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IMPROVING THE METHOD OF ASSESSING THE POTENTIAL DAMAGE OF SPACE OBJECTS

Abstract

As the previous procedure of remediation of the space environment, estimating and ranking the influence caused by derelict objects significantly affect the sustainability of space utilization. Lots of related research had been done by different institutes and researchers before, and most of them focused on two aspects: the collision's probability or the long-term effection when a collision happens. However, both of these aspects have theoretical problems. For the calculation of collision's probability, when the uncertainty of an object's orbit is more significant than a certain level, the safety of this object will increase as the uncertainty increase, which is so-called "probability dilution". And for long-term analysis, the cumulative effect of stochastic interference, such as catastrophic collision or explosion event that happens randomly and affects in the long-term, is not considered. Hence the estimation may not reflect reality well after a long time if some conditions are not satisfied strictly in practice.

This work provides an algorithm that solves these two problems above, where the information entropy was calculated to measure the uncertainty and determine a probability measure based on the information theory. For the long-term effect, we assumed the effect of initial spatial density is a integral about time for each orbit, and the uncertainty of air drag, which increases the interval of estimation with time, will be regarded as the diffusion terms. Then we assume the launches and explosions satisfied with the Poisson distribution. With these assumptions, the long-term evolution will become a stochastic differential equation (SDE) with jumps, which could be solved by the Euler-Maruyama method.

The algorithm in this work has performed well in some historical data, and the accuracy and precision of the estimation of collision's probability and the long-term evolution it promoted could be helpful for active remediation strategies.