SPACE DEBRIS SYMPOSIUM (A6)
Measurements (1)

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POSITION SENSING OF ORBITAL DEBRIS BY LASER ILLUMINATION: OPTIMIZATION OF SYSTEM PERFORMANCE

Abstract

The growing threat of space debris is an equally growing concern for satellite operators. In low earth orbits (LEO), the spatial density of non-functional man-made objects is peaking at altitudes of approximately 780 km. Until active debris removal measures are not conducted, the space faring community has to handle this threat by performing collision avoidance maneuvers. In order to accomplish this, it is self-explanatory that accurate position information of the debris is necessary as a basis of orbit propagation.

An emerging method for position sensing of LEO debris is the utilization of pulsed laser ranging and tracking. This method features inherently a comparable high accuracy, as a range resolution on the order of one meter and an angular accuracy of approximately ten micro radians are possible. Parameters influencing the system accuracy are the laser wavelength, the pulse length, and the aperture sizes of the transmitting telescope.

Besides the achievable accuracy of the position measurement, the "performance" of a debris tracking and ranging system could be assessed in terms of measureable debris size as well. Naturally, the energy of the laser pulses and the aperture size of the receiver telescope are critical regarding the debris size threshold, likewise has the object's distance to be considered. Furthermore, the chosen laser wavelength exhibits considerably different characteristics with respect to atmospheric turbulence and extinction, respectively.

In this paper, we assess how a laser-based orbital debris position sensing system could be optimized in terms of both perceptions of "performance". This includes the mutual influence of the above mentioned parameters on both, the measurement accuracy and the debris size threshold. Depending on the intention of the operator - either to optimize the accuracy or to minimize the size threshold - the system parameters could be altered in order to tune the system towards the chosen direction. Beyond that, we discuss further system parameters like laser pulse repetition rate or eye-safe wavelength, which do not directly influence the "performance", but do have an impact on the technology acceptance as well as the operational availability of such system.

Concluding, the laser-based position sensing of LEO debris has experimentally proven itself as promising technology for debris observations. We will discuss that such system comprises several system parameters which influence the measurement accuracy as well as the debris size threshold in conflictive directions. Furthermore, we will elaborate reasonable routes for future laser-based systems or networks.