Paper ID: 14570
oral
student

ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control (1) (1)

Author: Dr. Jihe Wang
University of Tokyo, Japan, wang@space.t.u-tokyo.ac.jp

Ms. KUN QIAO
The University of TOKYO, Graduate school, Japan, qiaokun@space.t.u-tokyo.ac.jp
Dr. Takaya Inamori
University of Tokyo, Japan, inamori@space.t.u-tokyo.ac.jp
Prof. Shinichi Nakasuka
University of Tokyo, Japan, nakasuka@space.t.u-tokyo.ac.jp

FAILURE SCENARIOS BASED COLLISION AVOIDANCE CONTROL STRATEGIES FOR SATELLITE FORMATION FLYING

Abstract

Considering the close distances between member satellites in satellite formation flying, it is essential to avoid all possible collisions between member satellites in all formation operation scenarios. It is well known that when formation is in normal operation phase, possible collisions could be avoided by using various collision avoidance strategies extensive studied over the past twenty years. However, these normal collision avoidance strategies have difficulties to address potential collisions caused by satellite failure, for the reason that two important issues are missing, namely, collision prediction to predict future collisions and failure scenarios based collision avoidance control strategies corresponding to various possible failures. Therefore, a collision avoidance control strategies for satellite formation flying is proposed to guarantee collision free operation in satellite failure case.

In order to propose failure scenarios based collision avoidance control strategies, firstly, one collision prediction algorithm based on calculating the minimum distances between probability ellipsoids obtained by propagating the initial relative states and errors are presented. Secondly, by analyzing possible collisions when satellites are in failure mode, four different potential collisions scenarios are proposed, namely, short term recoverable (collision will happen in short time and the failure can be recovered), long term recoverable, short term unrecoverable and long term unrecoverable. Finally, regarding to four different failure scenarios, corresponding collision avoidance control strategies are proposed as: for short term and long term recoverable failure cases, the failure satellites will be controlled to its normal orbits, but, for short term and long term unrecoverable failure cases, in stead to control the failure satellite back to normal formation configuration, the formation will be controlled to one new collision free configuration with passive safety characteristic is obtained by using genetic algorithm.

In order to verify the effeteness and validity of our proposed failure scenarios based collision avoidance methods, several numerical simulations are conducted. The results show that for four different failure cases, the corresponding failure scenarios based collision avoidance method is effective to avoid potential collision cases. The collision avoidance methods proposed in this paper is valid.