

## 控制理论与实践

### 基于协方差分析描述函数法的非线性交会精度分析

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摘要:

交会精度分析是交会对接任务设计和实施过程的一类重要问题。传统的Monte Carlo方法计算成本较高, 协方差方法对于大导航偏差或长时间交会问题误差较大。针对这些问题, 提出了一种新的非线性交会精度分析方法。采用协方差分析描述函数法(covariance analysis description equation technique, CADET), 考虑导航偏差和控制偏差, 建立了含 $J_2$ 摄动的非线性交会精度分析模型。采用一个寻的交会问题和多圈非共面交会问题测试了提出的算法, 并和Monte Carlo方法及协方差方法进行比较。结果表明, 相比Monte Carlo方法和协方差方法, 导航偏差较大或长时间交会时采用CADET方法, 计算速度快、精度高, 具有较好的工程实用价值。

关键词: 非线性交会 精度分析 协方差分析描述函数法 导航偏差

### Precision analysis of nonlinear rendezvous by covariance analysis description equation technique

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Abstract:

The rendezvous precision analysis is an important task in rendezvous mission design and execution. The currently employed Monte Carlo method is time-consuming, and the covariance analysis method has poor precision for nonlinear rendezvous problems with big initial navigation errors or long-time flight. In order to overcome these problems, a new method for nonlinear rendezvous error propagation and analysis is proposed. Based on the covariance analysis description equation technique (CADET), the models of error propagating and analyzing are deduced, which include the  $J_2$  perturbation, navigation errors and actuation errors. The proposed method is testified by two examples including a homing rendezvous problem and a multi-revolution noncoplanar rendezvous problem and compared with Monte Carlo method and covariance analysis method. The results show that for the precision analysis of nonlinear rendezvous problem with big initial navigation errors or long-time flight, the CADET based method has advantages such as higher precision and low time-cost compared with Monte Carlo method and the covariance analysis. It has better engineering application value.

Keywords: nonlinear rendezvous precision analysis covariance analysis description equation technique (CADET) navigation error

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