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Student Designed Solutions for In-Orbit Detection and Tracking of Small Orbital Debris

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Overview

During the Fall 2010 semester, 16 senior undergraduate engineering students investigated options for a satellite and sensor capable of detecting and tracking small orbital debris. Small debris is defined as debris with diameter between 1 cm and 10 cm. NASA estimates that there exist about 500,000 occurrences of small debris in Low Earth Orbit (LEO). Debris of this size isn't currently tracked from Earth, but it poses a danger to missions Earth's orbit. Though it is small, at orbital velocities, this debris is capable of causing catastrophic damage to functional objects.

Results of a European Space Agency (ESA) lab test showing results of an impact at 6 km/s between a 1.2 cm aluminum sphere and a 18 cm aluminum block.

If this debris can be detected and tracked in-orbit, not only will we be capable of creating a catalog of the debris to improve situational awareness in LEO, but such a mission could prove the feasibility of a future in-orbit active removal method.

Explanation

Safe access to space is critical to the future of space science. Tracking and cataloging space debris not only allows for situational awareness in orbit, but also improves the possibility of future removal.

Key Findings

Optical vs. Laser Sensors

Optical sensors were considered and eliminated, based on factors such as there being no optical sensor powerful enough to see debris at a sufficient distance and that range is difficult to determine with an optical method.

Laser sensors use reflected light to determine the range and movement of an object. Laser range finders (LRF) and the Light Detection and Ranging (LIDAR) system currently being developed by the National Institute for Standards and Technology (NIST) were compared using the Analytical Hierarchy Process.

	Mass		Power		Data Vol. Generated		Reliability		Development		
Options	*Weight*	*Score*	*Weight*	*Score*	*Weight*	*Score*	*Weight*	*Score*	*Weight*	*Score*	*Total Score*
LIDAR	8%	25%	40%	25%	13%	88%	23%	80%	15%	83%	**55%**
LRF		75%		75%		12%		20%		18%	45%

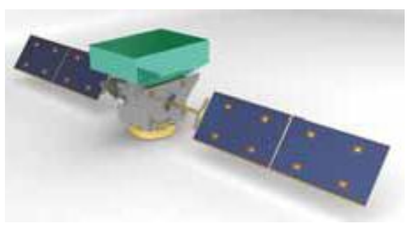
Results of Analytical Hierarchy Process comparison of LRF and LIDAR.

Spacecraft Platform Configuration

Options considered for the spacecraft bus included a custom bus with gravity gradient stabilization and various commercial off the shelf (COTS) spacecraft platforms.

Recommendations

The team recommends the NIST LIDAR on a COTS spacecraft bus (for example, the Surrey SSTL-600). Data can be sent to ground stations for evaluation and cataloging.



SSTL-600 in Flight Configuration

Impact

IPT's research shows that it will be possible in the future to detect and track small debris in-orbit. This is essential to the future of space technology, research and exploration.

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