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EVALUATION OF ACTIVE DEBRIS REMOVAL STRATEGY USING A DEBRIS EVOLUTIONARY MODEL

Abstract

Active Debris Removal (ADR) has been studied in order to preserve the space environment. Large debris objects such as defunct rocket upper stages and satellites in crowded regions are considered as ADR targets, but it is important for efficient ADR to identify which debris objects, and how many debris objects should be removed, and so on. Future environmental changes have been evaluated by using a space debris evolutionary model that considers future launch traffic, explosions, collisions, and other factors. This study evaluates the effectiveness of ADR strategy by using the Near-Earth Orbital Debris Environment Evolutionary Model (NEODEEM) that was jointly developed by Kyushu University and JAXA. The effectiveness of ADR is evaluated comparing some different ADR indexes such as collision probability and mass, expected number of fragments generated, or other indexes that have been proposed by past studies. It is shown that each index is effective for suppressing the increase of space debris, even though ranking orders are different for each other. The effects of limiting targets are also discussed such as debris type (for example, only rocket upper stages), mass, orbit range, and so on, by showing relations between limiting ADR targets and required number of ADR for suppressing the increase of space debris. It is shown that if ADR targets are limited to rocket upper stages, with mass less than 4 ton for example, the number of debris to be removed per year will increase. It is also shown that the removal of debris objects in lower altitude are not effective even though they have higher collision probabilities. The effect of disposal orbit of ADR is investigated by changing the altitude of disposal orbit where debris objects are to be moved. The effectiveness of ADR for large constellations are also discussed.