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Mp5 report

A1.

These are the update equations we need for the Kalman filter.

Time update

$$\hat{x}_k^- = A\hat{x}_{k-1} + Bu_{k-1}$$
$$P_k^- = AP_{k-1}A^T + Q$$

Measurement update

$$\hat{x}_k = \hat{x}_k^- + K_k(z_k - H\hat{x}_k^-)$$
$$K_k = \frac{P_k^- H^T}{HP_k^- H^T + R}$$
$$P_k = (I - K_k H)P_k^-$$

The Kalman filter equations allow us to measure something that we cannot measure dirrectly. We use this by using all of the information given to predict what the state is and then update that estimation base on the measurement. The goal is to minimize the difference between the estimated and measured state distances so that they converge. We use the Kalman gain which is a value that dictates how much we trust our observation over the estimation to minimize the error distance. With this, we are able to use the previous state, xk-1, and the given controls, uk-1, with the mathematical model to estimate the state which we can then use along with our real measurement to find a better estimate of the state xk.

A4.

I decided to use .45 for the scalar because I noticed that the average error decreased as the scalar approached .5 from 0 but once my scalar hit .5 my estimates would randomly skew far from the observations. This made me decrease the scalar to 4.5 and after this, I received low average errors.

B2.

At first, I decided when to shoot based on the the error of the x position. I based my threshold value based on the calculated errors from part A. I chose one that was very close to the observed and used that as my threshold for deciding when to shoot. Afterward, it was brought to my attention that the noise matrices were supposed to be changed from part a to part b and this made my error increase as time went on so I found the error at each iteration and since my error increased as time went on I used the first iterations error as the base when deciding my threshold of error of when to shoot the laser. I also made it so that if the error is increasing over time the laser will fire as soon as possible.

B3.

At first, I noticed that as the time went by my error decreased so I used guess and check on a couple different times to find the right time where It is fast but still pretty precise when shooting the laser. Afterward, it was brought to my attention that the noise matrices were supposed to be changed from part a to part b and this turned everything backward. This made my error increase as time went on so I shot the laser after the first iteration and this gave me a good result.