18th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Virtual Presentations - 18th IAA SYMPOSIUM ON SPACE DEBRIS (VP)

Author: Prof. Zhaodong Niu
National University of Defense Technology, China, niuzd@nudt.edu.cn

Dr. Quan Sun
National University of Defense Technology, China, nudt_sunquan@163.com
Dr. Weijun Zhong
Xi'an Satellite Control Centre(XSCC), China, 125525926@qq.com
Dr. Hong Liu
Xi'an Satellite Control Centre(XSCC), China, liuhong19870518@126.com
Dr. Shengtong Yang
National University of Defense Technology, China, 1025277992@qq.com
Dr. Shuai Feng
National University of Defense Technology, China, 1185146849@qq.com

INDEPENDENT SURVEILLANCE OF GEO DEBRIS VIA A DUAL TELESCOPE ARRAY WITH LARGE FOV MOUNTED ON AN EARTH-ORIENTED SATELLITE

Abstract

To avoid potential collision events in outer space, it is necessary to maintain an orbit catalogue of space debris. Nowadays, space-based optical surveillance has become an important supplement to ground-based surveillance. Many dedicated satellites have been designed to monitor GEO debris, such as Sapphire satellite, ESA SBSS demonstration mission and ORS-5 satellite. Different from the above-mentioned special surveillance satellites, a dual telescope array with large field-of-view is assumed to be mounted onto an earth-oriented satellite fixedly as a secondary payload to realize independent monitoring and cataloguing of GEO debris. The satellite orbit is selected as sun-synchronous dusk-dawn orbit. Besides, the line-of-sight of payload should preferably point away from the Sun, for example, when the local time of orbital ascending node is 06:00 a.m., the azimuth of the pointing direction in the satellite body coordinate frame is selected as negative 90 deg. Through the selection of satellite orbit and azimuth angle of line-of-sight, the payload can have good phase condition for object observation. The key issue in the design of the object observation strategy is to optimally determine the field-of-view, aperture diameter and elevation angle of the payload. For this reason, this paper firstly analyzes the relationship between the coverage area of the payload on the spherical surface of GEO orbit and its field-of-view, as well as its elevation angle. Then the sufficient conditions for the total coverage of the GEO debris are deduced theoretically. Based on the theoretical analysis results, a dual telescope array of 12.5 deg by 25 deg field-of-view is designed. The field-of-view, aperture diameter and focal length of a single telescope are equal to 12.5 deg by 12.5 deg, 15 cm and 22 cm respectively. In accordance with the telescope, a sCMOS detector with pixel resolution of 6k by 6k and pixel size of 8 μm is chosen as the imager. This paper validates the surveillance performance of the proposed payload by simulation experiment, in which the number of simulated GEO objects is 1150, and the scenario time is set from 00:00 a.m. on the 21st to 12:00 p.m. on the 25th of each month from September 2017 to August 2018. Experimental results show that the limiting magnitude of the payload is about 16 mag and it can effectively detect more than 99% of all GEO objects larger than 80 cm in diameter twice a day. The average duration of each observation exceeds 10 minutes.