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CAPABILITIES OF A NANO-LIDAR FOR FUTURE RECONNAISSANCE MISSIONS TO NEOS

Abstract

Many Near Earth Objects (NEOs) have significant uncertainty in their orbital elements and physical characteristics. This leads to even greater uncertainty in their impact risk as their orbits are propagated forward in time. The orbital elements, size and shape of an asteroid could be more precisely determined by a spacecraft flyby in which the relative position and velocity vectors are measured using time-of-flight LIDAR. In combination with the more precisely known orbital elements of the spacecraft, these measurements can increase the accuracy with which the NEO's parameters are known. It is also feasible to gather other information about the visited targets using the same instrument, for example information on the physical size and shape of the object, which is both interesting scientifically and useful if an impactor is detected.

Due to the large number of targets that would be interesting to investigate, sending a large, expensive spacecraft to each one is infeasible, and instead a fleet of nanosatellites could be deployed with the sole purpose of encountering multiple targets each and measuring their orbits along with some other physical parameters. We have constructed a simulation to determine the maximum distance at which a target could be reliably detected with a ToF LIDAR utilizing a Geiger-mode avalanche photodiode (GM-APD) based detector as a function of transmitted laser pulse energy in order to determine how close a flyby would be needed. Using the results of this, we also assess a method for using the LIDAR during flyby to perform 2D scans of the target, and derive limitations on the flyby conditions – relative velocity, closest approach distance, target size - that would allow such a measurement to be taken without significant deformation of the reconstructed image due to motion blur at high flyby velocities.

The simulation results were used as the starting point for the design and realization of a first sensor prototype that is currently in the construction/testing phase in the laboratory of the Fraunhofer Centre for Applied Photonics at the University of Strathclyde.