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UNCERTAINTY CHARACTERIZATION AND PROPAGATION FOR THE ORBIT OF CHINESE SPACE LABORATORY USING NON-INTRUSIVE POLYNOMIAL CHAOS

Abstract

The increasing number of space objects (spacecraft, rocket body, space debris, etc.) brings new challenges to the management of spacecraft and subsequent space missions. In order to ensure the safe implementation of space mission, it is necessary to calculate the relative position relationship with space objects for effective collision warning. The accuracy of orbit prediction directly affects the feasibility and confidence of collision warning based on collision probability. Therefore, this paper performs the uncertainty characterization and propagation for the orbit of Chinese space laboratory. Firstly, the dominate source of uncertainty inherent to the orbit of Chinese space laboratory is analyzed. Uncertainties in the initial state and the atmospheric drag force are considered. Mathematical statistics methods are used to establish the probabilistic model of the 3-hour geomagnetic index, daily and 81-day averaged radio flux indices. Secondly, the non-intrusive Polynomial Chaos Expansion (PCE) method is used to analysis the covariance of the position and velocity. Lastly, the error of orbit prediction is calculated by comparing the orbit determination results with the orbit prediction results at same epoch time. The covariance of the position and velocity are obtained through the statistical analysis of one year's orbit prediction error. This statistical analysis results are compared with the results of PCE method. The results show that PCE method are in good agreement with those of statistical analysis, which validates the effectiveness of uncertainty characterization and propagation method established in this paper.