relative angular rates (< 200 arc-seconds/s) also exist in the few orbits ahead of the TCA for most conjunction geometries.

Results of several imaging campaigns of conjuncting objects are presented, from a variety of relative velocities and approach angles. The photometric characterizations of conjuncting debris are analyzed and the impact on orbit determination and probability of collision accuracy improvement from near TCA angles-only data is also presented.