The Integration of Strap-Down INS and GPS Based on Adaptive Error Damping

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References:

Abstract:
The concept and results of integration of a strap-down inertial navigation system (INS) based on low-accuracy inertial sensors and the global positioning system (GPS) have been presented in this paper. This system is aimed for the purposes of navigation, automatic control, and remote tracking of land vehicles. The integration is made by the implementation of an extended Kalman filter (EKF) scheme for both the initial alignment and navigation phases. Traditional integration schemes (centralized and cascaded) are dominantly based on the usage of high-accuracy inertial sensors. The idea behind suggested algorithm is to use low-accuracy inertial sensors and the GPS as the main source of navigation information, while the acceptable accuracy of INS is achieved by the proper damping of INS errors. The main advantage of integration consists in availability of reliable navigation parameters during the intervals of absence of GPS data. The influence of INS error damping coefficients is different depending on the fact whether the moving object is maneuvering or is moving with a constant velocity at that time. It is proposed that INS error damping gain coefficients generally should take higher values always when GPS data are absent, while at the same time their values in the error model (EKF prediction phase) can be additionally adapted according to the actual values of vehicle acceleration. The analysis of integrated navigation system performances is made experimentally. The data are acquired along the real land vehicle’s trajectory while the intervals of absence of GPS data are introduced artificially on the parts characterized both by maneuver and by constant velocity while at the same time their values in the error model (EKF prediction phase) can be additionally adapted according to the actual values of vehicle acceleration. The analysis of integrated navigation system performances is made experimentally. The data are acquired along the real land vehicle's trajectory while the intervals of absence of GPS data are introduced artificially on the parts characterized both by maneuver and by constant velocity.

Keywords:
Inertial navigation, Extended Kalman filter, Position estimation, Global positioning system, Navigation, Land vehicles