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A SEARCH STRATEGY APPLICABLE FOR BREAKUP FRAGMENTS IN HIGHLY ELLIPTICAL ORBIT

Abstract

Recently, breakups on Highly Elliptical Orbit (HEO) came to be considered as more serious problem for the orbital environment. In HEO, most breakups took place on Molniya orbit or Geostationary Transfer Orbit (GTO) whose perigee altitude is below 2000km, which means a large number of fragments can collide with objects in Low Earth Orbit (LEO). In addition, little is known about fragments on HEO because there are two major problems in tracking them. One is the ambiguity of the event time. This problem lowers the accuracy of origin determination, and the accuracy of estimation of the fragments distribution. The other is that geocentric distance and velocity of each fragment change along with the orbital position unlike in circular orbits. These changes make it difficult to determine optimal directions of observation. Therefore, this study aims to design a search strategy for fragments in HEO by developing an effective observation planning scheme and a breakups evaluation scheme. In the observation planning, this study utilized previous strategy aimed for Geostationary Orbit (GEO) objects. The previous strategy predicts the population of fragments from a single breakup event and then specifies the point where most fragments will be detected as a function of geocentric right ascension and declination. This study upgraded this strategy by introducing the separation angle between observation direction and direction of a fragment so that high latitude areas are also evaluated properly. In addition, the limitation of observation facilities and the feasibility of orbit determination are also taken into the consideration. As for evaluation of breakup events, inclination vector was introduced. Inclination vector is defined by the inclination and the right ascension of the ascending node (RAAN). Since these parameters are not perturbed lot during long term orbit propagation, inclination vector guarantees a high accuracy. We found that possible orbital planes of fragments from a single breakup event form an ellipse when expressed on the inclination vector plane. The slope of the major axis varies depending on the right ascension of the event position. Therefore, by comparing this constraint and cataloged objects, we can estimate detailed event position, or detailed event time. As verification, we estimated the event time of 1968-081E (US Titan 3C Transtage) because its detailed event time was available. Consequently, we found that the estimation error was less than 1 min compared with officially reported time.