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GROUND-BASED OPTICAL OBSERVATION SYSTEM FOR LEO OBJECTS

Abstract

We have examined the possibilities of a ground-based optical observation system for low Earth orbit(LEO) objects. Simulations and a test observation showed that two longitudinally separate observation sites with arrays of optical sensors can detect many LEO objects 30 cm in size and precisely determine their orbit. The space environment has recently deteriorated due to space debris, particularly in the LEO region. In order to protect active satellites in LEO, space debris must be precisely monitored. Although currently, this is mainly handled by the Space Surveillance Network (SSN), via global radar observation sites of the United States, the SSN detection limit is about 10 cm which is insufficient to protect active satellites. Most satellites cannot survive a collision with an object of 1 cm. Conversely, optical sensors are mainly used to monitor geostationary (GEO) orbits because GEO is too far for radar observation. However, enhancing the detection efficiencies of optical sensors and PC performances, and the extremely low cost compared to radar systems may enable optical sensors to monitor LEO objects as radars. To complement radars, optical sensors can help monitor LEO objects and also have the advantage of being able to determine the positions of space objects to accuracy of within one arc second, which will facilitate precise orbit determination. An array of numerous optical sensors may even be equivalent to a radar observation system. However, their disadvantages are the limits on observation time due to daylight and weather conditions. Although the observable period for optical sensors is limited to 4-6 hours per day, they are much cheaper than radar systems, which easily outweighs their disadvantage. We carried out some simulations to evaluate the optical system, which showed that identical objects were recognized from the data of four individual sets of equipment installed on two separate sites using the orbital elements of each object. This enables us to determine the orbits of uncatalogued LEO objects precisely. We also carried out a test observation to determine the orbit using actual observation data. The results showed that the optical system is capable of determining the orbits of LEO objects accurately enough to track them the following day using data from two separate sites.