Kinematic Positioning and Navigation – Winter 2018: Homework #6

Kalman filtering

1. Create your own modified version of the Kalman filter MATLAB function used in class. This time, the measurement is reversed from the example in class. Specifically, in the class example, the aircraft altitude along the trajectory was measured, and the Kalman filter output consisted of smoothed estimates of the altitude, as well as the vertical velocity. In this HW exercise, the aircraft's vertical velocity is measured (instead of its elevation), but the state vector should remain the same as in the class example. Test your version of the code using the program "apply_kalman2.m." The input file to test it on is "noisy_ngs_vert_vel.mat." Both files can be found on the class Canvas site.

    a. What are the effects of adjusting **Q** and **R**? What values do you feel provide the best results? Illustrate your answer with screenshots.

    b. Say you are unable to obtain satisfactory performance by adjusting **Q** and **R**. What would be the next step(s) in modifying or enhancing your Kalman filter?

    c. Include your MATLAB code with your HW submission.

2. Consider another extension of the example used in class. This time the desired state vector in our Kalman filter is:

$$\mathbf{x} = \begin{bmatrix} E \\ \dot{E} \\ N \\ \dot{N} \\ H_{el} \\ \dot{H}_{el} \end{bmatrix}$$

   Where *E* and *N* denote Easting and Northing, respectively. The measurements this time are:

$$\mathbf{z} = \begin{bmatrix} E \\ N \\ H_{el} \end{bmatrix}$$

    a. What are the <u>dimensions</u> (number of rows by number of columns) of the $\mathbf{\Phi}$ and **H** matrices for this extension of the problem?

    b. What are the $\mathbf{\Phi}$ and **H** matrices? (You don't have to write any MATLAB code for this question; just write down the $\mathbf{\Phi}$ and **H** matrices.)

Helpful hint for question 2b: think about partitioning each matrix into blocks corresponding to easting, northing, and height. For example, you could think of the state vector, **x**, being partitioned as:

$$\mathbf{x} = \begin{bmatrix} E \\ \dot{E} \\ \cdots \\ N \\ \dot{N} \\ \cdots \\ H_{el} \\ \dot{H}_{el} \end{bmatrix}$$