Homework 9 Data Adjustment 1

Kalman Filter, assigned Mon 18 April 2011, Due Fri 29 April

1. Get hw9_data.mat containing 2 variables :

   X0 : 3x100 matrix of true position trajectory $\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_1, \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_2, \cdots \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{100}$

   ZZ : 3x100 matrix of observed position trajectory

2. $\Delta t = 1$ second interval between epochs

   We use CAM = constant acceleration model, with state transition matrix

$$\Phi_X = \begin{bmatrix} 1 & \Delta t & \Delta t^2/2 \\ 0 & 1 & \Delta t \\ 0 & 0 & 1 \end{bmatrix}, \text{ for } \begin{bmatrix} X \\ \dot{X} \\ \ddot{X} \end{bmatrix}, \text{ same for } Y \,\&\, Z \text{ axes}$$

   The covariance matrix Q_x that goes with the transition equation is,

$$Q_x = \begin{bmatrix} 1e{-}07 & 0 & 0 \\ 0 & 1e{-}07 & 0 \\ 0 & 0 & 1e{-}07 \end{bmatrix}, \text{ same for } Q_y, Q_z$$

3. State vector will be $[X\ \dot{X}\ \ddot{X}\ Y\ \dot{Y}\ \ddot{Y}\ Z\ \dot{Z}\ \ddot{Z}]^T$

4. $\sigma_{obs} = 2$ or $R = \begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$

5. use $\begin{bmatrix} ZZ(1,1) \\ ZZ(2,1) \\ ZZ(3,1) \end{bmatrix}$ as initial position, with $\sigma_p = \begin{bmatrix} 2 \\ 2 \\ 2 \end{bmatrix}$

   use $\begin{bmatrix} 5 \\ 1 \\ 0.1 \end{bmatrix}$ as initial velocity, with $\sigma_v = \begin{bmatrix} 2 \\ 2 \\ 2 \end{bmatrix}$

   use $\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$ as initial acceleration, with $\sigma_a = \begin{bmatrix} 2 \\ 2 \\ 2 \end{bmatrix}$

$$\underbrace{}_{X^-} \qquad \underbrace{}_{P^-}$$

6. construct $\underset{(9,1)}{X^-}$ $\underset{(9,9)}{P^-}$

   construct $\underset{(3,3)}{R}, \underset{(9,9)}{Q}$,

7. Make the Kalman Filter Loop 99 times for observation vectors $ZZ_2 \rightarrow ZZ_{100}$

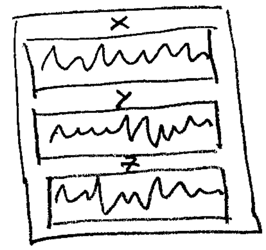
   for each loop,

   construct Z, H, K, X, P and

   predict X^-_{i+1}, P^-_{i+1}

8. Results presentation

   Use Subplot (3, 1, *) to make



   for each axis, plot

   observed − true (blue)

   estimated − true (red)

9. what do you see ?

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notes: since we observing coordinates directly, everything is linear, if we observed range, angle, etc. it would be nonlinear.

remember σ^2 goes in covariance matrix. any covariances not explicitly shown are ZERO.