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A MULTI-POSITION SYSTEMATIC CALIBRATION METHOD FOR LASER GYRO STRAPDOWN INERTIAL NAVIGATION SYSTEM

Abstract

Laser gyro strapdown inertial navigation system (LSINS) has been widely used in all kinds of space launch vehicles such as airship, airplane and so on. The process of calibration is the most essential factor to the accuracy of navigation. Separate calibration methods not only have great dependence on the accuracy of the testing facilities, but also may bring the dither noise of laser gyro into the calibration results. To solve this problem, this paper proposes a multi-position systematic calibration method. This method can identify all the parameters of LSINS including biases, scale factors and misalignments of accelerators and gyros with high degree of accuracy. In the beginning of this paper, accelerator and gyro error models are given, which tell twenty-one parameters to be identified. Based on the inertial navigation error equations, we present the parameter relationships between velocity errors, attitude errors and inertial sensor errors. During the course of deduction, the algebraic method is used to reduce the calculation burden. In the end, the principles on how to identify all the parameters are presented. To be specific, when LSINS is at rest, biases, scale factors and misalignments of accelerator and biases of gyro can be identified through the observed velocity errors and attitude errors. When LSINS rotates from one position to another position, scale factors and misalignments of laser gyro can be identified. To identify all the parameters, LSINS should rotate at least nine times and ten positions are the least number of positions. Following the theoretical analysis above, this paper gives the rules to design a proper multi-position calibration procedure. The designed positions should satisfy the requirement that the deduced matrix is full rank. Based on the rules, this paper designs a multi-position systematical calibration procedure. The original position is east-north-up. Then, the LSINS rotates 90 degree around x, y, z respectively. Using the deduced equations, all parameters of accelerator and laser gyro can be calculated. Simulation and experimental results show the feasibility and superior performance of the proposed multi-position calibration method.