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oral

SPACE DEBRIS SYMPOSIUM (A6)
Measurements (1)

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TRACK INITIATION USING SPARSE RADAR DATA FOR LOW EARTH ORBIT OBJECTS

Abstract

This paper deals with the track-initiation problem of Low Earth Orbit (LEOs) objects observed by a space surveillance radar system of wide cross-elevation, narrow elevation sized field-of-view (FOV). Recently, a method to limit the association possibilities of short arcs (SAs) at one revolution of interval has been proposed in [2], enabling the track initiation in a Multiple Hypothesis Tracking algorithm (MHT) [1]. In this paper, starting from two SAs at one revolution of interval, an approach to estimate the state (six orbital elements) is presented. The method is based on the geometrical determination of four orbital elements, enabling the association of a third SA to find the two remaining orbital elements. The resulting state constitutes an initial orbit (IO), enabling the use of regular tracking techniques [3][1].

The following hypotheses on the ground radar are made to stick to current specifications of space surveillance systems being designed: south-oriented, monostatic radar installation of wide cross-elevation (160), narrow elevation (2) FOV providing range, azimuth and elevation measurements. To simulate detections from the ground radar, we use real data from the Space-Track Two-Lines Elements (TLE), a space objects catalogue provided by USSTRATCOM combined with SGP4 propagator [4]. The main problem is to obtain orbital elements with a sufficient precision to limit the number of valid third SAs in order to keep under control the number of association hypotheses in the MHT algorithm. The principle of the presented approach follows three steps: First, the semi-major axis, the inclination, the right ascension of ascending node and the mean anomaly are retrieved from geometrical considerations – additionally, the semi-major axis undergoes a correction to be more suited to an SGP4 propagator. Then, the covariance matrix of the obtained state-vector is computed using a Monte-Carlo method and the resulting distribution is propagated at the times of new observations using an unscented transform (UT) [5] to assess their correlation. Finally, a Gibbs problem is solved using a set of three correlated SAs to find the values of the eccentricity and argument of perigee. The resulting state may be used as an IO in regular definitive orbit determination [1] and tracking [3] techniques.

The principle and functioning of the method on realistic simulation are presented, as well as its performance and limiting cases.