16th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 16th IAA SYMPOSIUM ON SPACE DEBRIS (IP)

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REAL-TIME ORBIT DETERMINATION OF NONCOOPERATIVE MANEUVERING TARGETS WITH SPACE-BASED BEARING-ONLY MEASUREMENTS

Abstract

Real-time orbit determination of noncooperative maneuvering targets is one of the most important techniques in the space situation awareness (SSA). The space-based bearing-only measurement will probably be the main observation means in the future SSA because of its merits compared with the ground-based observation, e.g., high measurement accuracy, independency of atmosphere and geography. Therefore, the real-time orbit determination of noncooperative maneuvering targets with space-based bearing-only measurements is studied in this article. First, the maneuver inside orbit plane is researched according to the characteristic of maneuvering flight. The maneuver is decomposed into radial and in-track components and established into kinetic and dynamic models along the two directions. Second, the models of real-time orbit determination are studied using space-based bearing-only measurements and the kinetic and dynamic models. The extended Kalman filtering (EKF) is adopted to calculate the real-time orbit and corresponding kinetic and dynamic parameters. Finally, numerical simulations are introduced to compare the orbit determination results of the two models. The simulated cases include high and low targets with maneuver in the radial, in-track, integrated direction, respectively. According to the research, the following conclusions can be drawn. 1) With the low continuous thrust along the radial direction, the orbit 'relative height' varies as the initial orbit height increases and appears an inflection point, which indicates the complicated integral effect of orbit perturbation and thrust. In contrast, the case with low continuous thrust along the in-track direction has a minor difference from the two-body orbit. 2) With the same observation arc and low thrust, the orbit determination result of low targets is better than that of high targets when the kinetic model is used. However, the orbit determination results with the kinetic model are barely satisfactory because the kinetic parameters cannot precisely reflect the detail characteristic of maneuvering orbits and the orientation measurements poorly constrain the solution of maneuvering orbits especially with only a single space-based platform. 3) Results of real-time orbit determination with the dynamic model are well beyond that with the kinetic model. With the given simulation conditions, the orbit determination accuracy can be better than 1 km and 5 km respectively for the low and high maneuvering targets. Furthermore, the estimated accuracy of thrust parameters and ratio of area to mass is satisfactory. This research can be beneficial to the future space situation awareness and mission operation.