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ESTIMATION OF ORBITAL PARAMETERS OF BROKEN-UP OBJECTS FROM IN-SITU DEBRIS MEASUREMENT

Abstract

The risk of space debris is an important issue for the long-term sustainability of outer space activities. Even sub-millimeter-size debris still could cause a fatal damage on spacecraft. Since such tiny debris cannot be followed up or tracked from the ground, so that in-situ measurement is essential to obtain knowledge necessary to design spacecraft. However, measurements are quite limited in terms of orbital regimes and not continuously available yet. Therefore, Kyushu University has initiated IDEA the project for In-situ Debris Environment Awareness, aiming to provide a better definition of the current sum-millimeter-size debris environment, and its first satellite "IDEA OSG 1" is ready to be launched. One of primary objectives of IDEA project is to identify the location of on-orbit satellite fragmentations and the resulting environmental change. Previous research has revealed theoretically that two or more measurement satellites are necessary to identify the location of on-orbit satellite fragmentations, then, it was assumed that orbits of measurement satellites and broken-up objects were in Sun-synchronous orbit(SSO). In fact, in previous research, due to no significant difference of nodal regression rate between two orbits, aforementioned revelation was reached. Hence, first, this paper shows that a single measurement satellite can estimate the orbital parameters of broken-up objects in the presence of enough difference of nodal regression rates between the measurement satellite and broken-up objects. Estimation the orbital parameters of broken-up objects is obtained based on ideal condition which means that a measurement satellite detects impacts with fragments from a broken-up object at the line of intersection between two orbital planes of the measurement satellite and broken-up object. Second, this paper investigates how to estimate the location of on-orbit satellite fragmentations from realistic impact data, aiming to make the estimation method more robust. Realistic impact data are obtained from a conjunction analysis between a measurement satellite and sub-millimeter-size debris generated from a break-up event. Two line elements of the debris are given by NASA's standard break-up model.