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Author: Mr. Jixin Li
Luoyang Optoelectro Technology Development Center, China

Mr. Xiaogeng Liang
Luoyang Optoelectro Technology Development Center, China
Mr. Weihua Ma
Northwestern Polytechnical University, China
Mr. Keqiang Xia
State Key Laboratory of Astronautic Dynamics, China
Mr. Xuanbo Wei
Northwestern Polytechnical University, China
Mr. Chen Xu
Northwestern Polytechnical University;National Key Laboratory of Aerospace Flight Dynamics, China

KALMAN FILTERING FOR SINS/GNSS INTEGRATED NAVIGATION OF LONG RANGE CRUISING VEHICLES

Abstract

Abstract: The Kalman Filter of Strapdown Inertial Navigation System/Global Navigation Satellite System(SINS/GNSS) has been researched for long range cruising vehicles. Because these vehicles fly for a long time and may experience very different environments and motion states, the measurements short-term/long-term noises and system errors are always complicated and uncertain sometimes. These factors will cause the kalman filter's model parameters unfit with real signals from SINS and GNSS. Then the navigation precision may be degraded enormously and can not meet the requirement during the long cruise. One of the critical elements which determine the performance of the SINS/GNSS navigation system is the system variance matrix, as well as the measurement variance matrix. Because the longitude/latitude/altitude states involve system noises implicitly, so the relevant factors in the variance matrix should not be set to be zeros, but to be non-zero ones. Several methods of setting the system covariance matrix properly in advance in Kalman filter are put forward and tested: the first, the proper values can be selected according to the offline error analysis and engineering judgment; the second, the proper values can be determined by the equations which can be derived from the system state functions; the third, when the sensor noises change with time or conditions, the online estimator of sensor noises may be necessary to determine the time-varying covariance matrix. The integrated navigation simulations with very-high speed long range cruising vehicle demonstrate that both the system covariance matrix and the altitude channel modification architecture are the critical elements in engineering practice, and the modified system covariance matrix significantly improved the position convergence speed and the navigation precision, to be no more than one third of the traditional approach in altitude channel in the given simulation scenario. Key Words: Kalman filter, SINS/GNSS, navigation, cruising vehicle