ECE-520: Discrete-Time Control Systems
Homework 5

Due: Thursday October 7 in class

For these problems you will need to download the code from the class website. You should put your results for these problems in a word file and write me a short memo summarizing your results.

1) Run the program **plant_identification_driver.m** as it is, and try to understand what is going on. Try a variety of forgetting factors, including $\lambda = 0.05$, $\lambda = 0.95$, and then a value of the forgetting factor that you think balances convergence to the correct parameter values in a reasonable time without too much overshoot. Include all three plots in your homework (do not include plots of the system output).

2) Using your choice of forgetting factor, rerun your systems using a step input, a sinusoidal input, and an input that pulses on and off (you just have to uncomment some of the code). Turn in all of your graphs and indicate if the system is working (do not include plots of the system output). If it is not working, why not?

3) Change the plant so that instead of sudden changes over time, there is a gradual change in a parameter,

$$y(n) = -0.5\cos(\pi n Ts)\, y(n-1) - 0.1 y(n-2) + 0.5u(n-1) + \cos(2\pi n Ts) u(n-2)$$

You should only have to uncomment code to do this, but you will have to change the Simulink file to make the Simulink model match the Matlab model. Modify the plot command so the true sinusoidal variation in b_2 and a_1 is plotted along with the RLS estimate. The input should be a random signal. Modify the forgetting factor to get as good a result as you can. Turn in both plots, and be sure your Matlab and Simulink plots of the output match.

4) Modify the time interval so Ts = 0.01 and try problem 3 again. Modify the forgetting factor until you get good results, and then turn in your graphs (two of them, one for the output and one for the parameter estimates). Why does this work better?

5) For this problem you will need the file homework5.m. This file just introduces you to the value of Matlab's pinv command. The file demonstrates trying to find the input signal given the output signal and a transfer matrix. Initially there is a very large signal to noise ratio (1000 dB). You are to modify the pinv command to get a reasonable estimate when the SNR is 10 dB and 20 dB. Do not expect to be able to get the exact answer, just try and get reasonably close. Turn in your estimates for x for the 10 and 20 dB SNR values, and indicate how you modified the pinv command.

6) (Oh No, a real world problem….) The primary cause of cardiac arrhythmias is unusual electrical conduction patterns in the heart, often caused by congenital defects or heart disease. One way cardiologists try to determine areas of unusual conduction is to map electrical patterns in the heart (or on the various surfaces of the heart chambers). One such method involves inserting two or more catheters through a vein in the leg into the left ventricle (LV). A special tip on one of the catheters is inflated (like a balloon), and there are 64 electrodes on this balloon. Based on measurements on these electrodes, the electrical pattern on the LV endocardium (inner heart surface) is estimated. Unfortunately, even though the distance from the source of the electricity (the endocardium) to the electrodes is at most a few centimeters, the transfer matrix relating them has a condition number of approximately one million. In this problem we know the measured electrical potentials on the probe (y), and the transfer matrix (H), and are trying to determine the actual potentials on the endocardium (x). One method to verify that we are doing this somewhat correctly is to use a separate catheter to actually measure the endocardial potentials at a few selected points and compare these points to our estimates. The program **probe_tsvd.m** use truncated singular value decomposition to estimate the potentials on the endocardium at selected points, and compare them with actual measurements. The input to this program is the number of terms to use in the svd, and the output is a plot of the estimated and measured electrograms at various points on the endocardium and the correlation coefficients between the measured and estimated electrograms. The program also outputs a plot of the singular values. You need to try and determine the number of terms to use in the svd to get reasonable estimates, and turn in the resulting plot (include it in your word file).