

Applied Kalman Filtering
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Part 5: Monte Carlo Analysis of the Tracking EKF Filter

Objective: Perform a Monte Carlo analysis to confirm the performance of the EKF state estimation error covariance matrix reflects the true state estimation errors

Background: Consider the two-dimensional tracking problem and the extended Kalman filter developed in Part 4.

Tasks:

1. Create a set of m sampled state estimation errors using the initial state estimation error covariance matrix \mathbf{P}_0 where $m = 1000$ to use to form the initial truth state vector and initial state vector estimate in the EKF
2. Remember that in your simulation the initial EKF state estimates are $\hat{\Delta}h_0 = 0$, $\hat{\Delta}\beta_0 = 0$, $\hat{\Delta}\rho_{o0} = 0$, $\hat{\Delta}k_{p0} = 0$, and $\hat{b}_{m0} = 0$. The truth values in the environment must be consistent with the initial state estimation error covariance matrix for each respective state variable as in (1) above
3. Run the EKF once and use the state state estimation errors and estimation error covariance each measurement update time t_k as the *nominal* performance (both *apriori* and *aposteriori*)
4. Save the state estimation errors (both *apriori* and *aposteriori*) for each run $m = 1, \dots, 1000$ at each measurement update time t_k and when the *Monte Carlo* simulation concludes, compute the sampled mean and the sampled state estimation error covariance (both *apriori* and *aposteriori*) at each time t_k
5. Make sure that the random process noise process $\mathbf{w}(t)$ and the random noise measurement noise sequence \mathbf{v}_k are different for each run (you need to manage the pseudo-random number generation)
6. Plot the mean state estimation error for each state and co-plot the \pm standard deviation (the \pm square root of the corresponding element of the sampled state estimation error covariance) along with a nominal \pm standard deviation of the corresponding element of the state estimation error covariance from the single EKF run
7. Confirm that the nominal state estimation error covariance matches the sampled state estimation error covariance, and if needed, tune the EKF
8. Be sure to adequately comment your code

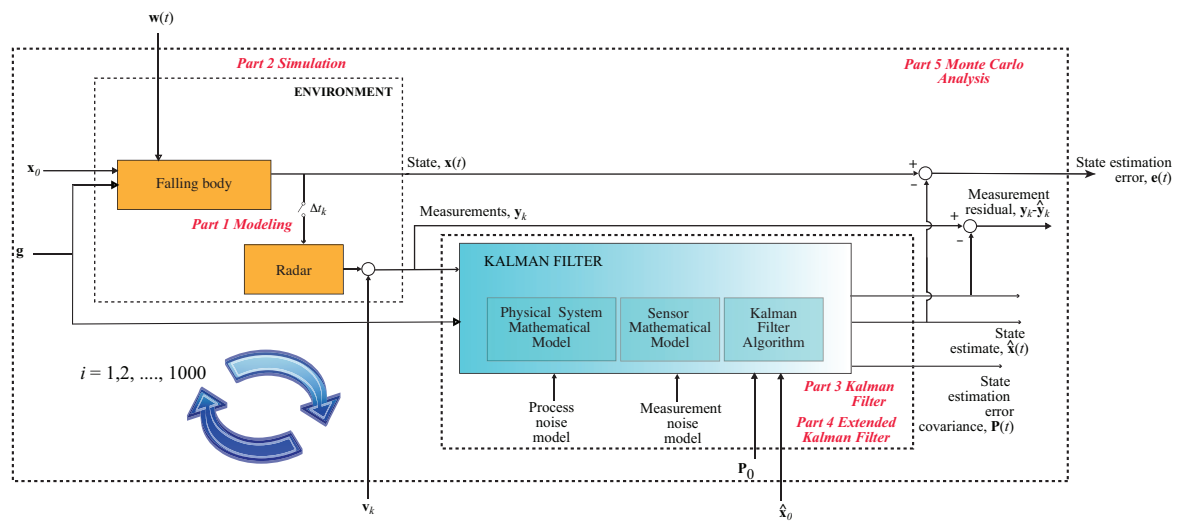


Figure 1: Simulation functional diagram