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Abstract:

Sensorfusion und sequenzielle Parameterschätzung in einer schwach gekoppelten Filterstruktur zur Navigation

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In this thesis two approaches to the improvement of the navigation solution of a localization system (e.g. for vehicles) are considered: the additional employment of filtered height information of a barometric sensor device and the utilization of continuously estimated (a-priori unknown and time-variant) noise parameters to incorporate the temporal correlation of inertial sensor measurements.

The navigation system is based upon a loosely coupled filter structure for fusing sensor information of an inertial measurement unit with information of other supporting sensors like a *Global Positioning System* device. The adopted filter is a so-called *linearized Kalman filter* for estimating the error of the navigation solution, which is continuously determined outside the filter. The Kalman filter estimates are obtained from satellite-based position and velocity information on the one hand and from reliable height information on the other hand. The height information derived from temperature and barometric pressure measurements using the formula of isothermal atmosphere. Additional topographical information is used to determine and adjust bias and scaling factor errors, stemming from inherent simplified assumptions.

Further, an algorithm for sequential estimation of time-variant system noise variances of a Kalman filter has been developed. The proposed approach relies on the *Expectation-Maximization (EM)-algorithm*, which processes the observations in batches. The objective function is specified in that way that the conditional expectation of the log-likelihood of the complete data can be described recursively. The optimization problem is solved by maximizing the objective function using Newton's method. The *sequential EM algorithm* is compared with two other approaches. While the so-called *covariance management* method empirically determines the mean and the variance of a stationary, stochastic process, the other approach obtains the difference of consecutive inertial measurements for a recursive description of the autocorrelation function of autoregressive models.

Experiments with artificially generated and field data were carried out to quantify the performance of the proposed approaches. Thereby, an improved navigation solution has been found when the *sequential EM algorithm* is incorporated. In a real-world scenario the combination of both the *sequential EM algorithm* and the approach relying on measurement differences led to the best results.