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RESEARCH ON THE NAVIGATION ALGORITHM BASED ON X-RAY PULSARS WITH CONSIDERATION OF CLOCK ERROR

Abstract

Navigation based on X-ray pulsars is a young celestial navigation system, the principle of which is steady, credible, precise and free from the limits of the near earth space, it is possible to replace the navigation that based on artificial beaconing. Navigation based on pulsars is autonomous, it can reduce the expenditure of maintenance and has become an international hot problem.

The essential of navigation based on pulsars is the accurate measure of time, when clock error exits in the spacecraft clock and drifts with time, the navigation error based on pulsars increases with time and which is likely to lead the mission failure, so clock error is one of the most important factors that effect the navigation and could not be neglected.

The principle of navigation based on pulsars with consideration of clock error is to measure the pulse arrival time on the spacecraft by its X-Ray detector, in order to compare the measured pulse arrival time with the predicted time at the origin of solar system barycenter(SSB), spacecraft projects the arrival times of photons by its detector onto the SSB origin by the transformation model of time, the time difference between the predicted time and the transferred time embodies the position error and clock error of the spacecraft. By measuring the pulse arrival times from different pulsars, adopting the arithmetic of navigation, the clock error and the position error could be well estimated.

Basing on the models of orbital dynamics and clock error which is simulated using a 3-state polynomial process, in this paper, the position, velocity, clock error, drift velocity of clock error and the drift acceleration of clock error are chosen as the state variable, the time of pulse arrive at the spacecraft is taken as the observation information, a new arithmetic of pulsar navigation with the consideration of the clock error is proposed. Taking the mid course of the deep impact orbit for example, the new arithmetic is verified by simulation. Results show that the effect of the clock error in the navigation is well dealt by this algorithm, so the new algorithm is referable to the application of navigation based on x-ray pulsars.