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GPS Pinning of Navigational IoT Data Streams in Compositional Kalman Filter

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Introduction

The problem of pre-processing multiple noisy data streams in IoT environment is considered employing Kalman filter (KF) algorithm. The suggested route starts from gathering the data streams in mini-groups on contextual IoT basis to minimize sets of state variables and ensure convergence of elementary KFs.

Aim

The redundancy in the data streams is explored to reduce an error in parameters estimation.

Materials & Methods

Two types of elementary KFs were selected: 1) GPS/V-KF, i.e. the KF relying on GPS signal to retrieve coordinates, x and y , of the vehicle positioning as well as on speedometer and orientation meter to retrieve velocity components, v_x and v_y , and form the set $[\mathbf{x}, \mathbf{y}, \mathbf{v}_x, \mathbf{v}_y]$ of the state variables; 2) V-KF, i.e. same as GPS/V-KF but excluding GPS signal and operating via the set $[\mathbf{v}_x, \mathbf{v}_y]$ to monitor the state of the system.

Results & Discussion

To achieve the goal, GPS/V-KF and V-KF are connected via an interface to form a compositional Kalman filter architecture of two interacting KFs with improved overall performance (Fig.1). The performance improvement is achieved via algorithmic solution, which, from one hand, gives preference to the more reliable estimate made by V-KF as compared to that of GPS/V-KF, but, on the other hand, does compensate the accumulated integration error of V-KF via GPS pinning procedure. It is found that pinning is most efficient after completion of the training period, i.e. at point B in our example (Fig.2).

Conclusion

The compositional KF architectures allows to efficiently eliminate accumulation of the integration error via GPS pinning procedure. This supports the notion of error reduction in parameters estimation by employing redundancy in the data streams.

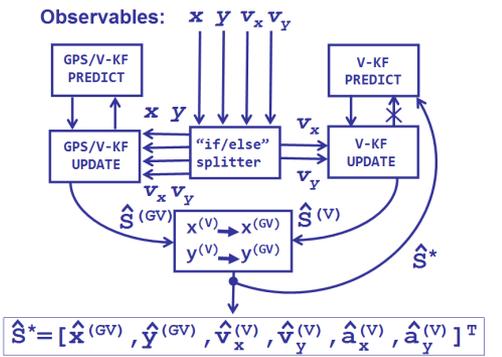


Figure 1: Compositional Kalman filter architecture for GPS pinning

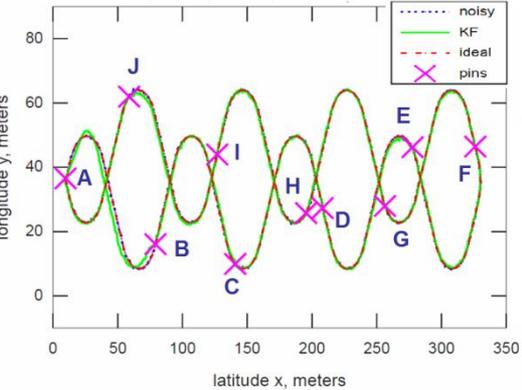


Figure 2: GPS pinning performance of the architecture of Figure 1