Technical Note: CRT-HT Position, Velocity & Attitude Results

Paul F. Roysdon Jay A. Farrell

I. Comparison: CRT HT Results

For each algorithm in [1], Fig. 1 shows the cumulative distribution function (CDF) of the position error norm $\|\hat{\mathbf{p}}_k - \mathbf{p}_k\|$ where the ground truth trajectory is used as $\mathbf{p}_k$. The value of $\hat{\mathbf{p}}_k$ is the *a posteriori* result after the optimization of eqn. (6) in [1] at the first time when the k-th epoch enters the sliding window. For outlier removal, the threshold was computed using a significance level of $\alpha = 0.05$. The CRT algorithm curves are included for various window lengths L. Similar results are shown in Figs. 2 & 3 for velocity and attitude error, respectively.

The CDF in Fig. 1 shows that the percentage of occurrences where the EKF position error is less than $0.1m$, is roughly 18%. Roughly 90% of the trajectory, as estimated by the EKF, has errors less than $1.0m$. This is as expected for a double-difference L1 pseudorange-only GPS-INS with an EKF. For the CRT with $L > 5$, 100% of the position errors are less than $1.0m$. CRT algorithms with $L > 20$ each achieve $0.6m$ position accuracy on 100% of the trajectory. The EKF and IEKF CDF plots do not reach 100% until the position accuracy is over $3.0m$.

The CDF in Fig. 2 shows that the percentage of occurrences where the EKF velocity error is less than $0.01m/s$, is roughly 15%. Roughly 85% of the trajectory, as estimated by the EKF, has errors less than $0.1m/s$. For the CRT with $L > 10$, 30% of the velocity errors are less than $0.01m/s$ and 100% of the velocity errors are less than $0.1m/s$.

The CDF in Fig. 3 shows that the percentage of occurrences where the EKF attitude error is less than 0.01^o, is roughly 10%. Roughly 98% of the trajectory, as estimated by the EKF, has errors less than 0.1^o. For the CRT with $L > 10$, 15% of the attitude errors are less than 0.01^o and 100% of the attitude errors are less than 0.1^o.

Figs. 1-3 indicate that accuracy improves from the EKF to the IEKF to the CRT. Also, CRT performance (generally) improves with the window length L.

References

[1] P. F. Roysdon and J. A. Farrell, "GPS-INS Outlier Detection and Elimination using a Sliding Window Filter," *American Control Conference, In Presc.*, 2017.

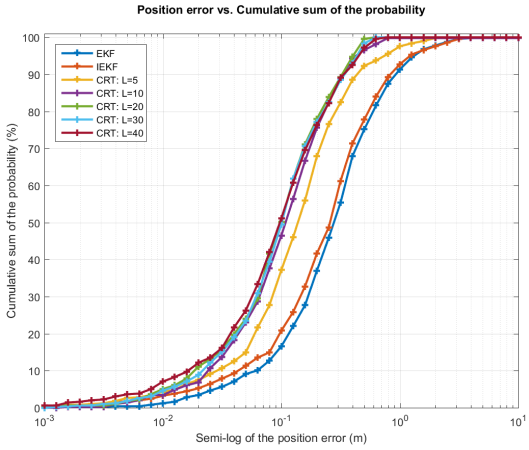

Fig. 1. Cumulative distribution of position error for each algorithm.

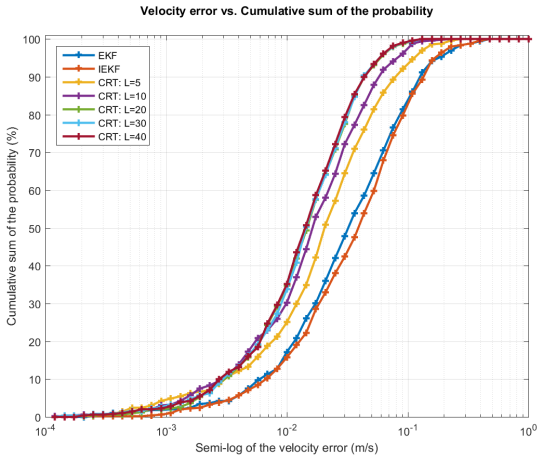

Fig. 2. Cumulative distribution of velocity error for each algorithm.

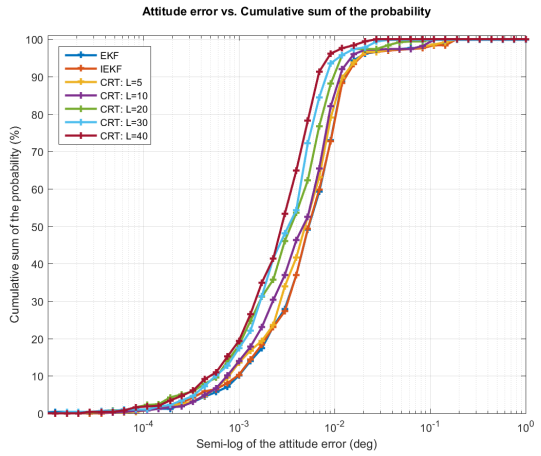

Fig. 3. Cumulative distribution of attitude error for each algorithm.