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SPACE DEBRIS SYMPOSIUM (A6)
Measurements (1)

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# MISSION ANALYSIS OF THE SPACE-BASED OPTICAL OBSERVATION FOR ORBITAL DEBRIS

**Abstract**

Technologies necessary for Space Situational Awareness (SSA) are essential for the current and future space development. Since the bases of SSA are observations, the improvements in the ability to observe debris are highly significant. We aim to establish a mission analysis tool in order to devise strategies using space-based optical observation. To accomplish this objective we developed a space-based optical observation simulator. One cm and larger debris to be tracked individually include catalogued space objects greater than 10 cm, and hypothetical fragments between 1 cm and 10 cm from major breakups. These features enable us to conduct virtual observations, which contain information on the angle, the angular velocity and the apparent magnitude for each debris. The outcome of the virtual observations clarified the impact of mission orbits on the observation capabilities. Here we restrict mission orbits to the low Earth orbit (LEO) region. This restriction means a spacecraft in the LEO region observe debris that across the LEO region. From the perspective of illumination environment constancy, spacecraft should be in sun-synchronous orbits. First, we evaluated mission altitudes based on two different measures: 1) the number of objects passing through each latitude bin, and 2) the effective number of objects at each altitude bin. We obtained two different promising altitudes as results of the evaluation. The local time of the ascending node (LTAN) is an important factor to determine the illuminant environment. We assumed three different LTANs with a consideration on the symmetry of orbital planes. Combining with two promising altitudes, then six different orbits in total were compared in terms of limitations in the angular velocities and the apparent magnitude to get an optimal orbit. Next, we analyzed the optimal observation direction of the observer in the optimal orbit with an assumption on the field of view. With these specifications we analyzed statistics such as the number of detected debris, the number of re-observed debris and the observation frequency in order to evaluate the observation capabilities. We also discussed two different observation capabilities improvement methods; one is the constellation and another is the observation range extension. This paper also summarized the effectiveness of these two improvement methods in terms of the number of observed debris and the observation frequency.