INS and GNSS Fusion Enhancement based on a Weighted Reliabilities Approach

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ABSTRACT

A common and respectable approach for INS/GNSS fusion purpose consists in highlighting their obvious complementarities. Indeed, fusion is interesting for GNSS augmentation with INS, or inertial drifts compensation with GNSS. However, fusion involving those coupled sensors is operated to compensate the weaknesses of one another. This can be performed considering the two navigation systems independently through loosely coupled fusion, whereas tight or ultra-tight fusion approaches lead to a more intimate result, through a so-called Kalman filter. Nevertheless, it has to be calibrated.

Our approach is based on the combined use of INS and Pseudolite-based positioning systems and aims at running both outdoors and indoors. Contrary to classical methods, the two techniques are permanently combined in order to obtain the best complementarities. Usually, indoors, radio positioning is preferentially used in large halls and INS in more confined areas. Time dependent accuracy is a consequence of radio signal error sources or INS drift accumulation without adequate compensation. Besides, our approach allows quantifying the sensor's reliability, at any given time, to improve the position computation.

The fusion consists in providing a single navigation solution by applying weighted confidences to each measurement provided by Pseudolites and INS. The weights rely on the past and instantaneous measurements uncertainties estimation. Accelerations and angular rates from INS as well as pseudoranges and Doppler values from pseudolites are used to compute the estimated position. Our study is fed by quantitative comparison results from both Matlab simulations and several repeatable experimental situations, which are precisely described in the paper in indoor and outdoor environments.

Results show that taking into account uncertainties at a given time allows our fusion technique to efficiently reduce the impact of multipath and inertial drifts in the position computation. This approach benefits to the hybridization of INS and GNSS for positioning in constrained environments.

KEYWORDS: INS (Inertial Navigation System) and GNSS (Global Navigation Satellite System) Fusion, Pedestrian Navigation, Pseudolites, Weighted Reliabilities, Hybrid positioning