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AN IMPROVED SYNCHRONIZED ORBIT DETERMINATION METHOD BASED ON DISTRIBUTED STAR SENSORS

Abstract

With the increasing amount of space debris and the shortage of space resources, the acquisition of orbital information with extensive space region and high accuracy is becoming more necessary. Comparing with ground-based facilities, space-based sensors can obtain preferable observation geometry and weak constraints to surveillance. To reduce the cost of space-based orbit determination (OD) and to establish a wide surveillance network, star sensor is introduced to obtain the angle information of non-cooperative objects (i.e. debris).

Star sensor is a necessary onboard sensor for attitude determination through taking star pictures and matching with star catalogue. But in this paper, we innovatively put forward to take advantages of star sensors to capture non-cooperative objects and obtain angle information of them from short visible arcs, which means most satellites in orbit with star sensors can be regarded as distributed space surveillance platforms to serve for synchronized ODs.

Based on the background above, this paper mainly concentrates on the analysis of visibility to distributed space-based space surveillance sensors and involved algorithm of initial OD.

First, the visibility of sensors in low orbits to observe the objects in high orbits, especially in GEO is analyzed. In this model of visibility, earth shadow, atmosphere, illumination conditions of sun and moon are taken into account. Second, an initial OD approach has been researched. Synchronized OD means one object will appear in different sensors' field of view simultaneously, and a series of angle information at the same epoch will be obtained. To eliminate trivial solution in classical Laplace method and to enhance the rate of convergence, a novel algorithm with improved Laplace method is proposed. Simulation results show that this proposed approach can not only decrease random errors, but also significantly reduce the requirement of short visible arcs in OD. The success rate of OD is also enhanced.