ASE 381P Problem Set #6

Posting Date: November 7, 2019

You need not hand in anything. Instead, be prepared to answer any of these problems on an upcoming take-home exam. You may discuss your solutions with classmates up until the time that the exam becomes available, but do not swap work.

1. This problem refers back to Problems 5 & 6 of Problem Set 5. Re-do Problem 6 using the Kalman filter problem matrices of Problem 5. Note that in Problem 5 there are 3 possible Q values. Run your truth-model simulation using the largest of the three Q values, but run your Kalman filter using the smallest of the three Q values. What does this do to your consistency evaluation? Is this what you expect?

2. There are two Kalman filtering problems defined by the two MATLAB scripts `kf_example03a.m` and `kf_example03b.m`. Solve each of these Kalman filtering problems in two ways. First, use a standard Kalman filter. Second, use a square-root information filter (SRIF). The two filters should work about equally well for the problem in `kf_example03a.m`, but the Kalman filter will not work as well as the SRIF for the problem in `kf_example03b.m`. This is true because of the small $R(k)$ value, which causes the computed covariance matrix to be ill-conditioned. Compare the state estimates and the covariances for the two filters at the terminal time. Is there a significant difference for the second filtering problem but not for the first?

   Note: this is a relatively benign case. The improvement due to use of the SRIF is not extremely significant. There are, however, known practical situations where a Kalman filter completely breaks down while an SRIF functions well.

3. Calculate the smoothed estimates for the problem in `kf_example03a.m`. Compare $\hat{x}(10)$ with $x^*(10)$ and compare $P(10)$ with $P^*(10)$. Is $P^*(10) \leq P(10)$? Do the smoothed state time history estimate plots look "smoother" than the filtered state time history estimate plots?