ECN-614: Assignment #2

A truck is moving on a frictionless straight rails buffeted by random accelerations. The position of the truck is measured every second using a not-so-good GPS system that commits random error in locating the position of the truck precisely. Let, $s(k)$ denotes the position of the truck measured at time k, $e(k)$ is the corresponding measurement error in the GPS system, and $a(k)$ is the random acceleration at time k assumed to be constant over the next one-second time interval. The random acceleration and the GPS measurement error are known to be statistically independent zero-mean white Gaussian random variables with variances 1.0 and 0.25, respectively.

(1) Taking $p(k)$ and $v(k)$ as the state variables denoting the position and velocity of the truck at time k, formulate the above as a Kalman filtering problem by writing down the corresponding process equation and the measurement equation.

(2) Given the measured positions $s(k)$ at time instants $k = 1, 2, ...$, a Kalman filter is used to recursively estimate the position and velocity of the truck at all times. Write a MATLAB program for the same.

Generate an arbitrary test sequence of 500 samples of measured truck positions as $s(k) = s(k-1) + r(k)$, $1 \leq k \leq 500$, where $r(k)$ is a random number distributed uniformly in the range 0 to 0.5, and $s(0) = 0$.

Assuming that the initial state distribution is Gaussian with zero mean and identity covariance matrix, i.e. $\mathcal{N}(\mathbf{0}, \mathbf{I})$, run the above program to estimate the position of the truck at all times till $k = 501$. Hence, plot the measured path of the truck, estimated path and the error in estimating the position of the truck.

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Given the measured positions $s(k)$ at time instants $k = 1, 2, ...$, a Kalman filter is used to recursively estimate the position and velocity of the truck at all times. Write a pseudo-code for the same.

Assuming that the initial state distribution is Gaussian with zero mean and identity covariance matrix, i.e. $\mathcal{N}(\mathbf{0}, \mathbf{I})$, estimate the position and velocity of the truck at time instant $k = 3$, given $s(1) = 0.2$ and $s(2) = 0.6$.