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THE PERFORMANCE ANALYSIS OF AN AKF BASED TIGHTLY-COUPLED INS/GPS INTEGRATED POSITIONING AND ORIENTATION SCHEME WITH ODOMETER AND NON-HOLONOMIC CONSTRAINTS

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Keywords: INS, GPS, Tightly-coupled, AKF, non-holonomic constraints

Abstract. INS/GPS integration scheme can overcome the shortcoming of GPS or INS alone to provide superior performance, thus this study implements a tightly-coupled INS/GPS integration scheme using AKF as the core estimator by tuning the measurement noise matrix *R* adaptively. The AKF is based on the maximum likelihood criterion for choosing the most appropriate weight and thus the Kalman gain factors. The conventional EKF implementation suffers uncertain results while the update measurement noise matrix *R* and/or the process noise matrix *Q* does not meet the case. The primary advantage of AKF is that the filter has less relationship with the priori statistical information because *R* and/or *Q* vary with time. The innovation sequence is used to derive the measurement weights through the covariance matrices, innovation-based adaptive estimation (IAE) in this study. The covariance matrices *R* are adapted in the study when measurements update with time. A window based approach is implemented to update the quality of GPS pseudo-range measurements by adaptively replace the measurement weights through the latest estimated covariance matrices *R*.

The use of odometer is particularly recommended when a low cost and precise vehicle localization system has to be implemented and there is the risk of GPS coverage failure, which is prone to happen when the vehicle enters a tunnel or cross deep valleys. Odometers are applied in land-vehicle navigation to provide augmented host velocity observations for standalone INS system in this study. There are two non-holonomic constraints (NHC) available for land vehicles. Land vehicles will not jump off the ground or slid on the ground under normal condition. Using these constraints, the velocity of the vehicle in the plane perpendicular to the forward direction is almost zero. EKF and AKF based tightly-coupled scheme with NHC is implemented in the study.

To validate the performance of AKF based tightly-coupled INS/GPS integration scheme with odometer and NHC, field scenarios were conducted in the downtown area of Tainan city. The data fusion of INS/GPS/Odometer/NHC can be used as stand-alone positioning tool during GPS outages of over 1 minute, and AKF based tightly-coupled INS/GPS integration scheme can be more stable combined with odometer and NHC during GPS outages of over 1 minute likewise.

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