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A MULTIOBJECTIVE GENETIC ALGORITHM FOR SCHEDULING FOLLOW-UP OBSERVATIONS OF GEOSYNCHRONOUS SPACE OBJECT

Abstract

Optical observations for space debris in the geosynchronous region have been performed for many years. During this time, observation strategies, processing techniques and cataloguing approaches were successfully developed. Nevertheless, the importance of protecting this orbit region from space debris requires continuous monitoring in order to support collision avoidance operations. So-called follow-up observations providing information for orbit improvement estimations are necessary to maintain high accuracy of the catalogued objects. Those serve a two-fold: Firstly, the orbits have to be accurate enough to be able to re-observe the object after a time without observations, that is keeping it in the catalogue, secondly, the importance of protecting active space assets from space debris requires even higher accuracy of the catalogue orbits. Due to limited observation resources and because a space debris object in the geostationary orbit region may only be observed for a limited period of time per the observation night and telescope, optimized scheduling of follow-up observations is a key element. This paper presents an optimal scheduling algorithm for a robotic optical telescope network using a multiobjective genetic algorithm based on the successful Non-dominated Sorting Genetic Algorithm II (NSGA-II). The developed scheduling algorithm has been utilized to provide optimized solutions for catalogue maintenance with two optimization parameter. As the first one, the information content of the orbit has been used. It will be shown that information content utilizing the orbit's covariance and the information gain of an expected update is a useful optimization measure. The second optimization parameter is the detection probability given by the pre-estimated magnitude of the object. Since the information content of a follow-up observation depends on the observation time and oszillates slightly during the night similar information gain values might be reached at different observation epochs. Therefore, it will be demonstrated that an optimized phase angle might not reduce the information content of a follow-up observation substantially. Finally, simulations of space debris objects are used to study the effectivity of the scheduling algorithm.