EE 236: Simple KF

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Formulate and implement a Kalman filter for the following system

$$x(k+1) = \phi x(k) + \Gamma u(k) + \omega(k), \text{ where } \phi = \begin{bmatrix} 1 & T & T^2/2 \\ 0 & 1 & T \\ 0 & 0 & 1 \end{bmatrix}, \ \Gamma = \begin{bmatrix} T^2/2 \\ T \\ 1 \end{bmatrix}, \tag{1}$$

$T = 0.01$, and $\omega \sim N(0, \sigma_\omega^2)$. The measurement is

$$y(k) = H\, x(k) + \nu(k), \text{ where each } \nu(k) \sim N(0, \sigma_\nu^2), \tag{2}$$

and $H = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$.

This assignment should be accompanied by a dataset (or several) containing:

Data: $u(k)$ and $y(k)$ for $k = 1, 2, 3, \ldots$

Parameters: $Q = \sigma_\omega^2$ and $R = \sigma_\nu^2$.

Your objective is to estimate the state sequence.

In two pages maximum (minimum 10 point font with 1 inch margins and all figure labels legible)[1]:

1. Describe your filter and any assumptions to the extent that a engineer familiar with estimation could replicate your results.
2. Pick a dataset. Clearly state which dataset you are using. For that dataset present and discuss the implementation results, including:
   (a) graphs of $x_i(k)$, and $x_i(k) \pm \sigma_{x_i}(k)$ for $i = 1, 2, 3$,
   (b) a graphs containing $y(k)$, and $\hat{y}(k) \pm \sigma_y(k)$,
   (c) a graph containing $r(k) = y(k) - \hat{y}(k)$, and $\pm\sigma_r(k)$,
   (d) a graph containing $\frac{r(k)}{\sigma_r(k)}$.

[1] I suggest using a two column format.