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THE ALGORITHMS ANDPERFORMANCE ANALYSIS OF SPACECRAFT INERTIAL NAVIGATION SYSTEM BASED ON ROTATION MODULATION

Abstract

Inertial Navigation System (INS) is an important navigation equipment for vehicles. However, its navigation precision would be generally worse and worse as the time goes on. INS precision depends on not only the accuracy of the inertial components such as the gyroscope and accelerometer, but also the new work mode like the Integrated Navigation. The Rotation Modulation (RM) is a new work mode to improve the precision.

The basic principle of RM is to rotate the inertial components around the certain directions designed in advance. Some navigation bias caused by constant errors of inertial components would be eliminated by integral algorithms. Generally, RM is widely used in ships to overcome navigation precision degradation caused by the bad measurement environment that ships always swing. Moreover, the effect of RM would be better for a longer working time.

However, there are few applications that the RM is used in the aircrafts and the spacecrafts. Since the RM is helpful during a longer flight and the worse measurement environment, it should have the potential ability to use for the high-speed re-entry aircrafts and spacecrafts. This paper selects the high-speed re-entry aircrafts and spacecrafts as the objects, discusses the application characteristics of RM and wish to put forward a possible engineering application for the future.

The preliminary work is as follows. RM error model based on the ENU coordinate is established. The related model of typical error sources, constant error, scale error, mount error and rand error, is

established under the time and frequency domain. Single-axis rotation modulation model of one-way rotation and two-way rotation is established.

Focusing on single-axis RM, the three modes, non-rotating, one-way rotation and two-way rotation, are analyzed on the precision changes.

In simulation, the constant errors are the constant drift bias of the gyroscopes in our work and are set as 0.01 degree/ hour and 1 degree/hour to denote the low precision gyroscopes and high precision gyroscopes, respectively.

Simulation results show that navigation accuracy of low precision gyroscope with RM is similar to the one of high precision gyroscope. Thus the requirement for the gyroscope precision could be reduced to fulfill the requirement of navigation precision. Compared with one-way rotation and two-way rotation, the error of rotating axis decreases but not obvious enough. Considering that two-way rotation increases the complexity of rotation mechanism, two-way rotation may not the best.