ECEN/MAE 5523

Homework #7

Write a MATLAB program to demonstrate the operation of the Kalman filter. The program should have the following parts:

1. Simulation of a linear state space system $\mathbf{x}(k+1)$.
2. Update equation for predictor $\hat{\mathbf{x}}(k+1|k)$.
3. Update equation for predictor covariance $\mathbf{P}(k+1|k)$.
4. Kalman gain $\mathbf{K}(k+1)$ calculation.
5. Update equation for filter $\hat{\mathbf{x}}(k+1|k+1)$.
6. Update equation for filter covariance $\mathbf{P}(k+1|k+1)$.

Demonstrate the performance of your program with the following system:

$$\mathbf{x}(k+1)=\begin{bmatrix} 0 & 1 \\ -0.81 & -1.8 \end{bmatrix}\mathbf{x}(k)+\begin{bmatrix} 0 \\ 1 \end{bmatrix}w(k)$$

$$z(k+1)=\begin{bmatrix} 1 & 0 \end{bmatrix}\mathbf{x}(k+1)+v(k+1)$$

where $\mathbf{Q}=1$ and $\mathbf{x}(0)\sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix},\begin{bmatrix} 4 & 0 \\ 0 & 1 \end{bmatrix}\right)$. Try two cases for $\mathbf{R}$: 0.25 and 4. Plot the diagonal elements of $\mathbf{P}(k|k-1)$ and $\mathbf{P}(k|k)$ for 100 time points ($\mathbf{P}_{1,1}(k|k-1)$ and $\mathbf{P}_{1,1}(k|k)$ on one plot, and $\mathbf{P}_{2,2}(k|k-1)$ and $\mathbf{P}_{2,2}(k|k)$ on another plot). Also, show $x_i(k)$, $\hat{x}_i(k|k-1)$ and $\hat{x}_i(k|k)$ on the same plot (one plot for *i*=1 and one plot for *i*=2).

Discuss your results.