15th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations (IP)

Author: Mr. Fei Su
National Astronomical Observatories, Chinese Academy of Sciences, China

Dr. Jing Liu
National Astronomical Observatories, Chinese Academy of Sciences, China
Mr. yao zhang
National Astronomical Observatories, Chinese Academy of Sciences, China
Mr. Xu Yang
National Astronomical Observatories, Chinese Academy of Sciences, China

IN-PLANE COLLISION AVOIDANCE MANEUVER STRATEGIES BASED ON ORBIT MAINTENANCE

Abstract

The process of trajectory design and maneuvering for preventing collision with other space objects is becoming increasingly important in space missions because of the growing amount of space debris and number of spacecraft in orbit. The increasing threat raised by space objects led to the development of different mathematical models and approaches to investigate the dynamics and optimal thrust of collision avoidance. In this review, the problem of in-plane impulsive collision avoidance maneuver strategies based on orbit maintenance between two colliding objects is developed, and the strategies can reduce collision probability and increase miss distance of two spacecrafts by the constraint of orbit maintenance. One of the orbiting objects (the primary) is assumed to be an active controllable spacecraft, the other object (the secondary) may not be controllable as in the case of a failure satellite or space debris. Suppose we are faced with a situation of high imminent collision probability or the relative distance that is above a specified acceptable threshold value. We wish to perform an orbit maneuver that is optimal in the sense it requires the velocity change to mitigate the potential collision threat with the orbit performance is unchanged. Firstly, Closed-form analytical expressions are provided that accurately predict the relative dynamics of the two objects in the encounter b-plane, which following an impulsive performed by one object at a given orbit location to the impact location. Then, the collision probability and the miss distance of spacecraft dangerous rendezvous are obtained by the relative position covariance information of the encounter b-plane. With the analytical model, the linear relationship between the maneuver impulsive and the relative motion of spacecraft is analyzed and the maneuver optimization problem formulates as a function gradient problem coupled to a simple nonlinear equation. Collision avoidance maneuver is calculated by a two steps strategy. Firstly, a gradient technique is used to find the maneuver direction. Secondly the maneuver magnitude is found using a one-dimensional root finding scheme that takes advantage of the linear relationship between the maneuver velocity and resulting displacement. Finally, this method is applied to an impact case, and the result is satisfying.