20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 20th IAA SYMPOSIUM ON SPACE DEBRIS (IPB)

Author: Mr. Mahiro Tanahashi
Kyushu University, Japan, tanahashi.mahiro.240@s.kyushu-u.ac.jp

Dr. Hongru Chen
Kyushu University, Japan, chen.hongru.462@m.kyushu-u.ac.jp
Dr. Yasuhiro Yoshimura
Kyushu University, Japan, y.yoshimura.a64@m.kyushu-u.ac.jp
Prof. Toshiya Hanada
Kyushu University, Japan, hanada.toshiya.293@m.kyushu-u.ac.jp

ESTIMATION OF ORBITAL PARAMETERS OF BROKEN-UP OBJECT USING IN-SITU DEBRIS MEASUREMENT SATELLITE

Abstract

This study introduces a new approach to estimate the orbital parameters of a broken-up object using an in-situ debris measurement satellite. The inclination, the nodal precession rate, and the right ascension of the ascending node of the broken-up object are estimated from the simulated in-situ debris measurement data. Furthermore, the estimation accuracy is improved by using an iteratively reweighted least square method.

Collisions and explosions of satellites generate a large amount of sub-millimeter-size debris, which can cause fatal damage to a spacecraft. Thus, it is important to understand the environment of sub-millimeter-size debris generated from breakups. However, such tiny debris cannot be tracked from the ground. An in-situ debris measurement satellite is proposed, which can detect impacts with sub-millimeter-size debris and record the time and position of detection. Using this measurement satellite, previous studies estimate the orbital parameters of the broken-up object from simulated measurement data. However, they made an ideal assumption that the measurement satellite detects impacts on the intersection of the orbital planes of the measurement satellite and the broken-up object. The actual position of impacts differ from this assumption. Thus, this study introduces a new approach that can be applied to realistic measurement data simulated by using a close approach method.

In this study, the inclination of the broken-up object is determined from the history of geocentric declination at the time of detection. The nodal precession rate is estimated from the inclination, assuming that the broken-up object is in a circular orbit. The right ascension of the ascending node is estimated using the constraint equation that relates the geocentric position vector at the time of detection to the orbital parameters. The estimation accuracy is improved by using the iterative least square method weighting with the angular separation from the line of intersection of the orbital planes of the measurement satellite and the broken-up object to the geocentric position vector at the time of detection.