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EE 706: Kalman Filtering 9 March 2018

Homework #7

1) Implement the Humvee Kalman filter we discussed in class on Thursday, 1 March 2018. As a reminder, the system model for that filter is:

$$\mathbf{X}(k+1) = f\left(\mathbf{X}(k)\right) + G(k)\mathbf{W}(k) = \begin{bmatrix} x(k) + TV(k)\cos\theta(k) \\ y(k) + TV(k)\sin\theta(k) \\ V(k) \\ \theta(k) \end{bmatrix} + \begin{bmatrix} 0? \\ 0? \\ w_V \\ w_\theta \end{bmatrix}$$

and the measurement model is

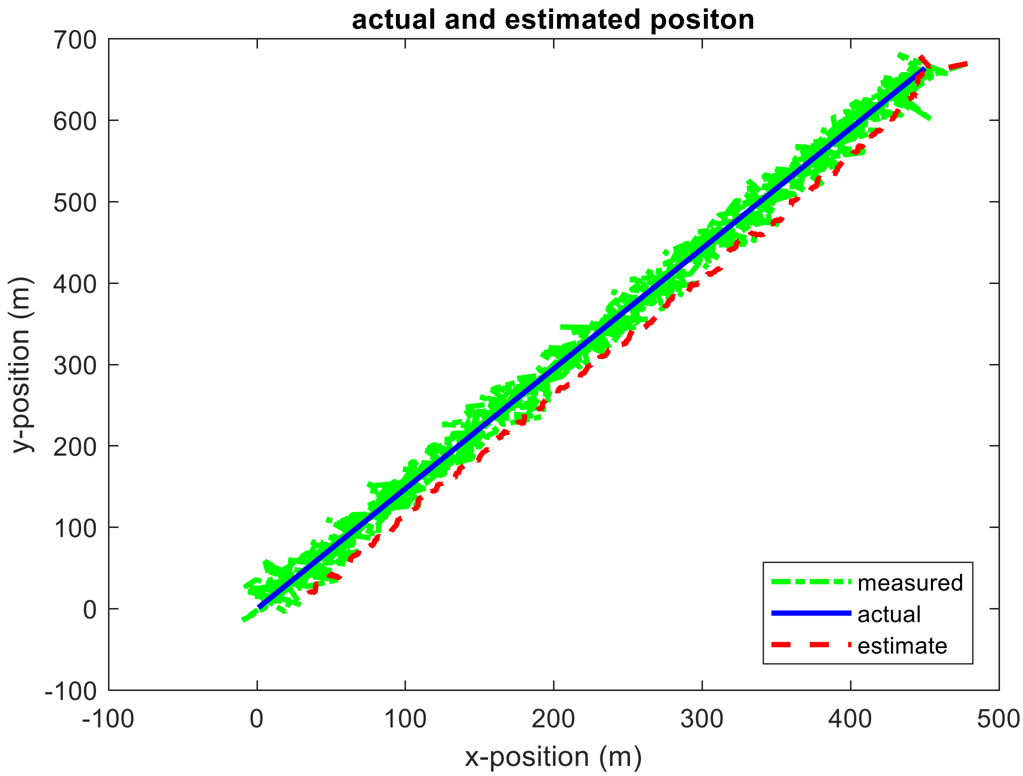
$$\mathbf{Y}(k+1) = \begin{bmatrix} x(k+1) \\ y(k+1) \\ V(k+1) \\ \theta(k+1) \end{bmatrix} + \begin{bmatrix} v_x \\ v_y \\ v_V \\ v_\theta \end{bmatrix}$$

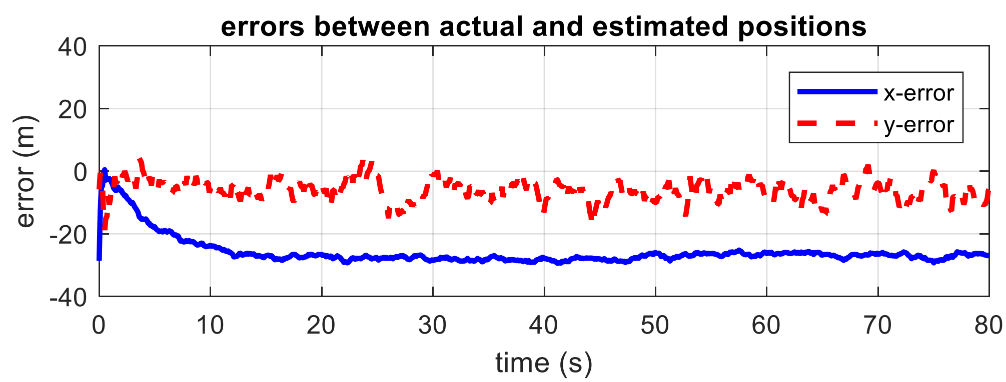
Use the same position initial conditions on your filter that you used in Homework 6. Set the initial estimate of speed to 10 m/s and the initial estimate of heading to 180 deg. Use the position variances of Homework 6. Use a speed measurement standard deviation of 1 mph and a heading standard deviation of 1 degree. Test your filter with all three of the Humvee trajectories. For each of the trajectories, generate plots like the ones below.

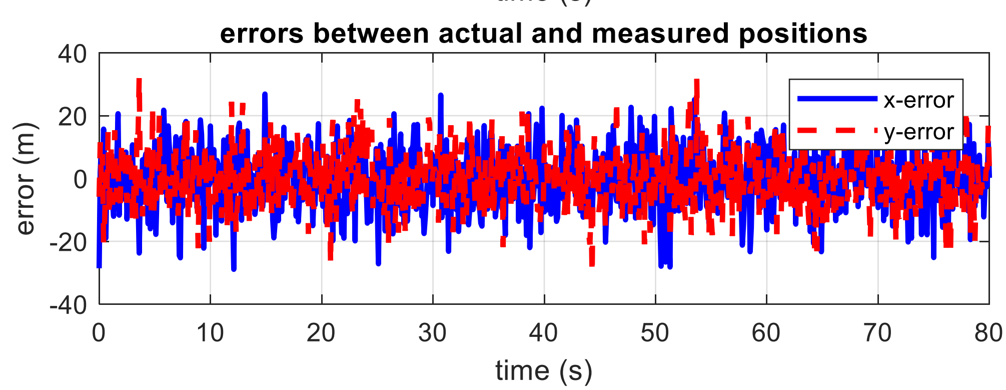
The objective of this homework is to gain experience designing and implementing an extended Kalman filter. To that end, you don't need to spend time trying to optimize tuning. I mainly want you to get the filter running, and producing reasonable results.

Compare the performance of this filter to the one you used in Homework 6. Use the results from only the Humvee3 trajectory in the comparison.

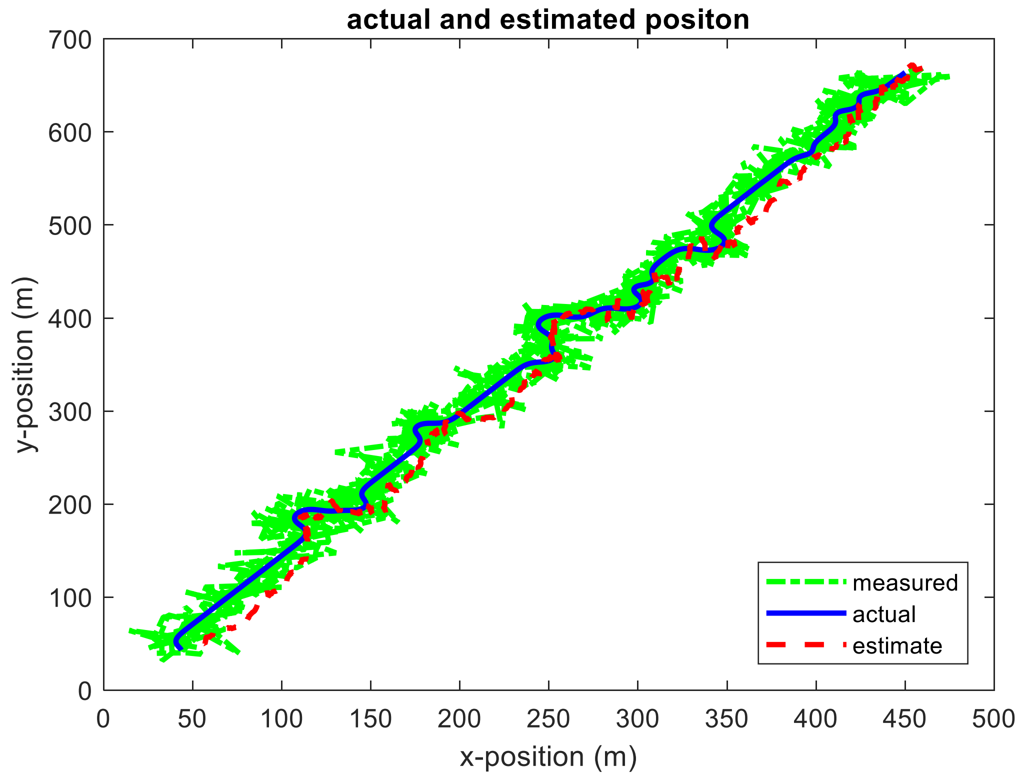
Trajectory 1 (humvee1.mat)

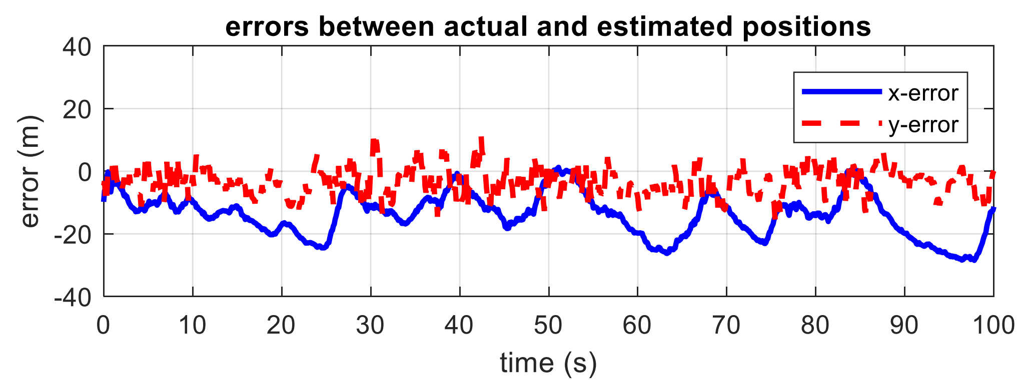


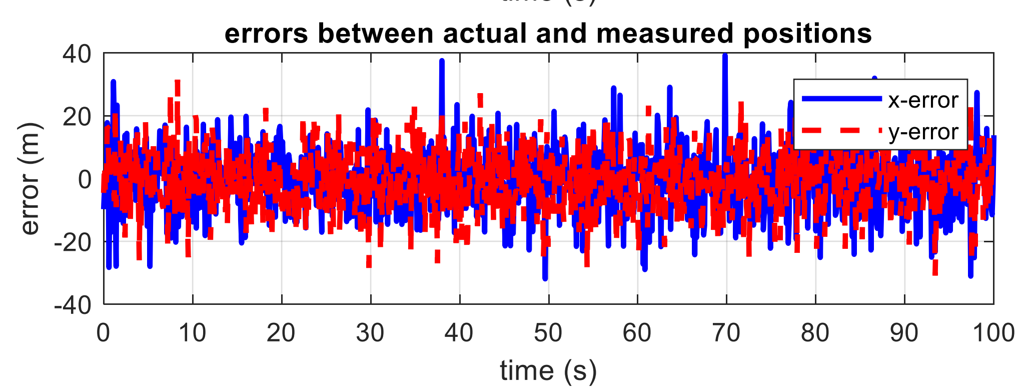




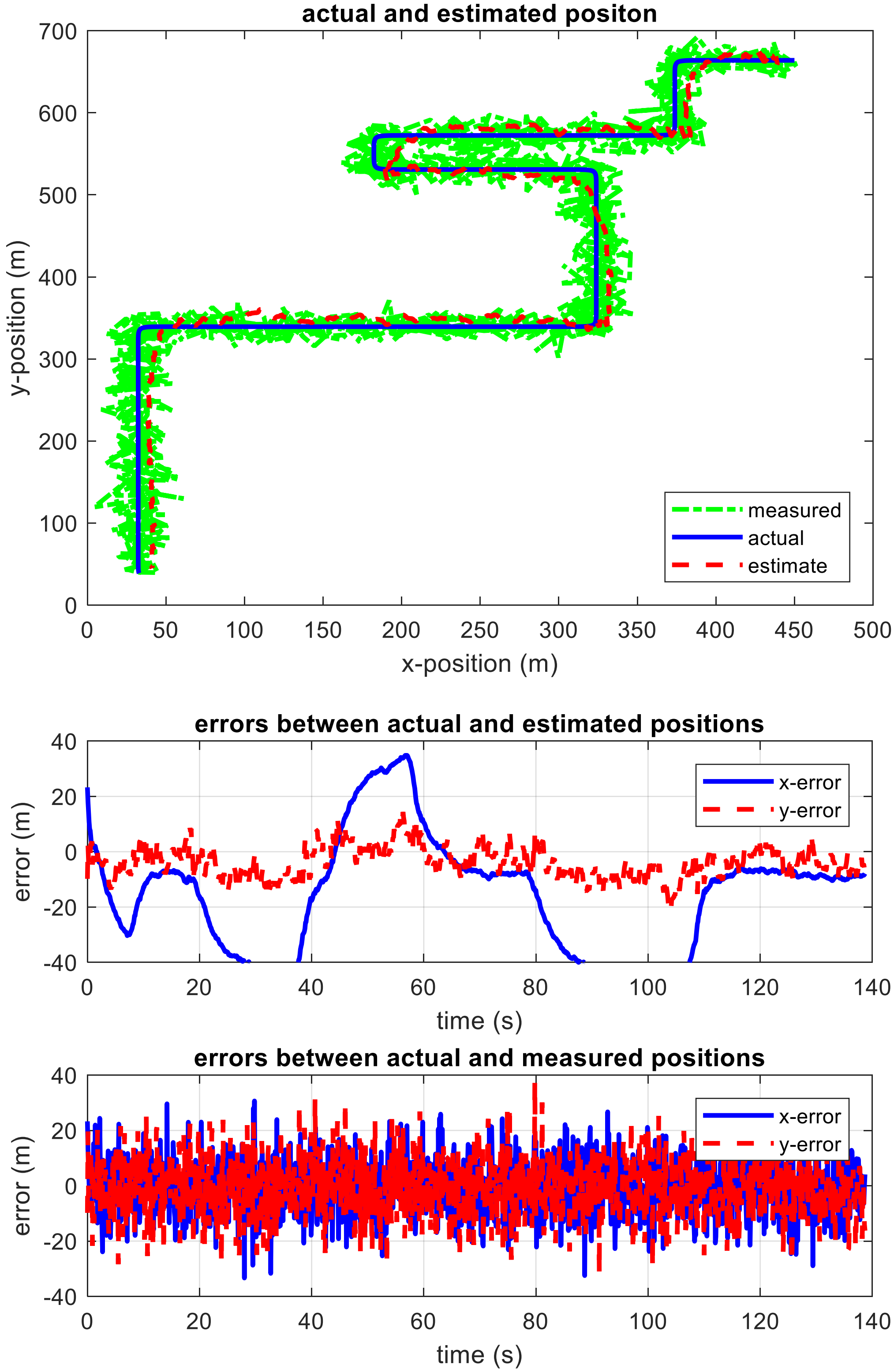
Trajectory 2 (humvee2.mat)



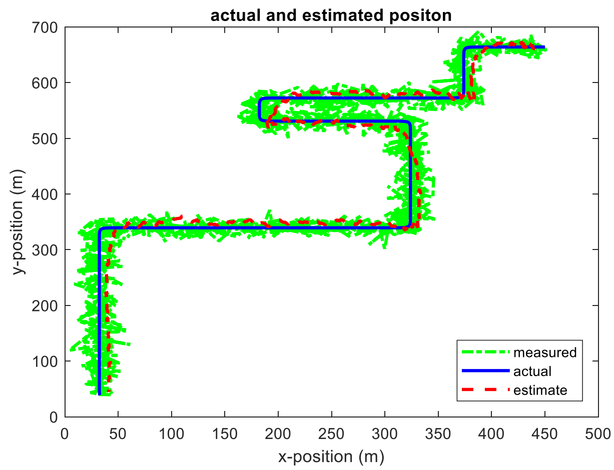
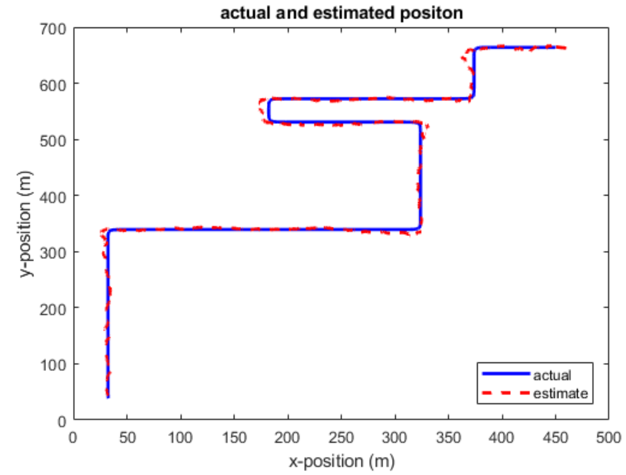




Trajectory 3 (humvee3.mat)



Comparison

<table>
<tr><th>Homework 7 (Extended Kalman Filter)</th><th>Homework 6 (Linear Kalman Filter)</th></tr>
<tr><td>
</td><td>
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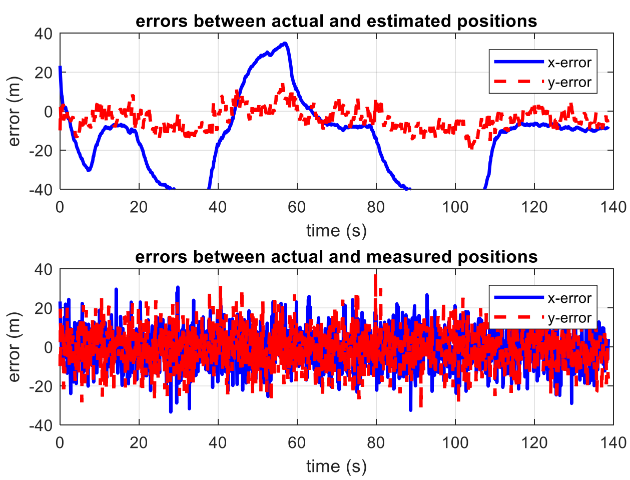
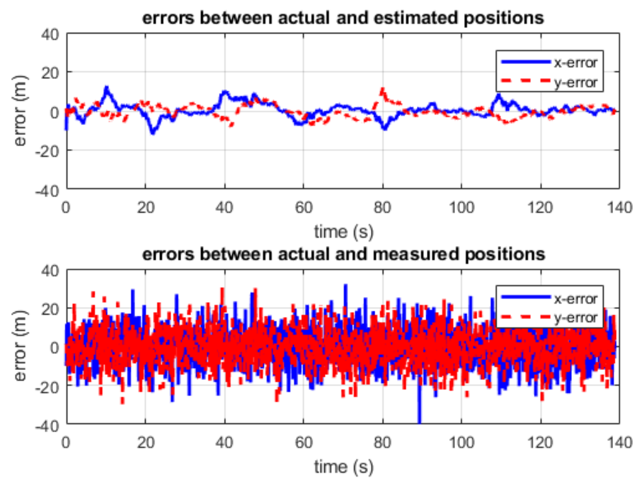
<tr><td>
</td><td>
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The first row of figures, “actual and estimated positions” show that the linear Kalman filter in Homework 6 tracking performance appears much better than the extended Kalman filter implementation in Homework 7. The x-position in the extended Kalman filter seems to be much worse than the y-position. This is further supported observing the second row of figures, “errors between actual and estimated positions,” where the in the top subplot we see that the y-position performance appears to stay within about +/-10 m of error while the x-position diverges in excess of +/- 40 m. For the linear Kalman filter, we see that the errors are much lower and that for both x- and y-positions they remain between +/- 15 m.